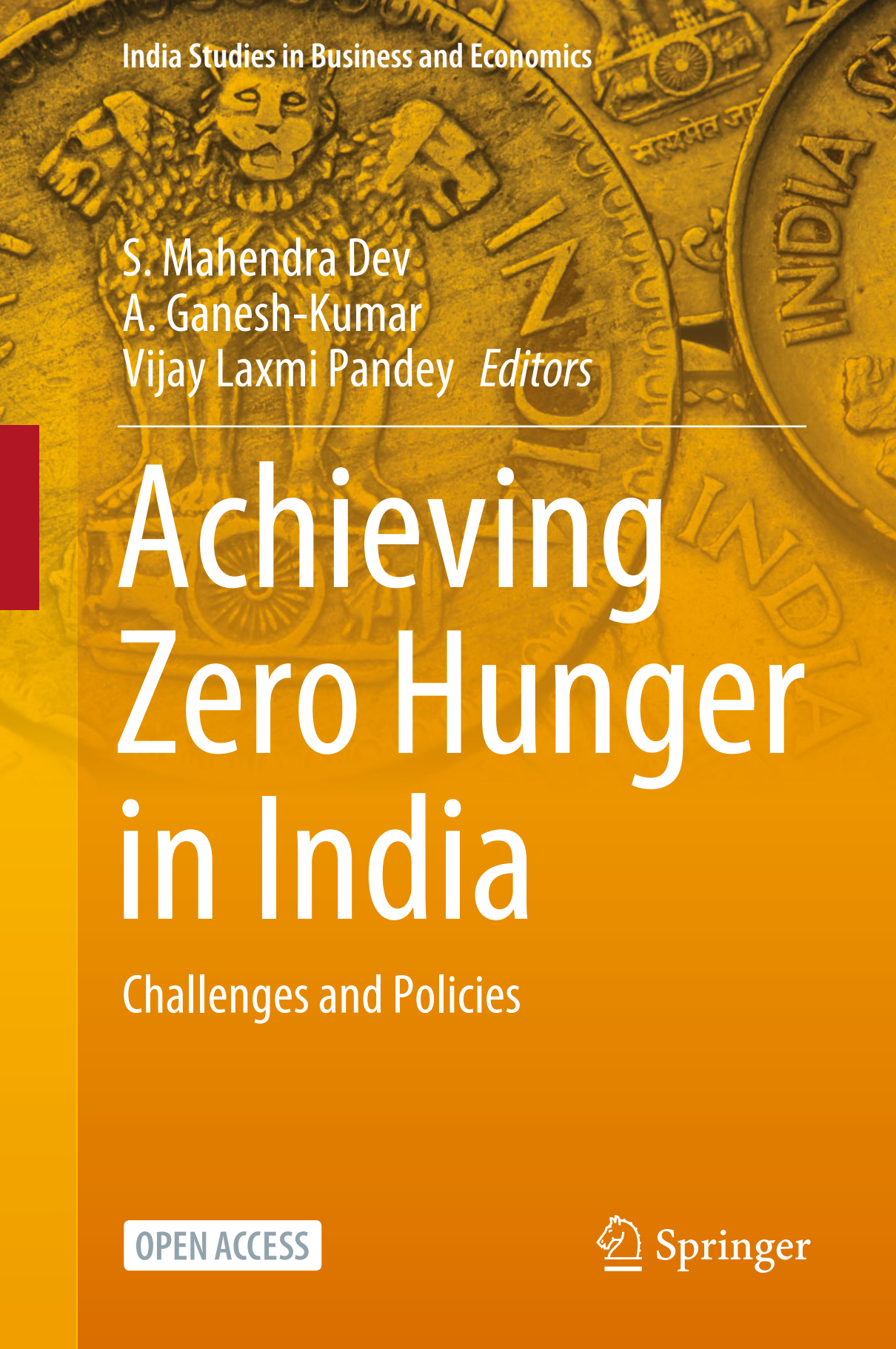

India Studies in Business and Economics
S. Mahendra Dev
A. Ganesh-Kumar
Vijay Laxmi Pandey Editors
Achieving Zero Hunger in India
Challenges and Policies
OPEN ACCESS
Springer

India Studies in Business and Economics

The Indian economy is one of the fastest growing economies of the world with India being an important G-20 member. Ever since the Indian economy made its presence felt on the global platform, the research community is now even more interested in studying and analyzing what India has to offer. This series aims to bring forth the latest studies and research about India from the areas of economics, business, and management science, with strong social science linkages. The titles featured in this series present rigorous empirical research, often accompanied by policy recommendations, evoke and evaluate various aspects of the economy and the business and management landscape in India, with a special focus on India's relationship with the world in terms of business and trade. The series also tracks research on India's position on social issues, on health, on politics, on agriculture, on rights, and many such topics which directly or indirectly affect sustainable growth of the country.

Review Process

The proposal for each volume undergoes at least two double blind peer review where a detailed concept note along with extended chapter abstracts and a sample chapter is peer reviewed by experienced academics. The reviews can be more detailed if recommended by reviewers.

Ethical Compliance

The series follows the Ethics Statement found in the Springer standard guidelines here. https://www.springer.com/us/authors-editors/journal-author/journal-author-helpdesk/before-you-start/before-you-start/1330#c14214

S. Mahendra Dev · A. Ganesh-Kumar ·
Vijay Laxmi Pandey
Editors

Achieving Zero Hunger in India

Challenges and Policies

Springer

Editors
S. Mahendra Dev
ICFAI
Hyderabad, Telangana, India

Vijay Laxmi Pandey
Indira Gandhi Institute of Development Research
Mumbai, Maharashtra, India

A. Ganesh-Kumar
Indira Gandhi Institute of Development Research
Mumbai, Maharashtra, India

ISSN 2198-0012 ISSN 2198-0020 (electronic)
India Studies in Business and Economics
ISBN 978-981-99-4412-5 ISBN 978-981-99-4413-2 (eBook)
https://doi.org/10.1007/978-981-99-4413-2

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Acknowledgements

This book is an outcome of the project 'System of Promoting Appropriate National Dynamism for Agriculture and Nutrition (SPANDAN)' sponsored by the Bill and Melinda Gates Foundation and housed in Indira Gandhi Institute of Development Research (IGIDR), Mumbai. The objective of the SPANDAN initiative is to undertake research on understanding the linkages between agriculture, nutrition and health in India, with a view towards propelling the country to achieve SDG-2 target(s). The SPANDAN research initiative led by IGIDR seeks to:

1. Build the Evidence Base to Better Understand and Strengthen Agriculture-Nutrition Pathways in India.
2. Evaluate Impact of Specific Agricultural Interventions and Policies on Nutrition Outcomes.
3. Advocacy: Bring Evidence on Strengthening Agriculture-Nutrition Linkages to Existing and New Stakeholder Policy Platforms.

The distinctive element of SPANDAN is the close interaction between experts across disciplines—development economics, agricultural economics, applied econometrics, clinical nutrition, gender, legal and anthropology—in building upon the knowledge of all partners in order to address common issues of interest. Each partner and collaborating researcher have independently worked on the issues related to agriculture, consumption, gender, and nutrition and has built a body of knowledge. As a result of this collaboration, it is expected that the research output would lead to a better understanding of the underlying issues and policymakers would be able to better appreciate the interplay between agriculture, consumption and nutrition outcomes.

The studies included in this book were commissioned by IGIDR either through open advertisement for research proposals or by invitation. Each of these studies was presented at three workshops and reviewed by experts at different stages, inception, mid-way and completion, to help the authors with comments and suggestions.

We thank all study teams and reviewers for their effort and persistence through the COVID-19 pandemic. We also thank the Bill and Melinda Gates Foundation and Ms. Shelly Sundberg in particular for the generous funding, understanding and continuous support amidst the repeated pandemic-induced disruptions to the project schedule.

S. Mahendra Dev
A. Ganesh-Kumar
Vijay Laxmi Pandey

Contents

About the Editors

Prof. S. Mahendra Dev is Distinguished Professor at ICFAI Faculty of Social Sciences, Hyderabad, Telangana, India. He was Director and Vice Chancellor, Indira Gandhi Institute of Development Research (IGIDR), Mumbai, India from 2010 to 2022. Prior to this position, he was Chairman of the Commission for Agricultural Costs and Prices, Ministry of Agriculture from 2008 to 2010. He was Vice Chairman of the Board of Trustees of International Food Policy Research Institute (IFPRI), Washington, D.C. His main areas of interest are agriculture, rural economy, rural non-farm sector, economic growth, global economy, macro policies, employment and unemployment, social protection, development economics and social sector. He published around 150 articles in national and international articles. He has written or edited 20 books.

Dr. A. Ganesh-Kumar is Professor at the Indira Gandhi Institute of Development Research (IGIDR), Mumbai. He is a Ph.D. from the Indian Statistical Institute, Kolkata. He specializes in computable general equilibrium (CGE) modelling with a focus on food security and grain management policies; issues in agricultural trade; pricing policies; spatial dimensions of Indian economy; and policies for sustainable human development and economic growth.

Dr. Vijay Laxmi Pandey is Professor at Indira Gandhi Institute of Development Research, Mumbai, India. She is an agricultural economist by training and has over 25 years of experience working in the field of agriculture and its relations with environment, nutrition, and rural economy. She has vast experience of conducting household level surveys. She has successfully completed many national and international research and consultancy projects and has a large number of research publications, which include research papers in peer reviewed journals, book chapters, a book and policy reports.

Introduction

S. Mahendra Dev, A. Ganesh-Kumar, and Vijay Laxmi Pandey

Despite a significant increase in the per capita food production in India, hunger and malnutrition are still quite high. The recent SDG Index of the NITI Aayog (Government of India, 2020–21) shows the SDG-2 Index score in 2020–21 for the country stands at 47 as against the target of 100. Indeed, in most of the SDG-2 indicators the country stands well below the target. For instance, 50.4% of pregnant women aged 15–49 years and 28.4% of adolescents aged 10–19 years are anaemic, both of which are twice their respective target levels. The indicators for children are even more alarming. The report shows that 33.4% and 34.7% of children under 5 years are underweight and stunted, respectively, as against their target values of 1.9% and 6%. Even the related indicators for agriculture production show that the country lags the targets significantly. Per hectare production of rice and wheat in the country is about 3 tonnes, whereas the target is 5.3 tonnes, and the gross value added per worker in agriculture at constant prices stood at ₹71,000 against a target of ₹122,000. The only bright spot is that the percentage of beneficiaries covered under the National Food Security Act (NFSA), 2013, is 99.5% just a shade below the target of 100%. This clearly shows that India is at a high risk of missing the target of achieving the SDG 2.1 target of zero hunger by 2030. The same NITI Aayog report also shows that there is significant variation across the States and Union Territories on all these indicators, highlighting the need to achieve food security by adopting a targeted approach for providing balanced and adequate nutrition to all citizens across the country.

Food security refers to ensuring 'that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life' (FAO, 1996). As per the

S. M. Dev
ICFAI Faculty of Social Sciences, Hyderabad, Telangana, India

A. Ganesh-Kumar (✉) · V. L. Pandey
Indira Gandhi Institute of Development Research (IGIDR), Mumbai, India
e-mail: agk@igidr.ac.in

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_1

Food and Agriculture Organization of the United Nations, there are four pillars of food security, viz., availability, access, utilization, and stability (FAO, 2006).

Given this definition of food security, achieving SDG 2 requires an integrated approach through coordination and concerted efforts from a host of stakeholders. This book takes such an integrated approach by examining diverse aspects of food and nutrition security. While being rooted largely in Economics, the book takes a multidisciplinary perspective spanning Agricultural Economics, Nutrition, Crop Sciences, Anthropology and Law.

Starting from the evolution of India's policy response for hunger and nutrition security, it examines calorie intake norms, and takes stock of the food insecurity status in some of the poorest regions of the country. It then moves on to cross-sectoral issues related to nutrition such as dietary diversity, bio-fortification, and crop insurance. Next, it explores the gender dimensions of nutrition through the lenses of gender budgeting and women's empowerment. Finally, the book provides an interdisciplinary perspective on food security relating to the socio-legal aspects of right to health, and subjective wellbeing in terms of life experience, attitude, and satisfaction.

Thus, the book reflects the diversity in disciplines in terms of the questions posed, the data sets used, the methodology followed and brings out a rich set of findings and policy recommendations for achieving the SDG 2.1 target of zero hunger by 2030. The chapters in the book are grouped into five parts covering various broad themes:

I. Food security, nutrition, hunger—policies, concepts, and measurement;
II. Status of food security in the poorest part of India;
III. Cross-sectoral impacts on nutrition;
IV. Gender dimensions of health and nutrition;
V. Inter-disciplinary perspective on food security.

In what follows, we provide the context for each of the themes, the gaps addressed by the chapters, and their major findings.

1 Food Security, Nutrition, Hunger—Policies, Concepts, and Measurement

Chronic food shortages and widespread poverty were the order of the day in India during the colonial era and for several years after Independence. Rising food production was both a necessity and policy priority for Independent India. The introduction of Green Revolution technologies was a major milestone in India's policy response to ease food availability at the aggregate level. Tracing the evolution of public policy response after independence with respect to SDG-2 covering hunger, nutrition, and food security is crucial to understand what has been achieved and what remains to be accomplished. Several indicators are used to examine the state of food and nutritional security in the light of the efficiency and environmental concerns. As the situation evolved over time, so did the concepts and policies, with overlaps between notions

of food and nutritional security, and poverty. Often these overlapping concepts and policies are overlooked by students, researchers, and sometimes even policymakers while examining the progress made. Measuring progress, however, is not without its challenges. A critical issue here is one of specifying minimum requirement norms for various nutrients against which deficiencies can be assessed. Various types of macronutrients and micronutrients in adequate amounts are required for proper functioning and growth. Specification of the adequate nutrient level for a population group is not straightforward because of inter- and intra-individual variations in nutritional need. The chapters in Part-I of the book are devoted to discussing the policies and concepts of nutritional adequacy, food security, and poverty.

In Chap. 2 titled '*Evolution of India's Policy Response to Hunger, Nutrition and Food Security since Independence*', Panda takes a walk through the history of policy response in India towards hunger, nutrition, and food security, the various concepts and measurement indicators that have guided policy, and some of the challenges that the country continues to face. Panda begins with a discussion of the various concepts that are at the base of SDG-2 such as Nutrition adequacy, malnutrition, hunger, and food security, and the related issue of poverty. After providing an overview of the policies, he then takes stock of the country's achievements relating to nutritional and food security and the continuing challenges that the country faces, the most recent being the COVID-19 pandemic and its impact. It is argued that the set of macro- and micro-level policy interventions have helped the country has made significant progress at both national- and individual-level nutrition and food security. However, the progress has come at a very high cost in terms of both fiscal and natural resources, especially water. The chapter highlights the need to evaluate policy alternatives that could be more efficient in terms of delivering benefits to the need at lower costs.

Several aspects of the nutrition situation in India remain to be answered satisfactorily. One such issue is the apparent lack of correlation between calorie intake deficiency and anthropometric outcomes on the one hand and the higher rates of prevalence of undernutrition (POU) in states that are ahead in economic and health metrics on the other. Earlier studies, while identifying these puzzling patterns, have not provided a satisfactory explanation for these phenomena. Siddiqui and Rahman attempt to provide an explanation in Chap. 3 titled '*In the pursuit of an appropriate calorie intake norm for Indian States*'.

They hypothesize that these phenomena are accounting artefacts that arise from the use of a nationally determined minimum dietary energy requirement (MDER). They argue that spatial variation in environmental and contextual factors such as epidemiological environment, health infrastructure, and level of mechanization of state economies, could cause the calorie requirement to differ spatially. People living in states with lower disease environment and better health infrastructure tend to have lower calorie intake. This pattern is consistent with biomedical literature that suggests people living in infectious environments tend to suffer from intestinal problems, which reduces their calorie absorption capacity efficacy and hence they tend to consume more calories to meet a given level of need. Similarly, with state economies showing significant differences in their structure and level of mechanization, the level of physical activity also could vary substantially, and consequently the need for

calories. For all these reasons, the calorie requirement may not be uniform across the country, and there is a need to work out state-specific calorie requirement norms. Towards establishing this, they estimate a multilevel model that combines information at the household and state levels. They use the consumption survey data for the year 2011–12 and the Survey on Drinking Water, Sanitation, Hygiene and Housing Condition 2012, both from the National Sample Survey Office.

Their results show that the economic status of a household, female-headed households, age of the head of household, access to public distribution system, and availability of cultivable land (for rural households only) all have a significant positive influence on calorie intake in both rural and urban areas. The socio-religious category of a household also matters for calorie intake in rural areas, but not in urban areas. Unlike the individual household's economic status, the state's economic status has a negative effect on calorie intake. This is because state's economic status is strongly correlated with both better health infrastructure and a higher level of mechanization. The epidemiological environment of states captured through the prevalence rate of infectious diseases has a positive effect on calorie intake. These results on the environment and contextual factors suggest that calorie requirements could vary across states.

Using the multilevel models, Siddiqui and Rahman then compute state-specific MDERs and rework the POUs. They find that the PoUs estimated using state-specific MDERs are more consistent with the economic status of the states. Further, they also show a significant correlation with anthropometric indicators of nutrition status, except wasting. These results demonstrate the need for state-specific MDERs to assess the nutrition status of individual status and hence of the country as a whole.

2 Status of Food Security in Poorest Part of India

There is a direct link between poverty and hunger; therefore, targeting the hotspots of poverty to tackle food security and hunger seems an obvious option. Bihar and Jharkhand (formed from erstwhile combined Bihar) have historically been among the most backward states in India in terms of both economic and human development indicators. This situation continues despite significant improvements in economic performance and government efforts at improving social development. The per capita state domestic product of these two states is only 36 and 62% of the national average in 2020–21, and their multidimensional poverty rates are 52 and 42%, respectively. Two-fifths of under-five children in these states are underweight compared to one-third at all-India level. A greater proportion of women in these two states are thin than in the country as a whole. And these two states hold the last two positions in terms of the composite SDG Index of the NITI Aayog (Government of India, 2020–21). All round progress in these two states, therefore, is a sine qua non for India to achieve SDG targets. Tracking the progress requires an understanding of the spatial dimensions of the problem of food insecurity at grassroots level and the strong and

weak points of policy intervention. Two chapters in Part-II of the book are focused on these two poorest states of the country.

In Chap. 4 titled '*Mapping the Food Security Situation in Rural Bihar and Jharkhand: Insights from Two Food Security Atlases*', Sharma et al. demonstrate the use of cartographic representation to locate the areas within these two states where food insecurity is alarmingly high. They explore the spatial dimensions of the three main dimensions of food security, viz., availability, access, and utilization, across the districts of Bihar and Jharkhand, and identify the regions/districts whose rural areas are most food insecure. Towards this, they draw information on 15 indicators from multiple secondary data sets covering rainfall, agricultural output, irrigation, agricultural labour, urbanization, social composition, household expenditure levels, access to roads, safe drinking water, toilets, female literacy, health care facilities, disease, and health behaviour. Using this information, they construct separate indices of food availability, food access, and food utilization at the district level. Additionally, they also construct an overall index of food security by combining three outcome indicators, viz., underweight children under age 5, women body mass index, and anaemic children in the age group 6–59 months. Using these dimension-specific and overall food security indices, they categorize the districts into five types, highly insecure, insecure, moderately secure, secure, and highly secure. Districts that are highly insecure or insecure are considered as priority districts. Finally, they use principal components analysis to identify policy variables that influence food security.

They find large inter-district inequalities across all three dimensions of food security. More than half the districts, 22 out of 38 districts in Bihar and 14 out of 24 districts in Jharkhand appear in the priority list of districts for policy attention. Among the 22 priority districts in Bihar, the situation in 8 districts (Sitamarhi, Saharsa, Banka, Madhepura, Gaya, Purnia, Araria, and Jamui.) is 'alarming' in that they are insecure or highly insecure in terms of both food security dimensions and outcomes. Of the 14 priority districts in Jharkhand, the food security situation is alarming in 6 districts (Dumka, Deoghar, Jamtara, Pakur, and Sahibganj in the Santhal Pargana region and Pashchimi Singhbhum in the Kolhan region). In these 'alarming' districts, policy attention has to be comprehensive covering both food security dimensions and food security outcomes. In the remaining districts in the priority list, policy attention is required either in terms of the food security dimensions or in terms of food security outcomes.

Sharma et al. also identify the critical variables that need policy attention. They find that the set of variables that needs to improve is not the same in both states. In Bihar, female literacy, dependency ratio, disease and health behaviour, access to toilets, non-agricultural employment, and irrigation are important for food security. In Jharkhand, however, value of agricultural output, availability of health institutions, and dependency ration are the key indicators influencing food security. Further, both states need special welfare programmes for vulnerable communities and food-insecure regions.

Bihar is predominantly rural with about 89% of its population residing in rural areas. It ranks second last in terms of SDG-2 and has a lowest overall development index among the states in India. Malnutrition continues to remain a matter of grave

concern in the state. A total of 43% of the children under the age of five were stunted and 23% of them were wasted in 2019–21 according to National Family and Health Survey-5. Food insecurity is a complex phenomenon having multipronged dimensions with an important element of malnutrition and poor health. The diversified food consumption is a proxy indicator of food and nutrition security.

Chap. 5 titled '*Food Security in Rural Bihar: Some Findings from a Longitudinal Survey*' by Dutta et al. analyses the status of food and nutritional security in rural Bihar since 1998. The study is based on a longitudinal survey conducted by the Institute for Human Development. Using this survey, they evaluate the changes in household expenditure on food items in rural Bihar during 18 years across various socio-economic groups along with households' perception on food security. Additionally, they conducted a rapid telephonic survey to understand the impact of COVID-19 on households' food security and the effectiveness of the government programmes in supplementing food and nutrition shortages. They have measured food security using four indicators, viz., Household Dietary Diversity Score, Food Frequency Score, Household Food Insecurity Experience Scale and Recommended Dietary Allowance.

Dutta et al. find that there is a need of expending the food basket. Households predominantly depend on cereals and vegetables to meet their energy and nutrient requirements, with relatively low consumption of other food items such as pulses, fruits, edible oils, milk, and other protein-rich food items. Over one-third of the households have low dietary diversity, i.e. they consume only 4 food groups out of 12 food groups. Shift in the cropping pattern from cereals towards millets and other food items (oil seeds, vegetables, etc.) is required for improving dietary diversity. Access to kitchen gardens (household or community) can greatly help in improving the dietary diversity of households. Migration has played an important role in improving the food security of the rural population. However, COVID-19 adversely affected migrant households much more than non-migrant households.

They also identify that there is significant scope in further strengthening PDS by eliminating the exclusion of beneficiaries and gradually including pulses, millets, edible oils, etc. The Mid-Day Meal Scheme and ICDS also need improvement in their functioning. For better utilization of consumed food, there is an urgent need to improve water and sanitation situation to tackle malnutrition in Bihar.

3 Cross-Sectoral Impacts on Nutrition

Nutritional outcomes are known to be influenced by several factors that cut across diverse sectors of the economy and through multiple cross-cutting channels. These factors could be on the demand side relating to the consumption pattern, especially the intake of nutritionally rich and desirable food items or could be on the supply side influencing the availability of various food items. The three chapters in Part-III of the book explore some of the cross-sectoral impacts on nutrition.

One aspect of the malnutrition problem among children in India is the high prevalence of stunting, which decreased a measly 3 percentage points between 2015 and

2019–21. Milk being an animal-sourced food (ASF), is known to play an important role in the growth of young children. Unlike other ASF such as meat or even eggs, milk is widely accepted even by vegetarians and is an important constituent of the diets of most Indians, with the exception of some tribal populations. Despite this, rigorous analysis of milk consumption patterns and its association with nutritional outcomes, in particular stunting among children, is lacking. Several questions remain open to rigorous analysis. For instance, what is the milk consumption frequency and pattern across age groups, gender, locations (urban vs. rural), and socio-economic groups? What are the factors that influence the probability of milk consumption? Does bovine ownership and breastfeeding status matter for milk consumption? And finally, what is the nature of association, if any, between milk consumption and nutritional outcomes, in particular stunting among children?

Viswanathan and Purohit explore some of these questions in Chap. 6 titled '*Milk Consumption Pattern of Young children: A Relook at the Indian Evidence*'. They use data on Consumption Expenditure for the year 2011–12 from National Sample Survey Organisation (NSSO) and the National Family Health Survey-4 for the year 2015–16 to analyse the milk consumption patterns and to explore the nature of association, if any, between milk consumption and nutritional outcomes with a focus on stunting among children. The authors focus on milk consumption of children in the age group 6–23 months as their nutrient intake during the first 1000 days has long-term impacts on their growth.

The data shows several interesting patterns on milk consumption. Among the households that report milk consumption, the modal frequency of milk consumption is twice per day, even though about two-thirds of children in rural areas and over half the children in urban areas have not consumed milk in the past 24 h. Currently breastfeeding children is high among children in the 6–23 months age group, and it declines relatively slowly with age in rural areas than in urban areas. Milk consumption by children in the last 24 h is significantly higher for better-educated mothers, increasing from 33% (38%) for no education to 52% (58%) for secondary and above education in rural (urban) areas. Looking across economic classes, breastfeeding declines as wealth index rises, but reverse pattern is observed with regard to milk and dairy products consumption. To understand the rich–poor gap, Viswanathan and Purohit estimate a series of logit models that control for several of these covariates. These estimates show that the odds for milk consumption in the last 24 h are 3–4 times higher for richer children in rural areas than children from the poorest households and that this gap declines when controlled for mother's education level and milk availability.

To understand the frequency of milk consumption, Viswanathan and Purohit estimate the Zero Inflated Poisson (ZIP) model to allow for the high number of zero consumption reported in the data. The ZIP model estimates show that currently breastfed is positively associated with no milk consumption, while consumption of other food items in the last 24 h is negatively associated. Further, mother's education level, bovine ownership, and economic status are positively associated with milk consumption. The ZIP model also shows that the frequency of milk intake increases

with age of the children, mother's education, and economic status, while currently breastfeeding reduces the frequency.

Finally, to explore the association between milk consumption and height-for-age Z-scores (HAZ) Viswanathan and Purohit estimate linear regression models allowing for the possibility that frequency of milk consumption could be endogenous due to its association with other socio-economic variables and controlling for child, mother, household, and regional characteristics. The results show that each frequency of milk consumption is significantly positive and that the effect is larger at higher frequencies. Interestingly, bovine ownership of milk availability in the district is not directly associated with HAZ, though they are good instruments for milk consumption frequency.

India has recently experienced triple burden of malnutrition consisting of micronutrient deficiency along with undernutrition and obesity (Jain & Agnihotri, 2020). This issue of the triple burden of malnutrition is relatively new and is not sufficiently discussed in the academic literature (Kumar et al., 2021). Therefore, there is a need to map the prevalence of the triple burden of malnutrition and the factors affecting the malnutrition in India.

The country attempts to address the malnutrition problem through several measures. The measures like income and food supplements by the central and state governments already exist; however, long-term strategies are required to tackle the issue sustainably. Bio-fortification is a promising strategy in this line. Biofortification improves the nutritional content of food crops through breeding or genetic engineering (Nestel et al., 2006; White & Broadley, 2005) and is cost-effective (Meenakshi et al., 2010), more sustainable than nutrient supplementation (Bouis, 1999). Nevertheless, the adoption of released biofortified crop varieties at farm level is quite minimal. Considering the vast potential that this technology holds in tackling the issue of malnutrition, there is a need to understand the impact of biofortified crops in improving the health outcomes of children and women and to solicit consumer's awareness, perception, and willingness to pay towards it. Singh et al. seek to do this in Chap. 7 titled '*Exploring the prevalence of undernutrition and consumers' knowledge, preferences, and willingness to pay for bio-fortified food*'.

The authors use data from National Family Health Survey (NFHS-4 and -5) fact-sheets to analyse the malnutrition status at national, state, and district levels. Three malnutrition indices (Normalized Child Malnutrition Index (NCMI), Normalized Adult Malnutrition Index (NAMI), and Combined Normalized Malnutrition Index (CNMI)), were constructed and used to compare the performances between NFHS-4 and -5 across the states. To identify the factors determining the malnutrition incidence in India, a district-level multivariate regression analysis was undertaken.

To understand the utility of biofortified crops in improving the health outcomes of children and women, a systematic review and meta-analysis was undertaken. An ex ante assessment of the health benefits of biofortification through the case of rice biofortification with zinc was also carried out. Further, to solicit the consumers' acceptance, a cross-sectional survey was conducted to assess consumers' awareness, willingness to pay for biofortification, and its benefits.

The study reports that country has made a moderate improvement in reducing the incidence of stunting, wasting, and underweight in children and the incidence of thin adults. The issue of obesity and anaemia has emerged as significant concerns. The northern and southern regions of the country were identified to be better nourished in general than the eastern and western regions. The malnutrition hotspots using district-level maps were also identified. With respect to determinants of malnutrition in children under 5, electricity access, sanitation facility, use of iodized salt, women's education, and institutional birth had a negative and statistically significant relationship with stunting. In contrast, the women with BMI below normal showed a positive relationship with stunting. For wasting, the socio-economic variables and the variables on mothers' health and child nutrition immediately after birth significantly affected the prevalence. The results point that mothers' nutrition is a crucial determinant of child nutrition. Women's education also helps reduce the incidence of malnutrition indicators.

The meta-analysis shows a positive impact of consumption of biofortified food on nutritional outcome of women and children. The ex ante health benefits assessment of biofortification reveals almost doubling zinc intake without increasing rice consumption. A savings of lost DALYs to the extent of 5.25 million is estimated by consuming biofortified food by the target population. However, awareness for biofortified food was less than 40% and a sizable number of respondents believed that biofortified foods are harmful to humans and the environment. The results reiterate the importance of biofortification programmes and help to determine the future course of action in intervention studies and points towards an urgent need for creating awareness among the consumers.

Weather-related shocks and stresses in agricultural production can affect small-scale as well as large-scale enterprises in rural areas. During times of production losses and related income crisis, farmers may resort to choosing low-risk or low-return crops and inadequate production methods. It may also affect the inter-temporal resource allocation, such as reducing food consumption or the use of healthcare services, or the withdrawal of children from school, which may eventually erode their future-earning capacity, aggravating their vulnerability and perpetuating the vicious cycle of poverty.

Crop insurance (CI) can play a critical role not only in mitigating crop production-related uncertainties a farming household may face during a particular cropping season but may also reduce the cost of risk-bearing to stabilize farmer's income over time. CI as a shock absorber can help the agricultural households in maintaining a threshold amount of consumption and demand for health services especially for women. However, in India, a large section of the farmers lacks proper insurance services.

The available literature generally focuses on the demand for CI and its impact on input use and also on food security. However, there is a need to focus on identifying the effect of CI on health-seeking practices and nutritional outcomes of the vulnerable populations, pregnant women and children. Sengupta and Rooj address this issue in Chap. 8 '*Does Crop Insurance Promote Nutrition and Good Health among Women and Children in the Agrarian Households of India?*'.

The authors focus on several measures of health-seeking practices, including prenatal and postnatal health care variables. Both secondary and primary data analysis is carried out to ascertain the effect of crop insurance adoption on women's health-seeking behaviour during pregnancy and household and child nutritional statuses. The study based on secondary data uses district-level data on crop insurance adoption paired with individual-level data on health outcomes to assess the role of crop insurance on the health-seeking behaviour of women in their reproductive age. The crop insurance information from the NSSO (70th round) aggregated at the district level, and women health care use information and child nutritional status from DLHS-4 at the individual level were merged using district identifiers to obtain comprehensive data containing individuals matched across different districts. In addition, a primary survey was conducted in 400 households from two districts of Bihar to examine the impact of government's income support programme on health-seeking practices by households, women, and children and food security.

The analysis indicates that crop insurance has substantial implications for women's of reproductive age in their healthcare-seeking practices. The women in districts with higher crop insurance adoption seek more antenatal care and are more likely to opt for institutional delivery and receive postnatal care in a private facility. The primary survey data analysis reveals that households who are beneficiaries of the PM-Kisan Samman Niddhi Yojna report a greater level of food security. Women from beneficiary households seek higher early antenatal care and children received higher immediate postnatal care in these households. Thus, crop insurance and income support programmes provide a hedge against crop loss and positively impact food security, healthcare-seeking practices by women in their reproductive age, and improves child nutritional outcomes.

4 Gender Dimensions of Health and Nutrition

Gender equality is a fundamental human right, and a necessary foundation for a peaceful, prosperous, and sustainable world. Therefore, achieving gender equality and empowerment is one of the goals of the Sustainable Development Goals (SDGs). The role of gender equality and empowerment to achieve food and nutrition security is well recognized. In Part-IV of the book, the gender dimensions of health and nutrition are explored.

Given the challenges in reducing gender inequality, there was a global consensus at the Fourth World Conference on Women in 1995 to integrate a gender perspective in budgetary policies of the countries. Gender budgeting or gender responsive budgeting (GRB) is defined as 'an approach to budgeting that uses fiscal policy and administration to promote gender equality, and girls' and women's development' (Stotsky, 2016). There are different approaches towards GRB and they have continuously evolved across countries in the framework adopted. The gender budgeting has been observed to be closely interlinked with economic development in emerging

economies (Nolte et al., 2021). Although there is large literature on defining, implementing, and justifying gender budgeting, there are very few resources on measuring its performance and impact on health outcomes.

In Chap. 9 '*Are gender budgets necessary for reducing inequalities in health outcomes*' Gupta et al. try to address this gap by looking into whether selected major health outcomes improved in countries that adopted GRB and one did not adopt GRB. The chapter also explores and attempts to understand the impact of GRB adoption by India on health inequalities and other possible factors affecting gender inequalities in health sector. The authors explore four indicators, viz., gender inequality index, maternal mortality ratio, all-cause mortality ratio for males and females, and treatment-seeking behaviour by gender, to understand the possible health impact. To understand whether government efforts in adopting GRB have translated into better outcomes, the good governance index was used to track India's progress in reducing gender gaps.

They argue that to bridge the gender inequality gap in health outcomes there is a need to upsurge the resources for health and universal health care (UHC). Countries that have been able to increase their health spending and expand UHC have made good progress on health outcomes and inequalities. It is possible to expand UHC through higher health allocations by governments, with the associated reduction in out-of-pocket spending. It is suggested to emphasize gender-responsive budgeting (GRB) in fewer targeted areas such as labour markets, political empowerment, and specific programmes targeting genders, instead of forcing all allocations to follow GRB guidelines.

Despite much higher growth rates and a larger GDP, India fares poorer on women's undernutrition compared to several sub-Saharan African countries (Coffey, 2015). The 'dual burden' problem, and the much larger incidence in rural areas are important characteristics of the nutrition status among Indian women. In 2015–16, in the country as a whole 23% of women were underweight and 21% overweight, while in rural areas 27% were underweight and 15% overweight. Importantly, while the underweight percentage is declining, the obesity problem is rising even among the poor. In the literature, access to food, agricultural income and prices and feminization of agriculture are seen as important pathways linking agriculture to nutritional outcomes. Feminization of agricultural labour force is expected to improve women's empowerment, which in turn would enable them to influence household decisions in a manner that positively impacts the nutritional and health status of all household members, especially the girl child and women themselves. Intersectional inequalities in different dimensions such as gender, region, religion, caste, and class, are known to affect health and several other developmental outcomes.

In Chap. 10 titled '*Revisiting Women's Empowerment as an Agriculture-Nutrition Pathway Using the Framework of Intersectionality*', Mukhopadhyay brings a new perspective of intersectional inequalities to examine the question of women's empowerment and how it affects the agriculture-nutrition pathway. The author examines how empowerment of women in agricultural households varies across social dimensions, and how these intersectional inequalities shape empowerment and nutritional

outcomes. The study makes use of the second round of the India Human Development Survey (IHDS) for the year 2011–12.

The study covers two social dimensions: (a) economic class measured as per capita income quintiles out of which the bottom two quintiles are treated as poor and the rest of the quintiles as non-poor; and (b) social groups defined along caste and religious lines. Based on the economic class and the social groups, 10 intersectional categories are then developed for the study. Women's empowerment is measured using three indices: (i) Survey-based Women's emPowERment index (SWPER) that looks at the attitude towards women in a parsimonious way; (ii) Index of Women's Empowerment (IWE), which is a more detailed measure covering economic domain, human resources, social resources, decision making within households including relating to sexual/reproductive domain, attitude towards socio-cultural norms and phenomena; and (iii) Index of Women's Empowerment in Nutrition (IWEN) covering aspects such food (knowledge, resources, and agency), health (knowledge, resources, and agency), institutions (membership, participation, access to information and services), and fertility (knowledge, resources, and agency).

Kernel density plots suggest that SWPER is bimodal, while IWE and IWEN are multimodal, and all three of them are positively skewed. The author then estimates quantile regression models to capture the effect of intersectionality on these empowerment indices. These regressions show that the way empowerment is measured can affect the conclusions drawn. For instance, women belonging to Brahmin agricultural households are worse off than women from other social groups according to SWPER, whereas this finding does not hold true when empowerment is viewed through IWE or IWEN. The latter two being more comprehensive bring out the role played by intersectional inequality on other dimensions such as resource and access, on women's empowerment. Logistic regressions estimated by the authors to study the association between empowerment and women's health status, however, do not give clear results. While BMI is higher for women with higher empowerment scores as expected, the results also show that higher values are IWEN and do not necessarily reduce the likelihood of being overweight.

5 Inter-Disciplinary Perspective on Food Security

Thus far, the chapters in Part-I–IV of the book essentially add to the knowledge base on the issues of hunger and nutrition from the perspective of economics as a discipline. The way the questions are posed in these chapters, the literature that they refer to, the analytical methods that they use, and the policy messages that they bring to fore all have an economics flavour. But the issues of hunger and nutrition have been studied by other researchers from disciplines as well. In the final Part-V of the book two such inter-disciplinary perspectives are brought to fore. One from the perspective of law/legal studies, and the other from anthropology.

Urban poor are affected by chronic poverty and are highly vulnerable to different forms of shocks, including those arising from pandemic. It has been reported that

by 2035 the majority of individuals in extreme poverty will live in urban areas (UN, 2019). Urban centers are characterized by cash-based economies and access to an income is therefore essential for household food and nutrition security.

India is bound to ensure food security and health for all under the Constitution of India and the other national legal frameworks. However, inadequacies in the nation's obligation to guarantee availability and accessibility of quality food to ensure physical wellbeing to all are being evident from its position in the recent Food Security Index, as well as Health Index. Consequently, there is a need to analyze the status of food insecurity and its impact on urban poor under a legal framework and success of the Government initiatives with reference to SDGs.

Keeping this in mind in Chap. 11 Shanthakumar and Dhanya explore the '*Socio-legal Analysis of the Impact of Food Insecurity and Hunger on Right to Health of Urban Poor Living in the State of Gujarat*'. They aim to analyze the status of food insecurity and its impact on urban poor living in Gujarat, and also the journey of 'right to food' as a fundamental human right under the Indian Legal system and success of the Government initiatives with reference to Sustainable Development Goals.

The authors have adopted both doctrinal and empirical methodologies. The primary survey data was collected from 400 urban poor in five districts of Gujarat for understanding the perception of respondents towards food insecurity. The study points out that the government action has failed to tackle the food insecurity issues faced by the urban poor in Gujarat because the entire focus is on the rural population. The authors suggest that a reasonable interference can be attuned to the prevailing situation, including appropriate food accessibility. The approach administered should be suitable and dealing with the elements of food insecurity, alongside the indispensable political adhesion to attain required success.

The analysis of primary survey data of urban poor shows very low awareness and accessibility to food security schemes. The majority among the surveyed category of respondents was migrant workers, they were out of reach of access to free ration schemes. In addition, the urban poor faced challenges like unavailability of clean drinking water, shelter, clothing, quality education, healthcare, and many other basic needs. The authors also reported that almost 90% of respondents agree that they consume less food and are unable to feed their children enough food due to lack of money. In times of food crisis especially during the lockdown due to COVID-19 pandemic, less than 10% of the respondents turn to government for assistance and almost half of the respondents (47%) have gone without food for two days.

To improve implementation of the schemes/programmes it is being suggested to take necessary steps to expand the coverage of existing welfare schemes to include migrant workers also. The implementation of 'One Nation One Ration Card Yojana' needs to be expedited, adequate number of awareness programmes needs to be initiated, and educating the urban poor about the formalities to be furnished to avail such benefits are required. More decentralized approach is required to the implementation of the welfare schemes on food, nutrition, and healthcare.

Wellbeing has been conceptualized differently because of its multidimensional nature. Even though the perspective towards wellbeing is totally relative, it is basically

connected with one's attitude towards quality of life (subjective wellbeing) and life circumstances. Particularly, in societies where economic activities are collective and cooperative endeavours, subjective and collective wellbeing are complementary to each other, such as in fishing societies. Therefore, looking into wellbeing from anthropological lenses is required to place individual life experiences and personal conceptualizations as significant factors from the perspective of culture and socio-ecological settings. In this context, it seems necessary to explore, what people think about wellbeing as rooted in the world of values construed by a unique cultural tradition such as marine fisher-folk societies from an anthropological perspective. Chapter 12 titled '*Subjective wellbeing of women in the Marine fisherfolk of Kerala: Anthropological insights on Life experience, Attitude and Life satisfaction*' by Ramachandran, explores both objective and subjective factors for explaining the state of wellbeing experienced by the women in marine fisherfolk of Kerala.

In societies like marine fishers where subsistence is based on unpredictable resources the infrastructural facilities, supportive environment, certainty in economy, access to non-economic resources, and life experiences are reported as some of the factors substantiating life satisfaction and wellbeing to both women fisherfolk and at community level. For analyzing the mediating effect of three socio-cultural domains such as life experience, attitude, and life satisfaction on different aspects of subjective wellbeing, a primary survey was undertaken. The primary data was collected using questionnaire from 310 women from the marine fisherfolk families in Kozhikode district of Kerala. The questionnaire included a total of 65 closed-ended questions with both binary and multiple responses.

The study reveals that a state of wellbeing for an individual is influenced by support from family along with the intervention of government and other agencies which can provide sustenance in the spheres of education, employment, health, and other infrastructural facilities. The creation of a positive attitude is vital in sustaining aspirations towards one's own wellbeing and the subsequent involvement in sustaining livelihood activities with anthropogenic management of resources.

6 Way Forward

As would be evident, the chapters in this book cover a wide spectrum of issues and come up with several policy recommendations. Some of the important policy messages are as follows:

i. There is a need to revisit the calorie norms so that the magnitude of hunger and food insecurity is more accurately accounted.
ii. Policy interventions must distinguish between supply-side constraints to food availability and demand-side factors that affect household access and utilization.
iii. The government should also identify regions that are food insecurity hotspots and have targeted programmes for those regions.

iv. Dairy consumption and biofortification are effective means to address malnutrition.
v. Crop insurance that protects farmers against losses improves health-seeking practices of women at reproductive age, and this improves child nutritional outcomes.
vi. In the current Indian situation where the overall public expenditure on health is low, gender-responsive budgeting is not as useful as expanding the overall resources available for health and making it universal.
vii. Existing welfare programmes need to effectively address the needs of marginalized sections of the population such as migrant workers and urban poor for which decentralization of their implementation is required.
viii. Even as there is a continuous need to improve public welfare programmes from time to time as the context change, it must be recognized that these programmes are not a substitute for family support that is essential for an individual's state of wellbeing. These programmes can at best complement the family support.

Going forward to address the issue of food availability, we need to emphasize reducing post-harvest losses and food wastages along with other factors such as improving productivity, developing climate-resilient crop varieties, etc. Post-harvest losses and food wastages undermine the sustainability of the food systems, as all the inputs of production (such as water, energy, capital, etc.) invested towards the lost and wasted food go to vain. With its hunger and malnutrition, a country like India cannot afford to let such precious resources be wasted.

Further, accessibility to good quality food for balanced and adequate nutrition can be attained by improving the purchasing power of marginalized people, ensuring legal entitlements, and demonstrating genuine political will (FAO, 2008). We are still grappling with pandemic-induced uncertainty and food insecurity, which is further fuelled by the series of shocks such as increased events of climate extreme, rising inflation, and energy crisis in most parts of the World. The ongoing Ukraine-Russia war has added to food insecurity in many countries by disrupting the food supply chains. Therefore, there is a '*need to have new institutions and frameworks, like a global agricultural trading system with sustainable supply chains as part of its mandate. Moreover, in the food and agriculture field, an institution that provides a clear structure for the interaction of science and policy, like IPCC in climate policy* (von Braun, 2022)'.

There is a need to understand food and nutrition security from a multidisciplinary perspective. The apparent lack of correlation between calorie intake deficiency and anthropometric outcomes, and the higher rates of prevalence of undernutrition in economically developed states, can also be examined from the concept of homeostasis in biology. Emerging research suggests that many individuals have a relatively stable set point for their body weight throughout adult life. Understanding of this set point of homeostatic (stabilizing) system that maintains the body's energy balance against fluctuations in food intake is needed in the context of utilization of food (Munshi, 2022). Additionally, the important role of media in building awareness and influencing public opinion through effective and responsible messages and

reporting cannot be ignored. A strong and credible media can help people make informed decisions concerning all the four dimensions of food security.

References

Bouis, H. E. (1999). Economics of enhanced micronutrient density in food staples. *Field Crops Research, 60*, 165–173. https://doi.org/10.1016/S0378-4290(98)00138-5

Coffey, D. (2015). Prepregnancy body mass and weight gain during pregnancy in India and sub-Saharan Africa. *Proceedings of the National Academy of Sciences, 112*(11), 3302–3307.

FAO. (1996). *Rome declaration on world food security and world food summit plan of action.* World Food Summit 13–17 November 1996. Food and Agricultural Organization of the United Nations.

FAO. (2006). *Policy brief*. Agriculture and Development Economics Division, Food and Agricultural Organization of the United Nations.

FAO. (2008). *Climate change and food security: A framework document*. FAO.

Government of India. (2020–21). *SDG India index & dashboard 2020–21. Partnerships in the decade of action.* NITI Aayog, Government of India and United Nations.

Jain, A., & Agnihotri, S. B. (2020). Assessing inequalities and regional disparities in child nutrition outcomes in India using MANUSH—A more sensitive yardstick. *International Journal for Equity in Health, 19*, 138. https://doi.org/10.1186/S12939-020-01249-6

Kumar, P., Chauhan, S., Patel, R., et al. (2021). Prevalence and factors associated with triple burden of malnutrition among mother-child pairs in India: A study based on National Family Health Survey 2015–16. *BMC Public Health, 21*, 1–12. https://doi.org/10.1186/S12889-021-10411-W/FIGURES/3

Meenakshi, J. V., Johnson, N. L., Manyong, V. M., et al. (2010). How cost-effective is biofortification in combating micronutrient malnutrition? An ex ante assessment. *World Development, 38*, 64–75. https://doi.org/10.1016/J.WORLDDEV.2009.03.014

Munshi, K. (2022, December 21–23). Economic development, undernutrition and diabetes. In Keynote Address in the *Second Biennial Conference on Development—Sustainable Development Goals amidst Multiple Global Shocks: Progress, Challenges and Way Forward*. Indira Gandhi Institute of Development Research, Mumbai.

Nestel, P., Bouis, H. E., Meenakshi, J. V., & Pfeiffer, W. (2006). Biofortification of staple food crops. *Journal of Nutrition, 136*, 1064–1067. https://doi.org/10.1093/JN/136.4.1064

Nolte, I. M., Polzer, T., & Seiwald, J. (2021). Gender budgeting in emerging economies–a systematic literature review and research agenda. *Journal of Accounting in Emerging Economies.*

Stotsky, M. J. G. (2016). Gender budgeting: Fiscal context and current outcomes. *IMF Working Papers: 1–50.* International Monetary Fund.

United Nations. (2019). *Over 820 million people suffering from hunger; new UN report reveals stubborn realities of 'immense' global challenge*. UN News. https://news.un.org/en/story/2019/07/1042411.

von Braun. (2022, December 21–23) The 2021/22 food crisis—Causes, impacts, and the way forward. In Keynote Address in the *Second Biennial Conference on Development—Sustainable Development Goals amidst Multiple Global Shocks: Progress, Challenges and Way Forward*. Indira Gandhi Institute of Development Research, Mumbai.

White, P. J., & Broadley, M. R. (2005). Biofortifying crops with essential mineral elements. *Trends in Plant Science, 10*, 586–593. https://doi.org/10.1016/J.TPLANTS.2005.10.001

Food Security, Nutrition, Hunger—Policies, Concepts and Measurement

Evolution of India's Policy Response to Hunger, Nutrition, and Food Security Since Independence

Manoj Panda

1 Introduction

In recent decades, there has been a renewed concern regarding widespread prevalence of malnutrition and food insecurity in the world despite fairly high economic growth in several countries comprising most of the global population. In 2015, the global community of 193 sovereign nations committed to the United Nation's 2030 Agenda for Sustainable Development that contained 17 Sustainable Development Goals (SDGs). Earlier at the turn of the century, the Millennium Summit of the United Nations had set eight Millennium Development Goals (MDGs) to improve the wellbeing of the world's poor population and the first of the MDGs related to a substantial reduction in poverty and hunger. As NITI Aayog (2019) states the SDGs 'substantially reflect the development agenda of India'. The SDGs consider poverty and nutrition as two separate goals because the two are distinct, though related, problems. SDG 2 aims to 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture'.

According to the State of Food Security and Nutrition in the World 2020 report,[1] about 690 million or 8.9% of the world's population were undernourished in 2019 and almost all of them resided in developing countries. A more worrisome point is the evidence that the number of people affected by undernourishment has been increasing since 2014 and the world is not on track on SDG 2. Further, the COVID-19 virus-induced depression in the world economy in 2020 led to the loss of job

[1] FAO, IFAD, UNICEF, WFP, and WHO (2020).

The author is thankful to A. Ganesh Kumar and Bijaylaxmi Pande for comments on an earlier draft presented in the IGIDR Webinar in February 2022.

M. Panda (✉)
Formerly at Institute of Economic Growth, Delhi, India
e-mail: pandamanoj2021@gmail.com

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_2

and income by a sizable section of people resulting in serious problems in access to adequate food and deterioration in nutritional security.

During the colonial era, India witnessed repeated shortage of food production due to the absence of a systematic long-term policy to meet frequent droughts. Millions of people have been reported to have died in several famines between 1769 and 1943. After its independence, the Indian government's declared policy response laid priority on increasing aggregate food production. The situation did not improve much and aggravated in the mid-1960s due to two consecutive drought years. Assistance from the United States under Public Law (PL) 480 for food aid against rupee payments was particularly helpful then since foreign exchange was also in short supply. This crisis helped to introduce what is known as the green revolution which was a success within a few years. Once adequate aggregate production materialized in the country at the macro level, attention of public policy shifted to several other areas such as household access to adequate food, enhancing purchasing power, composition of food basket, production of protein- and vitamin-intensive food items, and improvement in sanitary conditions. This paper evaluates Indian policy response after independence in different areas related to SDG-2 covering hunger, nutrition, and food security.

We may begin with a few basic background features of India. As per census data, India's population grew from 361 million in 1951 to 1210 million in 2011. It is estimated to be 1355 million in 2020 compared to 1402 million in China in the same year and is likely to surpass China as the most populous country within a few years. India's population predominantly resides in rural areas, but urbanization is growing fast. The rural share has fallen from 83% in 1951 to 69% in 2011. India's total population is projected to reach 1.64 billion by 2050 and more than half of them are likely to live in urban areas.

India followed a mixed economy model with a major role in the public sector till 1990. Industrial activities were extensively regulated with high tariff barriers. Real Gross Domestic Product (GDP) grew at a low rate of about 4% (2% in per capita terms) for four decades till 1991 when India adopted market-friendly economic reforms. Growth picked up slowly after the reforms and the average GDP growth rate remained close to 7% during 1992 and 2019. Its average level of living at $2100 in 2019 is still way below the world average of $11,000. In PPP terms too, India's per capita income at Int$ 7800 is less than half of the world average. In terms of the Human Development Index, India ranks 131 among 189 countries in 2019 reflecting a low social development process.[2] Life expectancy at birth stands at 69.7 years and literacy rate at 78% in 2019.

Section 2 explains the concepts of adequate nutrition, food security, and poverty. Section 3 describes the evolution of public policy responses for provision of nutrition and food security in India since independence. This section also discusses some major programmes undertaken by the government. Section 4 makes an evaluation

[2] There are large variations in human development attainment across states in India. It is well recognized that achievement in the state of Kerala has been comparable to those of some of the developed nations.

of achievements in various dimensions of food and nutritional security. Section 5 relates to way forward. Section 6 makes some concluding observations.

2 Concepts of Nutritional Adequacy, Food Security and Poverty

Nutrition Adequacy and Malnutrition

The human body needs various types of nutrients such as calories, protein, fat, and several vitamins and minerals in right amounts for proper functioning and growth. The food we take must provide all essential nutrients in the required amount. Malnutrition refers to a condition of health disorder that occurs due to lack of sufficient amounts of some nutrients. A household is nutrition secured if none of its members is malnourished.

Based on the requirement of nutrients and the nutritional contents of food items normally available and consumed in different countries or regions, nutritionists recommend diet baskets for different groups of the population classified by their age, sex and activity. These baskets meet the major nutrients in desired levels. But, specification of the adequate nutrient level for a population group is not simple because of inter- and intra-individual variations in nutritional need. Consider, for example, calories which are required for carrying out various activities, including metabolic activities when a body is at rest. Calorie need of a person is not fixed but varies over a large range depending on not only the age and sex of the person but also on physical activities,[3] body weight and climatic conditions. Further, nutritionists point out that there is considerable variation in calorie intake of an individual from one day to another even when she/he is engaged in similar work and maintains body weight. The human body has an adaptation mechanism which means that calorie requirement varies from one day to another for the same person engaged in similar kind of activity depending on the intakes (Sukhatme, 1978, 1981). Human body maintains energy balance by adapting through an auto-regulatory 'homeostasis' system and hence calorie needs of people are better viewed by means of a probability distribution.

Now, let us denote the mean calorie need of an individual in a given age–sex–activity group by m and the standard deviation by s in calorie intake distribution of a healthy and active population of this group. Consider a person p with observed intake level x averaged over a short period of a few days. If x falls short of the recommended average m of the group the person p belongs to, it does not necessarily mean the nutritional need of the person is not met. But, if x falls below the minimum of the required range, we may conclude that there is overwhelming statistical evidence that the nutritional need of the person is not met. Under the assumption that nutrient

[3] The recommended calorie range for an adult man, for example, varies from 2320 to 3490 depending on activity status (ICMR, 2010).

requirement of individuals belonging to a group follows normal distribution, and observed nutrient intake x falls below m-2.s level, we may conclude that she/he will not be meeting the calorie need with a high probability of 95%. In such a case, the person may be defined as an undernourished. Similarly, obesity might be defined as intake above m+2.s level.[4] Malnutrition may then be operationally defined as a condition when certain nutrients are less than or in excess of the required range.

Nutritionists recommend calorie need considering the observed average calorie expenditure levels among healthy and active population groups. The recommended dietary allowances (RDAs) are meant for the average nutrients per day for a population group and cannot be used to judge nutritional adequacy of an *individual* which is best judged by the range approach discussed above.

Some groups of the population such as pregnant or lactating women, children, and the elderly have high risk of malnutrition in the developing world. More than half of child death is attributed to malnutrition in these countries. Several women do not receive the supplementary diet they need during pregnancies and breastfeeding. When mothers do not receive adequate nutrients, children can be at the risk of malnutrition even before birth. Elderly people face higher risk of malnutrition because of changes in appetite, chewing problem, and dependency on others.

Consequences of malnutrition could be grave in various ways. Severe deficiency of Vitamin A and iodine leads to blindness and goiter, respectively. Malnourishment adversely affects the immunity system of a person and risk of contracting infectious diseases rises. Childhood malnutrition is considered as the single most factor responsible for child mortality. Some estimates show that eliminating childhood undernutrition could reduce child mortality by half and the burden of diseases by about 20% (Murray & Lopez, 1997; Pelletier, 1994). Child undernutrition not only puts children at a greater risk of disease vulnerability but also adversely affects physical and cognitive development of children (Barker, 1995).

Nutrition deficient individuals suffer from illness and inactivity resulting in low work capacity and income at work. Low income or purchasing power in turn contributes to poor nutrition. Thus, a vicious circle gets formed trapping the poor (Strauss & Thomas, 1998). Studies have found that nutritional deficiencies can also inflict lasting damages on health of people. Height for age at 2 years has been found to be highly associated with human capital and undernutrition in early childhood might lead to permanent damage and even affect future generations. Children born to undernourished mothers are more likely to suffer low birthweight causing intergenerational transmission of malnutrition (Behrman et al., 2009; Bhutta et al., 2008).

The recent literature also emphasizes on anthropometric-based outcome measures of child undernutrition: (a) stunting (low height-for-age) (b) underweight (low weight-for-age) and (c) wasting (low weight-for-height). To illustrate the measurement of these indicators, let us take stunting. Consider the observed height of a child and compare it with growth reference norms for a given age–sex group specified by the WHO by computing a standardized indicator called Z-score which is defined as

[4] Obesity or overnutrition is not focused in this paper.

Z = (observed height of child—reference median)/reference standard deviation. If the Z-score of a child is below −2.Z value,[5] the child is considered as stunted.

Hunger and Food Security

Hunger is commonly referred to as physical discomfort caused by insufficient food consumption. This is viewed as 'a relatively narrow measure' (Barrett & Lentz, 2016). Many analysts use a broad concept of food security that was adopted by the World Food Summit in Rome organized by the Food and Agricultural Organization (FAO) in 1996: 'Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'.

The above definition focuses on food sufficiency, safety, and nutritional content. To be relevant in practice, it goes beyond the normative biological issues and considers consumer behaviour through their tastes and preferences which are affected, among other things, by cultural attributes of the communities. Also, by containing the phrase 'at all time', the definition considers possible vulnerability in a forward-looking manner.

Analysis of food security often centres around four different pillars:

- Availability: Availability pillar considers supply side of the food security and gets reflected by sufficient aggregate food production to meet domestic demand.
- Access: Access pillar, on the other hand, displays the demand side at the household level. Sen (1981) asserted 'starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there *being* not enough food to eat. While the latter can be a cause of the former, it is but one of many *possible* causes'. This famous quotation was responsible for drawing world attention to demand side in policymaking through considerations of issues such as purchasing power, prices, inter- and intra-household distribution. In this process, the demand side links food security to income poverty and distribution issues.
- Utilization: Utilization pillar refers to the proper utilization of food expenditure by the households on nutritionally essential foods they can afford. It also includes considerations such as efficient absorption of food consumed by individuals and related issues like proper preparation, safe preservation, and sanitary conditions.
- Stability: Lastly, stability pillar considers the vulnerability of households to food insecurity due to inter-temporal fluctuations in availability or access.

Following Webb et al. (2006), we might describe the hierarchical nature of the four pillars. Adequate availability of food at macro level is essential but not sufficient to ensure access at the household level as emphasized by Sen. Similarly, access to adequate food is necessary but not sufficient condition for efficient utilization. The first three pillars do not ensure stability of food security over time which is a forward-looking feature. Analysts have also distinguished between chronic and transitory food insecurity. Chronic insecurity refers to long-term deficiency of food security and is normally associated with long-term structural problems of the economy; for example,

[5] If the observed score is below −3Z, the child is considered severely undernourished.

the situation prior to the green revolution in India. Transitory insecurity is associated with lack of food security for a short period in availability or access. It could be seasonal and recurring in a lean season of agricultural activities, but may also occur during a natural calamity such as earth quack, severe drought, critical health crisis, and war causing large-scale starvation and death (Devereux, 1993; Ravallion, 1997; Devereux et al., 2008). Considering such conditions, Basu (2010) states that food security for all need not involve 'the false promise that there will be food for all at all times, but simply that government will ensure that everybody has access to a certain minimal amount of food and, in case there is an overall shortage of food in the nation (which cannot be corrected through imports) then everybody will share in the shortage' (P. 32).

Poverty

A closely related concept is poverty and poverty line on income dimension. The poor are defined as those persons who fall below a benchmark income or consumption called the poverty line. This benchmark is a minimum desirable income or consumption level needed for a decent life that a society can afford. Extent of poverty refers to the proportion of poor in a given population, also referred to as the headcount ratio (HCR) of poverty.

The poverty line is often derived on a normative basis by employing the relationship between income and nutritional intakes. The quantity of food needed by an individual is normally determined by his or her calorie need. If we arrange households by per capita income level and move from low-income group to high-income groups, the average per capita energy (calorie) intake rises and tends to reach a plateau at a high level of income. Based on this relationship, poverty line may be defined as that level of consumption expenditure (or income) at which energy intake is just sufficient to meet the average calorie requirement level of the society. Households whose income fall below the poverty line are called poor in this approach.

The quantity of food needed by an individual is normally determined by his or her calorie need, while other nutrients contribute to the quality of food and make the diet a balanced one. As in the case of specific nutrients, nutritionists recommend balanced diet baskets separately for various age–sex–activity groups that meet the need for major nutrients keeping in mind the social and economic circumstances. The average food need of a society may be obtained as a population-weighted average of the recommended dietary allowances (RDAs) for different groups[6] and when some allowances are made for basic necessary non-food items, the expanded basket may be taken as a basic need basket.[7] The cost of the basic consumption needs then gives the basis for estimating an alternative normative poverty line.

A point to remember is that poverty is not measured by comparing the cost of the basket item by item, but by comparing the cost of the basket as a whole with income or total consumption expenditure. A household is called poor if its income is not

[6] See, ICMR (2010).

[7] An Expert Group headed by Rangarajan to review methodology for measurement of poverty in India calls it the poverty line basket (Planning Commission, 2014).

sufficient to afford the total cost of the basket, even though its actual consumption of a particular item might fall short of or exceed the norm used in the basic need basket. Similarly, even in the calorie-based approach to define poverty line, a particular household with income equivalent to the poverty line might or might not have intake equal to the calorie norm; the equality holds for an average household at that level of income.

3 Public Policy Response Since Independence

3.1 The Constitutional Framework

The various organs of the government in India function within the framework of the Constitution which came into effect from January 26, 1950. The Directive Principles of State Policy in the Constitution of India are considered to be guiding doctrines 'fundamental in the governance of the country', though they are not be enforceable by a court. They contain several provisions related to nutritional and food security of the citizens. Article 47 of the Constitution most directly recognizes the need to raise the nutritional level of the citizens by declaring: 'The State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties…'. Article 39 specified 'certain principles of policy to be followed by the State' and the very first among them says that the State should direct its policy towards securing 'the citizens, men and women equally, have the right to an adequate means of livelihood'. Further, Article 35 stipulates 'The State shall endeavour to secure, by suitable legislation or economic organization or in any other way, to all workers, agricultural, industrial, or otherwise, work, a living wage, conditions of work ensuring a decent standard of life and full enjoyment of leisure and social and cultural opportunities …'. Article 48 is another Directive Principle which states 'The State shall endeavour to organise agriculture and animal husbandry on modern and scientific lines…'. All these constitutional provisions relate to availability, access, and affordability dimensions of food and nutritional security.

3.2 Policies Followed for Food and Nutritional Security

As noted earlier, India adopted a mixed economy model where public and private sectors coexisted. The Planning Commission played an important role in designing and monitoring public policy for the economy and preparation of the Plan documents. Role of the public sector declined over time after the economic reforms in 1991. A new government formed in 2014 finally discontinued the Planning Commission. Till

then, however, the Five-Year Plan documents provided the overall approach of the government towards various policies during the respective plan periods.

Attaining the maximum feasible GDP growth subject to available resources, obtaining corresponding sectoral composition and allocation of investment across sectors was the main objective of a plan exercise. This core exercise was complemented by feasible allocations to social welfare-improving sectors like health, nutrition, and education. The 5th Plan was the first plan to attempt to formally introduce a target on poverty reduction and integrate it with GDP growth target with certain assumptions on consumption distribution. We briefly document below the policies followed on nutrition front based on some of the Five-Year Plans supplemented by a discussion of major policies for attaining food security.

Nutrition Security

The First Five-Year Plan initiated by the government in 1951 recognized that nutrition was an important factor for preserving health of the people and that it affected the productive capacity of an individual. It noted the widespread existence of undernutrition in the country and lack of protective food to supplement staple cereals leading to malnutrition in the country.[8] The Second Five-Year Plan was frank in its admission that it was not possible then to provide nutrition at the optimal level to the entire population within the Plan period. Noting that damage to proper growth and development at early ages 'cannot be made good even by providing adequate nutrition at a later age', it initiated certain schemes aimed at nutritional improvement for the vulnerable groups of the population such as expectant and nursing mothers, infants, and children.[9] The Third Five-Year Plan also expressed a similar view.

The Minimum Needs Programme (MNP) introduced in the Fifth Five-Year Plan[10] aimed at the provision of certain basic services and facilities of social consumption up to specified norms. The MNP contained two types of activities: (a) basic human resources development activities covering elementary and adult education, health, drinking water supply, nutrition, and rural housing and (b) basic infrastructure for area development activities like rural roads and village electrification. The MNP continued in several subsequent plans too with new activities like cooking energy, sanitation, and urban slum development added to the list. Both individual beneficiary development and area development components were viewed from the angle of their productive capacity-enhancing roles. It is interesting to note that public distribution was added to the MNP list during the 7th Plan.

The Integrated Child Development Services (ICDS) Programme started in 1975 to improve the nutritional and health status of preschool children along with their learning and social development. It also aimed at maternal care and supplement their

[8] First Five-Year Plan, chapter 32; the plan documents prepared by the erstwhile Planning Commission are available at: https://niti.gov.in/planningcommission.gov.in/docs/plans/planrel/fiveyr/index1.html.

[9] Second Five-Year Plan, chapter 25.

[10] The 4th Plan had only some peripheral references to nutrition and did not contain any substantive point on strategy or scheme.

nutritional needs. The services provided by the Anganwadi workers under ICDS include supplementary nutrition, immunization, health check-up, referral services and preschool education. It started in selected blocks and gradually expanded to other areas. Similarly, programmes for the prevention of iodine deficiency disorders, anaemia, and blindness due to Vitamin A deficiency were initiated.

The 6th Plan contained some detailed discussion on nutrition. It considered nutritional improvement as depending mainly upon the awareness, knowledge, and income of the family and viewed family employment and income as essential prerequisites for the improvement of nutritional status. It stated 'employment is the best and cheapest guarantee to enhance the nutritional status of the families'.[11] Thus, access to minimum income or poverty alleviation played a central role in the nutritional strategy of the 6th Plan, though it did recognize roles of several other factors such as food production, post-harvest processing, storage, expansion of fair price shops network, mid-day meal scheme, cropping pattern changes, fortified food, and participation of community-based organizations.

The 7th Plan quoted the National Nutrition Monitoring Bureau which showed that nearly 50% of the households surveyed consumed food which was quite inadequate to meet their requirements of either calories or proteins, or both, and that only 15% of children could be considered as having a normal status of nutrition; the rest suffered from varying degrees of under-nutrition.

A new element in the 7th Plan was that the objective of nutritional policy was stated as increasing the functional efficiency of the labour force and reduction in infant and maternal mortality rates[12] which implied that the Planning Commission was then mostly guided by the instrumental role of nutrition rather than its intrinsic role. In terms of policy instruments, the approach of the 7th Plan to nutrition problem was similar to that of the earlier two plans. It considered 'expansion of employment opportunities and stabilisation of income, especially among the vulnerable population groups' as the main long-term strategy for ensuring adequate nutrition. It also aimed at the expansion of public distribution system (PDS) covering cereals and non-cereal food to enable families for a balanced diet at 'reasonable prices'. Besides, it stressed on nutritional education, sanitation and hygiene, adequate spacing between births of children and safe drinking water.

The 10th Plan noted that 'over half the children under the age of five years in India are moderately or severely malnourished, 30 per cent of new born children are significantly underweight and nearly 60 per cent of pregnant women are anemic' (Chapter 2). It observed the impact of malnourishment on 'cognitive development and learning achievements, reducing the capacity to work and productivity among adults and enhancing mortality and morbidity among children'. On the positive side, it stated that 'nutritional deficiency diseases viz., Kwashiorkor, marasmus, pellagra, lathyrism, beriberi and blindness due to severe Vitamin-A deficiency, have become rare'.

[11] Sixth Plan, ch. 22.

[12] 7th FYP, ch. 13.

The 10th Plan noted a clear shifting of consumption pattern from foodgrains to other food items due to changing age, occupational structure, and higher income. It felt the changing consumption pattern was desirable on nutritional grounds and supported establishment of storage structure due to short shelf life of several non-grain food items and adjustment of minimum support prices to support diversification of food basket. It also advocated the use of huge public stocks of foodgrains built up by then for reducing widespread undernutrition.

The 11th Plan argued for multiple interventions such as dietary improvement, nutrition supplementation for children, better childcare practices, access to safe drinking water, improved sanitation, and immunization. It stated that the National Rural Health Mission could deliver a better system of affordable curative health care. It saw the need for raising public health spending to at least 2% of GDP during the 11th Plan period.

We document above the evolution of the approach of the government policies towards malnutrition over time. Policymakers have always recognized widespread prevalence of undernutrition and malnutrition. Some of the broad features of the nutritional problem in India talked about in the 2010s and 2020s were known even in the 1950s and 1960s. Resources were certainly a major constraint then. There was virtual admission of infeasibility of solving the malnutrition problem during the initial decades of independence and hence focus was on child and maternity care that required priority attention. Schemes like ICDS were tried on an experimental basis in limited blocks and got extended to other areas as more resources were available. Evaluation studies have pointed out deficiencies in ICDS such as inadequacy in the cold chain for vaccines, irregular supply of nutrition supplements and even inappropriate food. Multidimensional nature of the problem including safe drinking water and sanitation attracted policy attention over time. However, calorie intake which is more directly linked to foodgrains consumption has always received focused attention from the government.

Food Security

Low productivity and rising population called for major restructuring of policy for increasing foodgrains production to meet domestic demand. Large-scale dependence on imports could not be a viable strategy for a large country like India since world trade in grain market is thin, particularly for rice where volume of world trade is only about 10% of our consumption. While international trade volume is not that thin for wheat, cartelization in food grains market is widely prevalent. It was clear to policymakers that the strategy of food security had to largely depend on the domestic production of foodgrains, staple food of Indians.[13] But the strategy did not preclude international trade as the need arises to supplement domestic production with some imports in deficit years and exports of part of the surplus in other years.

[13] Parikh et al. (1997) argue why free trade in rice may not be in India's interest.

Introduction of the Green Revolution[14] initiated in 1968 in rice and wheat involved the use of high-yielding variety (HYV) seeds together with irrigation, chemical fertilizers, pesticides and use of tractors. Supported by research and extension services, the innovative and risk-taking farmers in Punjab, Haryana, Western Uttar Pradesh, and some parts of Tamil Nadu and Andhra Pradesh were the first to adopt the new technology that transformed the food production system. Application of the HYV in wheat was particularly a great success in raising its productivity. Institutional changes like consolidation of holdings carried out earlier in some states provided the right environment for the use of new technology. Agriculture was treated as a priority lending sector by the banks and farmers got better incentives through prices. The revolution slowly spread to other parts of the country. The success of the green revolution was evident in the 1970s when India became self-sufficient in grains production. This was an essential first step in India's attempt towards food and nutritional security. The emphasis on the Green Revolution continued over several plans with the required allocation of financial resources. As it turned out, India has become a net exporter of cereals since the 1990s.

Public Distribution System (PDS)

Food production in India is characterized by seasonality and annual fluctuations. To meet the consequent instability, government decided to undertake public buffer stocking operations involving procurement and offloading of foodgrains as per need. The PDS has been an important instrument to provide food security to the people in India. It started as a mechanism to distribute food at a fair price for the urban consumers during the war and slowly got expanded to supply rice and wheat at affordable prices to cover rural areas, particularly during the 1980s and 1990s. Both the Union and state governments are involved in the operation of the PDS. The Food Corporation of India (FCI) set up in 1965 by the Centre as a statutory corporation is responsible for the procurement and storage of grains. The state governments are responsible for issuing ration cards[15] to the beneficiaries and distributing the entitled food quantities to them at subsidized prices through a network of fair-price shops. To meet the supply, FCI procures food grains from farmers at government-specified prices called minimum support price (MSP) intended to provide remunerative prices to farmers. The Central government decides the prices taking into consideration recommendations of the Commission for Agricultural Cost and Price (CACP). The difference between cost of procurement (including transport) and prices realized from the beneficiaries is borne by the government as food subsidy. Some states have added other food items like sugar, pulses, and edible oils at different times to be

[14] The HYV seeds of wheat imported from Mexico were developed by Norman Borlaug and of rice from the Philippines developed by Peter Jennings and Henry M. Beachell. M. S. Swaminathan played a major role in introducing these seeds in India.

[15] The ration cards issued by the government to a household states its drawing rights of grains from the PDS. For the poor, it was a proof of identity with address for several government transactions. Even for the relatively better offs, the ration cards used to be an important document for address proof and buying subsidized LPG from the government agencies.

available through the PDS. The FCI maintains buffer stocks to meet demand–supply gap due to shortage of rainfall or other calamities and to meet working stocks.

Subsidized distribution of food has been an integral part of India's food security for the low-income group. Without this support, small relative price or income changes can lead to considerable suffering for the poor (Sen, 1981; Dreze & Sen, 1989). The PDS has undergone several modifications. In 1997, the government launched Targeted Public Distribution System (TPDS) which operated under a dual price regime, one price for households below poverty line (BPL) and another for those above poverty line (APL). The BPL group had to pay lower prices for ration issued to it compared to the APL group. For beneficiary identification, most state governments roped in local bodies like Gram Panchayats. In 2000, the TPDS introduced a category called poorest of the poor households under the Antyodaya Anna Yojana (AAY) that received 35 kg of food grains at a highly subsidized rates of Rs 2 per kg for wheat and Rs 3 per kg for rice.

National Food Security Act

A paradigm shift occurred from 'welfare' to 'rights based' approach when Parliament passed the National Food Security Act (NFSA) in 2013 following a rights-based approach for 75% of rural population and 50% of the urban population or, about two-thirds of the total population in the country. The Act stipulated public provision of 5 kg of food grains per person per month to eligible households at Rs 3 per kg for rice, Rs 2 for wheat, and Rs 1 for coarse grains. The AAY households continued to receive 35 kg per household per month. There were additional provisions for pregnant and lactating mothers and children. The NFSA expanded the entitlement group for PDS substantially, though quantum of drawing rights per household did not change much and in fact might have reduced for some poor households not belonging to the AAY category due to adoption of per person criteria instead of per household. Yet, the NFSA was a major step aimed at food and nutritional security of the people. By converting subsidized food availability into legal entitlements, it empowered them and contained provisions for grievance redressal mechanisms and social audit.

Thus, government intervention in the food grain market has been widespread and persistent. The level of food grains procurement by the government has increased over the years to reach 25–30% of total food grain production of which about two-thirds get distributed through the PDS. PDS mechanism also helped in managing price stability in the open market to some extent. Farmers in different parts of the country have been complaining from time to time that they do not receive prices profitable enough for their produce. The stated preference of a substantial number of farmers has been to move out of agriculture if they can get job opportunities outside agriculture.

PDS, particularly TDPS, played a significant role in the nation's move towards ensuring food security of the people. Most evaluation studies have criticized PDS on grounds of inadequate coverage of the needy, leakages, inefficiency, and wastage at different stages of supply management. In a six-state study of TPDS, NCAER (2015) reported that beneficiary households felt that the TPDS was important to cover a substantial portion of their requirement of food grains at subsidized prices.

While the PDS was, in principle, supplemental in nature and was not initially intended to meet the entire requirement of grains of a household, the target groups under the NFSA could in practice meet most of their food grain needs through the PDS. The prices specified in the NFSA were so low that a rural labour household could purchase monthly entitlements with a few days' wage earnings. Given the popularity of NFSA among the masses and competitive potential electoral gains in a democracy meant that all the states adopted NFSA,[16] although they had an option to join NFSA or continue with the TDPS.

3.3 Income-Generating Programmes

By the mid-1970s, Indian policy priority started focusing on the generation of a minimum income for poor households and in the process expanding their access for food and nutritional security. Since the low-income groups may not derive sufficient benefits from the economic growth process, several income-generating programs were introduced targeted at them. The antipoverty programmes broadly fell into two categories, one related to self-employment and another to wage employment.[17]

In the first category, the Integrated Rural Development Programmes (IRDP) was started in 1980 to enable poor households to cross over the poverty line through self-employment. Similar programmes in one name or another have continued with varying degrees of emphasis to enable livelihood opportunities. The government helped in acquiring productive assets or subsidized financial assistance for taking up activities like animal husbandry, fishery, weaving, food processing, small trade, or other services. These programmes have come under criticism for imperfect targeting and improper identification of viable projects.

Wage Employment programmes too have evolved over time under various names like National Rural Employment Programme or Employment Assurance Scheme to provide the rural poor with gainful wage employment through public works such as construction of village roads, watershed developments, irrigation wells, school buildings, and houses for the poor. Finally, a legally binding act called Mahatma Gandhi National Rural Employment Guarantee Act (MG-NREGA) got adopted in 2006. The Act guarantees 100 days of public manual employment to a household in a year within 15 days of demand at a specified wage rate. It was visualized as an open-ended demand-driven scheme and, by and large, the demand for employment has been met. One of the main merits of public wage employment programme lies in its self-targeting nature due to manual work and consequent effectiveness in reaching the poor.

[16] NITI Aayog (2021) states 99.5% of the targeted beneficiaries have been covered.

[17] See, Panda (1999) for a discussion of several poverty reduction programmes undertaken till the 1990s.

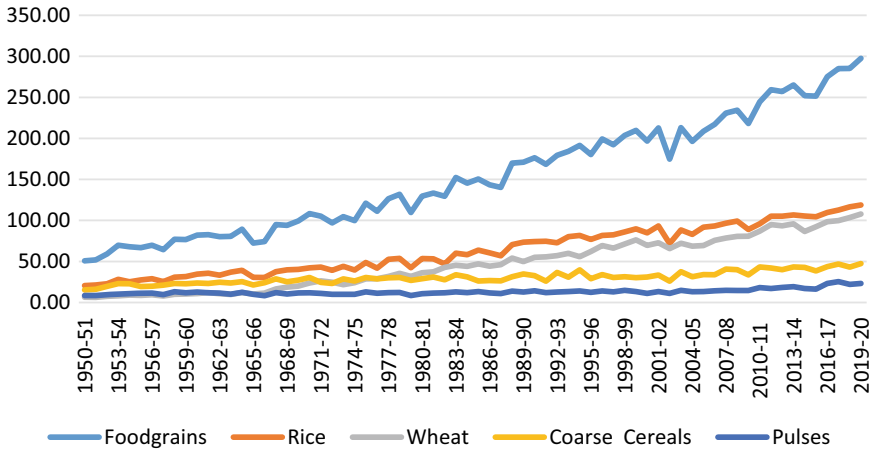


Fig. 1 Production of food grains (million tonnes).
Source Economic survey

4 Achievement and Prevalence

We now turn to a discussion of trends and achievements in some key variables related to nutritional and food security.[18]

Food Production and Availability

After the commencement of the green revolution in 1968, food grain production in India rose from 95 million tonnes in 1967–68 to 130 million tonnes in 1980–81 and crossed 300 million tonnes in 2020–21 (Fig. 1). Except for the bad years, it has remained higher than population growth rate by above 1% per year for over five decades. The green revolution took place mostly in wheat and rice. Production of coarse cereals and pulses did not show spectacular rise and, in fact, declined in per capita terms (Fig. 2).

Following the success of the green revolution, India has been an exporter of food grains for about 3 decades now. The huge increase in production of wheat and rice has, however, not been accompanied by an increase in per capita net availability to the same extent. On a per capita per day basis, food grain availability (defined as net production + net imports—changes in government stocks), which was 395 g per day in 1951, rose to 469 in 1971 and reached 510 in 1991. It exhibited both falling and increasing trends thereafter: declined to 436 in 2008 and rose again to 495 in 2019. Wheat and rice are the staple foods in the country and constitute three-quarters of the total food grains production. Per capita availability of pulses has increased from 33 to 55 gm/capita/day during the last two decades.

[18] See, Dev and Pandey (2022) for a status report on nutrition and food security.

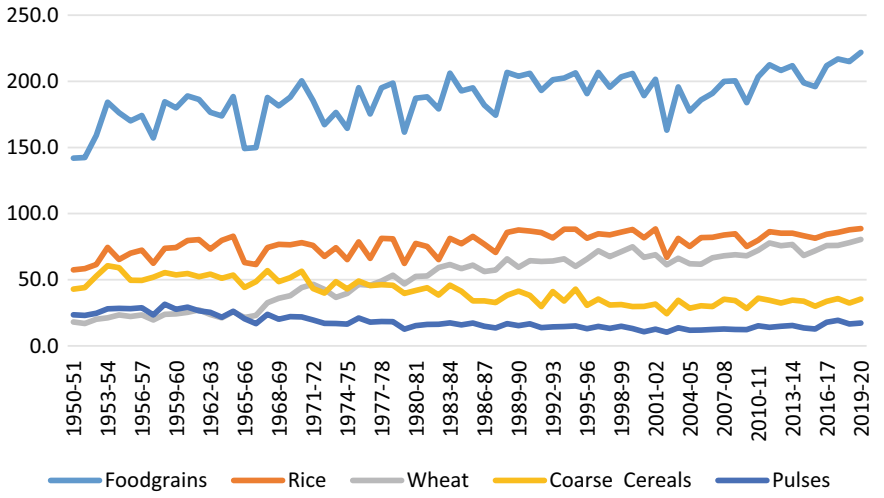


Fig. 2 Per capita food grain production of food grains (Kg).
Source Author's calculation based on data in Economic Survey

Consumption expenditure surveys conducted by the NSSO reveal that per capita monthly domestic consumption demand for cereals has fallen from 12.1 to 11.2 kg in rural areas and from 9.9 to 9.3 kg in urban areas during 2004–05 and 2011–12.[19] Reduced incidence of heavy manual activities due to mechanization, general shift in lifestyle towards sedentary activities, and diversification of the consumption basket are some of the factors contributing to the fall in cereals demand. The reduced demand could partly also be due to the fact that cereal consumption in the survey does not include the cereal content of food that is received by the household from outside in the form of meals, cereal preparations, or snacks.

Per capita consumption of pulses decreased from 705 gms in 2004–05 to 651 gms in 2009–10 but rose to 783 gms in 2011–12 in rural areas and exhibited similar trend in urban areas too with 824, 786, and 901 gms in the 3 years. Monthly milk consumption has shown a rising trend from 3.9 kg in 2004–05 to 4.3 kg in 2011–12 in rural areas and from 5.1 kg in 2004–05 to 5.4 kg in 2011–12 in urban areas.

The success of the green revolution on the production or availability front did not translate to household-level food and nutritional security for *all*, primarily due to lack of purchasing power by a significant section of the population. While famine-like situations or starvation deaths on a large scale have been avoided, incidence of malnutrition and food insecurity is not insignificant, though magnitude of undernutrition or calorie deficiency has fallen considerably.

[19] NSSO report No. 558, P. 22.

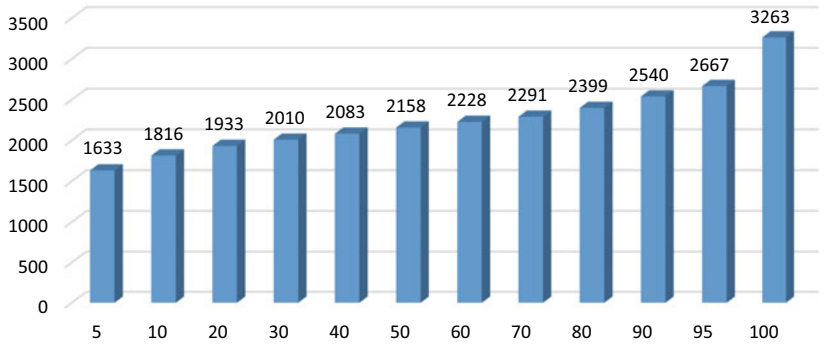


Fig. 3 Per capita calorie intake per day by fractile classes: rural India 2011–12. *Note* Fractile classes 5 and 10 above denote 0–5 and 5–10 percentiles, respectively, and so on. *Source* Based on NSSO report no. 538

Nutrient Intakes

This brings us to nutrient intake side. Figures 3 and 4 depict the per capita calorie intake by different fractile groups for the years 2011–12.[20] Per capita per day calorie intake for the bottom 5% of the population was only 1633 and 1637 in rural and urban areas, respectively, in 2011–12. A Task Force on poverty estimates (GoI, 1979) had worked out the per person calorie norm to be 2400 cal for rural areas and 2100 cal for urban areas. Subsequently, ICMR (2010) has revised its recommended dietary allowances (RDA) for different nutrients for various age–sex–activity groups. An Expert Committee headed by Rangarajan (Planning Commission, 2014) for the estimation of poverty reworked out the average norms considering the revised recommendations by ICMR and the weighting diagram of these groups based on more recent population distribution. The new average norms for the population as a whole turned out to be 2155 and 2090 for rural and urban areas, respectively. Further, in view of the criticisms by Meenakshi and Viswanathan (2013) and Sukhatme's homeostasis hypothesis discussed in Sect. 2, they treat calorie norm to be lying in the range of $\pm 10\%$ and conclude that 'intakes at the lower level need not compromise the health and activity status' of the population. This practically reduces the average calorie norms to 1940 and 1880 for rural and urban populations, respectively. The Rangarajan Committee also worked out protein and fat requirements on a similar basis and obtained average nutrient requirement levels as in Table 1.

The Expert Committee found the requirements of calorie, protein, and fat are met by the 25–30 percentile group in rural areas and by the 15–20 percentile group in urban areas. Calorie intake levels by fractile classes for 2011–12 are given in Figs. 3 and 4 and protein and fat intake levels in Table 2. Judged by the new norms arrived at by the Rangarajan Committee and permitting a 10% lower limit for calorie norms, it is found that about 20% of the population did not meet the calorie norm in both rural and urban areas. For protein and fat too, the population proportion below the

[20] NSSO consumption survey data are not available after 2011–12.

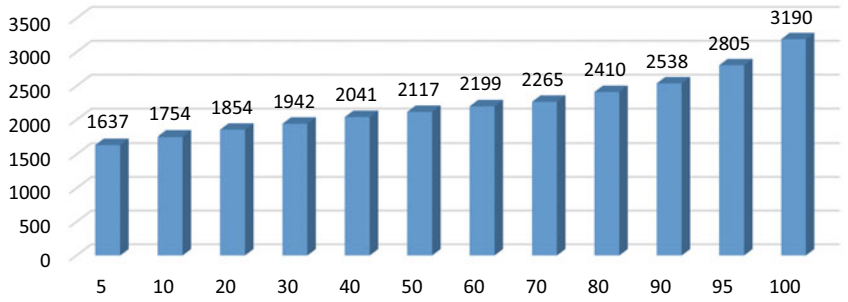


Fig. 4 Per capita calorie intake per day by fractile classes: urban India 2011–12. *Note* Fractile classes 5 and 10 denote 0–5 and 5–10 percentiles, respectively, and so on. *Source* Based on NSSO report no. 538

Table 1 Nutrient requirement norms per capita per day as estimated by the Rangarajan expert group

	Rural	Urban
Calorie	2155	2090
Protein (gms)	48	50
Fat (gms)	28	26

For calorie, a±10% variation was allowed by the expert group
Source Planning Commission (2014)

norm is no more than 20%. Overall, the prevalence of undernutrition was about 20% of the three main nutrients: calorie, protein, and fat.

However, conclusion regarding the nutritional inadequacy of a person and of a society may not be arrived at using the same norm. If calorie intake of a person is at or above the lower bound advocated by Sukhtma and others, the evidence is not significantly beyond doubt to define her as undernourished. But, the intake level at its lower bound cannot be used for judging sufficiency of average calorie intake of a nutritionally secured society. Consider, for example, if calorie intake of most of the population in a society is found to be at or close to the lower limit and nobody below it, it may not be described as a nutritionally secured society. The closure the average intake is to the minimum, the higher is the risk of incidence of undernutrition for the society, even though it is difficult to arrive at such a conclusion for a specific person. Since both requirement and intake follow certain statistical distributions, judgement about adequate supply or intake must be based on the parameters of the distributions.[21] The population-weighted RDAs will then seem to be more relevant for comparison with average availability.

On the calorie intake side, the averages were 2233 and 2206 for rural and urban areas, respectively. Given the reworked out per capita calorie norms of 2155 and 2090 for rural and urban populations by the Rangarajan Committee, the overall

[21] Chakrabarti and Panda (1981) argue for determining incidence of undernutrition considering the joint distribution of intake and requirement.

Table 2 Per capita protein and fat intake per day by fractile classes in 2011–12

Fractile class	Protein intake (gms)		Fat intake (gms)	
	Rural	Urban	Rural	Urban
5	42.8	44.0	20.8	26.5
10	48.0	47.5	26.0	34.4
20	51.5	50.6	30.4	39.5
30	53.8	53.3	33.8	44.9
40	56.2	55.9	38.2	50.2
50	58.3	57.7	42.3	54.7
60	60.5	60.2	45.6	58.6
70	62.5	62.1	49.9	63.4
80	65.8	66.0	54.7	69.8
90	70.3	69.6	61.6	75.3
95	74.1	77.2	69.5	86.7
100	90.9	86.5	92.2	99.7
All	60.7	60.3	46.1	58.0

Note Fractile classes 5 and 10 denote 0–5 and 5–10 percentiles, respectively, and so on
Source Based on NSSO report no. 538

calorie intakes were higher than the respective norms for both rural and urban areas. We may also note that the average calorie intake has nearly remained stable between 1993–94 and 2011–12. The average protein intakes were higher than average RDAs in 2011–12 by about 3 g a day. In the case of fat, average intake has gone up by about 10 g a day since 1993–94 and has remained above the RDA since then. Thus, the broad conclusion seems to be that India has moved a long way in meeting the *average* quantum of food required for calorie, protein, and fat, the three macronutrients.

The undernutrition problem mainly lies on adequate purchasing power due to lack of purchasing power for the lowest 15–20% of the households who constitute 200–250 million population. They are among the most deprived sections economically such as small communities living in remote areas, destitute, unemployed without other means of living, and children and old age persons without family support. Reaching out to this last mile is a very challenging job at the grassroots level. The universal nature of the NFSA 2013 for the bottom income groups is a major step for empowering them. After its implementation, the proportion of calorie-deficient households could have considerably come down further from the 2011–12 levels, though we have to wait for the next round of NSSO consumption survey data for comparable numbers.

Turning to anthropometric outcome indicators like the prevalence of stunting, wasting, and underweight among children as revealed by the National Family Health Survey (NFHS) data, their high levels have been a matter of concern. Prevalence of stunting and underweight has fallen over time, but that of wasting has nearly remained stagnant (Fig. 5). Admittedly, anthropometric outcome indicators yield

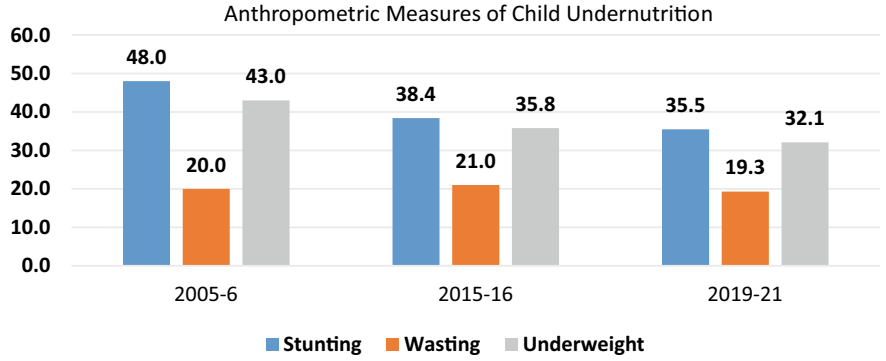


Fig. 5 Anthropometric indicators of child undernutrition. *Source* NFHS factsheets

results only over a longer time span, but the prevalence of stunting and underweight have remained fairly high at 36 and 32%, respectively, even in the recently conducted NFHS-5 during 2019–21.

Consumer demand pattern has been changing over time: from food to non-food and from cereals to non-cereals within food. This is expected by Engel's law which states that the share of income spent on food decreases as household income rises. NSSO consumer expenditure data shows that the share of food has fallen from 63% of total consumption expenditure in 1993–94 to 48% in 2011–12 for an average consumer in rural areas and the share in urban areas has dropped from 55 to 39% during the same period. Share of cereals within food has declined from 39 to 25% and from 26 to 19% in rural and urban areas. Even though the poor continue to spend more than half of their total consumption expenditure on food, the shift away from cereals to other food items such as milk and milk products, and fruits and vegetables is a desirable change.

Turning to another point, if hunger is perceived by the common man as not being able to afford two square meals a day, then India may claim near elimination of hunger. In this sense, less than 2% of the Indian population reported hunger in the late 1990s. The NSSO stopped asking the question pertaining to two square meals a day due to its low incidence. Hence, policy focus moved to other forms of hunger at the turn of the millennium. Note that a higher percentage of persons reporting perceived hunger in some poor areas may not be inconsistent with the small percentages in NSSO surveys at the national level.

Poverty

Considering the international poverty line of US$1.90 a day, India had the largest number of poor across countries at 224 million (World Bank, 2016). But, percentage of population below poverty line has been falling over time. As per the poverty line suggested by the Tendulkar Committee (Planning Commission, 2009), the head-count ratio (HCR) fell from 37.2% in 2004–05 to 21.9% in 2011–12 at the all-India level (Planning Commission, 2013). The Rangarajan Committee report (Planning

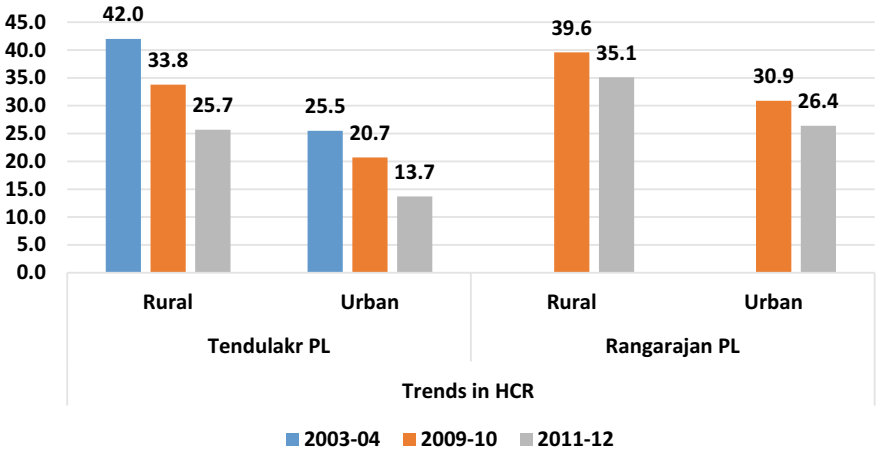


Fig. 6 Trends in headcount ratio of poverty.
Source Planning Commission (2013) and Planning Commission (2014)

Commission, 2014), which had been set up to re-evaluate the methodology for determining the poverty line, showed HCR reduced from 38.2% in 2009–10 to 29.5% in 2011–12 at the all-India level. Figure 6 shows that poverty fell in both rural and urban areas. Most of the public intervention programmes for poverty alleviation also have specific proportions of funds earmarked for the socially disadvantaged groups like Scheduled Tribe (**ST**) and Scheduled Caste (**SC**) which account for a substantial proportion of the poor.

Datt et al. (2016) show that poverty declined by 1.36 percentage points per annum after the reforms post 1991 as compared to that of 0.44 percentage points per annum prior to 1991. They also find that, within the post-reform period, poverty declined faster during the 2000s than during the 1990s. Based on the Tendulkar Committee poverty lines, poverty declined only 0.74 percentage points per annum during 1993–94 to 2004–05 and by 2.2 percentage points per annum during 2004–05 to 2011–12 (Planning Commission, 2013). The various pieces of evidence thus strongly indicate that economic growth has a poverty-reducing effect.

COVID-19 Impact

The outbreak of COVID-19 pandemic in early 2020 led to lockdown in most of the countries in the world. India imposed a nationwide lockdown during March last week to May 2020 which got relaxed in stages from June onwards. All production activities, except agriculture and some essential services, were completely closed during the lockdown. Many workers engaged in small- and medium-scale industries lost jobs. The migrant labourers returned home from the cities where they were working, some of them walking on foot hundreds of kilometres. The loss of jobs and income meant a large number of persons struggling to adequately feed the family. A well-functioning supply chain is crucial to food security in such a condition. The

government soon intervened to save life and released additional food stocks for distribution to people through the PDS network. Distribution at the rate of 5 kg per person per month was *free* in addition to normal entitlement under NFSA. This helped to avoid the possibility of a large-scale hunger problem. According to several telephonic surveys by research bodies and social groups, about 80% of households having ration cards did receive the food grains meant for them (Dreze & Somanchi, 2021). This confirms an earlier conclusion by Radhakrishna (2005) that PDS had made a significant contribution in 'protecting the poor by smoothening their consumption from shocks'.

Similarly, a large number of migrant returnees to the villages could be provided manual work through the employment guarantee programme MGNREGA. Government increased financial allocation for the programme to provide needed social protection since demand for MGNREGA work remained at a higher level during the pandemic in different months in 2020 and 2021 compared to corresponding pre-pandemic level in 2019. Economic Survey 2021–22 notes that employment under MGNREGA reached a peak of 45.9 million persons in June 2020 (P. 371). A critical factor for feasible expansion is the development of capacity at the grassroots level 'to quickly translate funds into jobs' (Afridi et al., 2021).

5 Way Forward

Analysts have also been drawing attention to several problems in current policies for food and nutritional security from long-term sustainability point of view. While government expenditure has been fairly large, more attention needs to be given towards its effective utilization of resources. Large-scale leakages are not uncommon in some programmes. Involvement of the non-government organizations (NGOs) with good track record for social audit has been found to have helped in reducing such leakages in some cases. Also, participation of local self-government bodies in the implementation, and monitoring of projects is a good step undertaken in recent years.

Government market intervention in procurement and distribution has played an important role in lessening the distress of the low-income groups. It also led to building up of huge public stocks which have attracted criticisms from several quarters. As argued earlier, per capita cereals demand is tending towards a plateau and domestic demand will increase mostly due to population growth of about 1% a year. Other factors influencing future cereals demand will be rising income of the lowest two deciles, changing dietary patterns, and growing urbanization. The demand-increasing effect of the first factor will be mostly offset by the demand-reducing effects of the other two factors. World market can absorb only a small part of India's production. The rest feeds to the growing stocks which reached 78 MT in 2020–21 rising from 43 in 2017–18. The fact is that stocks rose by 4 MT even during the pandemic year 2020–21 despite enlarged food distribution involving food subsidy of more than 2% of GDP. This obviously implies excess production relative to demand

involving wastage of resources. Public sector management of grain trade needs major changes to provide right signals to the producers.

Different scholars have, however, different views on reforms needed on market intervention. Chand (2003) was of the opinion that private traders would derive excess profit in the absence of a public agency such as the FCI. He stated: 'What now goes as inefficiency of FCI would go as excessive profit of private trade' and advocated modernization and professionalism in management. According to him, the maximum level of grain stock should be sum of stocks needed for 6 months by PDS and the highest shortfall in production during the previous decade.

Another view is that food grain management policies adopted in the past to attain self-sufficiency have served their purpose and have lost their relevance. According to Ganesh-Kumar et al. (2007), for example, the cost of continuation of past policies has risen and the benefits have declined. They state that the dominance of the public sector in the grains market discourages development of the private markets that could promote modernization of market and reduction of inefficiency in food security policies.

Procurement at remunerative prices and distribution at subsidized prices are instruments that have created their own constituencies over the decades. Proposals to introduce certain legal changes in the agricultural market to provide more scope to private traders in 2021 were fought with resistance from a section of the beneficiary farmers in the west and north India leading to repeal of the bills. Competitive political pressure in a liberal democracy makes it very difficult to remove existing subsidies. On the whole, however, a consensus exists among scholars on the need for reducing excess surplus in stocks.

Another point related to food grains production in the country is the issue of water use. The pioneering regions of Green Revolution in Punjab and Haryana have been experiencing indiscriminate withdrawals of groundwater. This has resulted in mining of groundwater resources more than the annual replenishment. As a result, there has been a continuous fall in water table in this region. Gulati et al. (2012) is of the view that water use in Punjab's agriculture has reached an alarming state and policy priority be shifted from subsidies to investment. Product prices must reflect scarcity value of water. It is important that procurement policy for rice considerably improves in Eastern India where water is abundant. Simultaneously, new policies need to be designed for providing equally attractive alternative options to the existing rice producers in Punjab and Haryana to enable them to shift to other crops.

Income support will be less distorting to prices and cropping patterns. Some states have recently introduced income support to farmers and lessons learn from this experiment could be used to expand it to other states. But, if income support is provided in addition to existing procurement schemes, then government finance would be strained further and hinder other welfare schemes. It is necessary to examine the entire system of production of crops, procurement, and distribution of food grains in an integrated manner. As Basu (2010) argued 'Trying to correct one segment of this complicated system is likely to end up in failure and, at best, have limited success' (P. 9).

This paper has mostly focused on policy evolution to tackle undernutrition and evaluation of the extent of success of the policy. We list below some important nutrition and food security issues which were not the focus here:

- India remains home to the largest number of undernourished people in the world. About 15–20% of the population with an absolute size of 200–250 million were likely to be calorie deficient in 2011–12. The introduction of the NFSA in 2013 would have largely reduced this number by 2022. But, the left-out group needs special attention at the ground level in terms of both access and affordability for their nutritional and food security.
- Deficiency of several micronutrients with serious consequences on a large scale continue to be a problem. Urgent attention needs to be given to micronutrient supplements, fortification of food items, production of fruits and vegetables, and communication strategy. There has been a shift from quantity to quality in an average food consumption basket. Increased production and consumption of milk, pulses, fruits, and vegetables in recent years is a welcome development and this trend needs to be continued to overcome an extensive deficit of certain micronutrients.
- We need to guard against vulnerability of population to possible disasters and natural calamities following lessons learnt during COVID-19 to strengthen institutions for their efficient functioning.
- For the top two deciles, calorie intake remains above the upper limit of the RDA. While it may partly be due to meals taken by guests and other external members who are not counted as household members, it also partly reflects overconsumption leading to obesity which needs separate consideration. Obesity causes several diseases such as cardiovascular diseases, diabetes, cancers, and chronic respiratory diseases. Some of them are also referred to as diseases of affluence. Estimates indicate the incidence of obesity to be roughly about 15% in India with some urban areas having higher rates.

6 Conclusions

Food and nutrition adequacy are important measures of human welfare. The issues involved should be analysed from various angles such as food production, household access, adequate purchasing power, expenditure allocation, nutrient intake, access to clean water and sanitation, and nutritional education and communication. Faced with widespread hunger in the country, Indian policymakers focused on increasing food grain production in the initial decades after independence. The success of the green revolution was evident in the production of adequate food grains to meet domestic demand by the early 1970s when India did not depend on imports and subsequently turned to be an exporter of grains to the world market. Production exceeded domestic and external demand resulting in huge public stocks.

Success of the green revolution did not translate to food and nutritional security for *all* even after half a century. As government budgetary constraints got relaxed with

GDP growth, policymakers shifted attention to provision of minimum income to the poor to equip them with adequate purchasing power. The incidence of income poverty reduced over time due to the overall growth of the economy and specific wage and non-wage income-generating measures for the poor. Even then, the bottom 15–20% of the population do not get sufficient nutritional intakes like calorie, protein, and fat. Deficiency of micronutrients prevails for a wide section of the society. Anthropometric evidences related to stunting, wasting, and underweight among children point towards the prevalence of even larger incidence of undernourishment.

Several specific programmes and schemes have been introduced over the years for ensuring food and nutritional security. Included among them are the PDS system, the ICDS, and the self- and wage employment-oriented programmes. The National Food Security Act and the Mahatma Gandhi National Employment Guarantee Act empowered the poor with legal entitlements on food grains and employment for manual work. The mistargeting problem has reduced considerably in some of the programmes in part due to the technology-enabled identification process, but still remains to some extent.

The utility of the existence of institutions like the PDS could be evident during the COVID pandemic in so far as it enabled the government to quickly distribute food to a vast number of households. Similarly, MGNREGA played a major role in providing wage employment in rural areas for up to 100 days a year.

There have been commendable achievements during the last half a century in making the country self-sufficient and enabling exports. Yet, there is no room for complacency on food security front and major tasks remain ahead. Reaching out to the bottom of the pyramid for adequate nutrition remains a major challenge for the near future. Children and women particularly belong to the vulnerable malnourished groups even among those who are above the poverty line and programmes like the ICDS need reorientation for coverage and efficiency. Deficit of micronutrients among the poor as well as the rich call for urgent policy attention. Huge food grains stock with the government is putting strains on government budget and calls for a new look for designing an efficient market intervention mechanism.

References

Afridi, F., Mahajan, K., & Samgwan, N. (2021). *Did MGNREGA cushion job losses during the pandemic*. Ideas for India. https://thewire.in/labour/mnrega-cushion-job-losses-during-the-pandemic-covid-19-crisis.

Barker, D. J. (1995). Fetal origins of coronary heart disease. *BMJ (clinical Research Edition), 311*(6998), 171–174. https://doi.org/10.1136/bmj.311.6998.171

Barrett, C. B., & Lentz, E. C. (2016). Hunger and food insecurity. In D. Brady & L. M. Burton (Eds.), *The Oxford Handbook of Social Science of Poverty*. Oxford University Press.

Basu, K. (2010). *The economics of foodgrain management in India.* Ministry of Finance. Government of India.

Behrman, J. R., Calderon, M. C., Preston, S. H., Hoddinott, J., Martorell, R., & Stein, A. D. (2009). Nutritional supplementation in girls influence the growth of their children: Prospective study in Guatemala. *The American Journal of Clinical Nutrition, 90*, 1372–1379.

Bhutta, Z. A., Ahmed, T., Black, R. E., Cousens, S., Dewey, K. G., Giugliani, E., Haider, B. A., Kirkwood, B., Morris, S. S., Sachdev, H. P. S., & Shekar, M. (2008). What work? Interventions for maternal and child undernutrition and survival. *The Lancet, 371*, 417–440.

Chand, R. (2003). *Government Intervention in Foodgrain Markets in the New Context*. Policy Paper 19, National Centre for Agricultural Economics and Policy Research.

Datt, G., Ravallion, M., & Murgai, R. (2016). *Growth Urbanization and Poverty Reduction in India.* NBER Working Paper 21983.

Devereux, S. (1993). *Theories of Famine*. Harvester Wheatsheaf.

Devereux, S., Vaitla, B., & Swan, S. H. (2008). *Seasons of Hunger: Fighting Cycles of Quiet Starvation Among the World's Rural Poor*. Pluto Press.

Dev Mahenda, S., & Pandey, V. L. (2022). Dietary diversity, nutrition and food safety. In R. Chand, P. Joshi, & S. Khadka (Eds.), *Indian Agriculture Towards 2030*, NITI Aayog, FAO and Springer.

Dreze, J., & Somanchi, A. (2021). The covid crisis and food security. Ideas for India. https://www.ideasforindia.in/topics/poverty-inequality/the-covid-19-crisis-and-food-security.html.

Ganesh-Kumar, A., Gulati, A., & Cumming, R., Jr. (2007). *Foodgrains policy and management in India—Responding to today's challenges and opportunities*. PP-056, Indira Gandhi Institute of Development Research, Mumbai and International Food Policy Research Institute (IFPRI).

Government of India. (1979). *Report of the task force on projection of minimum needs and effective consumption demand*s. Planning Commission.

Indian Council of Medical Research. (2010). *Nutrient requirements and recommended dietary allowances for India.* ICMR.

Meenakshi, J. V., & Viswanathan, B. (2013). Estimation of calorie norms and measurement of food intake: Some implications for the magnitudes of the prevalence of undernutrition in India. *Indian Economic Review (Special Issue on "Perspectives on Economic Development and Policy", XLVIII*(1), 167–188.

Murray, C. J., & Lopez, A. D. (1997). Mortality by cause for eight regions of the world: Global burden of disease study. *Lancet (london, England), 349*(9061), 1269–1276. https://doi.org/10.1016/S0140-6736(96)07493-4

National Council of Applied Economic Research. (2015). *Evaluation study of targeted public distribution system in selected states*. NCAER.

NITI Aayog. (2019). *Localising SDGs early lessons from India.* Government of India. www.niti.gov.in//www.niti.gov.in.

NITI Aayog. (2021). *SDG India index & dashboard 2020–21—Partnerships in the decade of action.* Government of India. www.niti.gov.in//www.niti.gov.in.

Panda, M. (1999). Growth with equity: Policy Lessons from the experience of India. In *Growth with Equity: Policy Lessons from the Experiences of Selected Asian Countries*. United Nations (ST/ESCAP/2007).

Panda, M., & Chakrabarti, S. (1981). Measurement of incidence of undernutrition. *Economic and Political Weekly, XVI*(31).

Parikh, K. S., Narayana, N. S. S., Panda, M., & Ganesh Kumar, A. (1997). Agricultural liberalization: Growth, welfare and large country effects. *Agricultural Economics*, *17*(1).

Pelletier, D. L. (1994). The potentiating effects of malnutrition on child mortality: Epidemiologic evidence and policy implications. *Nutrition Reviews, 52*(12), 409–415. https://doi.org/10.1111/j.1753-4887.1994.tb01376.x

Ravallion, M. (1997). Famines and economics. *Journal of Economic Literature, 35*, 1205–1242.

Sen, A. (1981). *Poverty and Famines*. Clarendon Press.

Strauss, J., & Thomas, D. (1998). Health, nutrition, and economic development. *Journal of Economic Literature, 36*(2), 766–817. Retrieved February 2, 2021, from http://www.jstor.org/stable/2565122.

Sukhatme, P. V. (1978). Assessment of adequacy of diets at different income levels. *Economic and Political Weekly, 13*(31/33), 1373–1384.

Sukhatme, P. V. (1981). On measurement of poverty. *Economic and Political Weekly, 16*(32), 1318–1324.

Webb, P., Coates, J., Frongillo, E. A., Rogers, B. L., Swindale, A., & Bilinsky, P. (2006). Measuring household food insecurity: Why it's so important and yet so difficult to do. *The Journal of Nutrition, 136*, 1404S-1408S.

Dreze, J., & Sen A. (1989). Hunger and public action. United Nations University World Institute for Development Economics Research (UNU-WIDER) and Clarendon Press, Oxford

Gulati, A, Gujral J., & Nandakumar T. (2012). National food security bill challenges and options, Discussion paper No. 2, Commission for agricultural costs and prices, Government of India

Planning Commission (2009). Report of the expert group to review the methodology for estimation of poverty. New Delhi: Government of India

Planning Commission (2013). Press Note on Poverty Estimates, 2011–12. Press Information Bureau, Government of India 22 July 2013

Planning Commission (2014). Report of the Expert Group to Review the Methodology for Estimation of Poverty. New Delhi: Government of India

Radhakrishna, R. (2005). Food and nutrition security for the poor in India. *Economic and Political Weekly, 40*(18), April

World Bank (2016). Poverty and shared prosperity 2016: Taking on Inequality. Washington, DC: World Bank

In the Pursuit of an Appropriate Calorie Intake Norm for Indian States

Md. Zakaria Siddiqui and Tauhidur Rahman

1 Introduction

India's nutrition intake faces several paradoxical empirical phenomena. First, there is a consistent temporal decline in per capita calorie intake in India while the per capita individual income has been increasing. A significant amount of academic effort has been devoted to rationalizing it (e.g. Deaton & Dreze, 2009; Gaiha et al., 2013; Desai & Thorat, 2013; Eli & Li, 2013; Basole & Basu, 2015, Duh & Spears, 2017; Siddiqui et al., 2019). Second, calorie intake varies significantly across Indian states and is in a counterintuitive direction: the states with better health and nutritional outcomes have lower per capita calorie intakes, while the states with poor health and nutritional outcomes have higher per capita calorie intakes. Third, the states with lower prevalence of nutritional deficiencies have higher prevalence of calorie deficiency.

Thus, the input measures of nutrition (i.e. calorie intake) and nutritional outcomes for Indian states are not strongly correlated (Meenakshi, 2012; Meenakshi & Viswanathan, 2017). While it is understood that caloric intake is not the sole factor behind the anthropometric indicators of the nutritional outcomes, very weak positive correlations between them pose a challenging phenomenon for researchers. Further, if sufficiency in calorie intake is indeed relevant for determining nutritional outcome, as many would agree, then there is a problem in the way calorie deficiency is being measured in India. In this study, we focus on this measurement problem.

Developing an appropriate measurement of calorie deficiency that is responsive to the anthropometric outcomes of the population is important for a variety of reasons,

Md. Z. Siddiqui (✉)
Department of Economics, Jamia Millia Islamia, New Delhi, Delhi, India
e-mail: zakaria.jnu@gmail.com

T. Rahman
Department of Agricultural and Resource Economics, University of Arizona, Tucson, AZ, USA
e-mail: tauhid@email.arizona.edu

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_3

including for a better understanding of the nutritional challenges that we face in India. In addition, it has implication for global reporting on nutrition and health. Prevalence of Undernutrition (PoU), or calorie intake deficiency, is one of the key indicators that the Food and Agriculture Organization (FAO) of the United Nations reports in its flagship publication, *The State of Food Security and Nutrition in the World* (SOFI). PoU is also used in Global Hunger Index with one-third of the weight assigned to it. Also, it is one of the indicators for sustainable development goals (SDG 2.1.1), relating to achieving the goal of zero hunger (SDG2). India accounted for 27.2% of the world population with calorie deficiency in 2018–20 (SOFI, 2021). As a result, the global estimate of PoU is expected to be highly sensitive to India's level of PoU. Therefore, it is important that PoU in India is estimated appropriately.

The puzzling aspect of Indian nutrition story is that states such as Kerala and Tamil Nadu, that are among the better performing Indian states in terms of health and economic outcomes, have higher PoU compared to states such as Bihar and Uttar Pradesh that are among the worst performing states of India. In 2011–12, the per capita daily calorie intakes in Bihar and Uttar Pradesh were 2057 and 2116 Kcals, respectively. The corresponding rates in Tamil Nadu and Kerala were 1925 and 1974 Kcals, respectively (NSSO 2014). This is contrary to the conventional wisdom that, by standard of nationally determined minimum dietary energy requirement (MDER), the states with lower per capita calorie intakes should have higher prevalence of PoU and they should have increased over time given that the per capita calorie intake has been declining. These complex features of calorie intake in India have been described as the Indian calorie consumption 'puzzle' (Deaton & Dreze, 2009).

1.1 Potential Explanations

A growing body of literature suggests that the environmental or contextual factors can partly explain the spatial and temporal variations in caloric intakes in India. Such factors may include differences in the epidemiological environment, health infrastructure, and mechanization of state economies. For instance, people living in less healthy environment generally consume more calories even if they are poor (Duh & Spears, 2017; Siddiqui et al., 2019).

Approximately 10% of the total variation in the per capita calorie intake across Indian states can be attributed to the interstate variations in disease environment and health infrastructure (Siddiqui et al., 2019). In other words, people residing in the states with better health infrastructure and epidemiological environment have lower calorie intakes, which is consistent with the biomedical literature that suggest that people living in infectious environments may suffer from intestinal health, necessitating higher calories for a given level of effective calorie need (Duh & Spears, 2017). For example, people living in infectious environment likely suffer more from a subclinical (undetected) medical condition known as Environmental Enteric Dysfunction (EED), where villi or tentacles of small intestine responsible for absorbing nutrition

from food are damaged, resulting in reduced absorption efficiency. Interestingly, EED is also responsible for stunting among young children (Budge et al., 2019).

Therefore, calorie needs of population may vary according to their epidemiological environments. Indian states, especially since 1990s, have witnessed divergent economic and health outcomes (Pingali & Aiyar, 2018). Therefore, it is plausible that they also differ significantly in their epidemiological environments. If this is the case, it will be contrary to the uniform MDER prescribed by Indian Council of Medical Research (ICMR). That is, the uniform calorie norm currently in practice in India does not account for the regional variation in calorie needs and requirements.

Another factor that may explain the regional variation in calorie intake is the variation in mechanization of state economies. Studies have shown that one-third of the decline in the calorie intake in India can be attributed to the reduced physical activity and mechanization of work environment (Eli & Li, 2013, 2021). While this finding is temporal, given the stark variation in economic growth rates across Indian states, variation in mechanization of state economies cannot be ruled out.

In fact, regional variation in various dimensions of development in India is a less studied area. Since the introduction of economic liberalization policy in 1990s, the state economies have diverged widely in terms of economic growth and per capita income (Cherodian & Thrilwall, 2015; Ahluwalia, 2000; Baddeley et al., 2006; Sanga & Shaban, 2017). Therefore, it is reasonable to assume that Indian states have also diverged in their contextual factors (e.g. epidemiological environment, health infrastructure, and mechanization), which also determine calorie intakes.

The remainder of this study is organized as follows. In Sect. 2, we present an empirical strategy to identify the importance of contextual factors in determining per capita calorie intakes across Indian states. We also describe a methodology for recalibrating the national-level MDER to impute state-specific MDER, accounting for the calorie intake that can be attributed to the contextual factors. In Sect. 3, we discuss our results and their implications. Concluding remarks are provided in Sect. 4.

2 Empirical Strategy

Our objective here is to address nutrition 'puzzle' of the *prima facie* lack of correlation between deficiencies in nutritional intake and health outcomes in Indian states. Meenakshi and Viswanathan (2017) and Meenakshi (2012) find that PoU or the deficiencies in nutritional (caloric) intake have no relationship with the anthropometric measures of health such as prevalence of wasting and stunting among children under 5 years, anaemia rates among women of reproductive age, and prevalence of adult undernutrition (i.e. adults with g BMI < 18.5).

2.1 Relationship Between Deficiencies in Nutritional Intake and Health Outcomes

We re-examine the findings of Meenakshi and Viswanathan (2017) to re-establish the *prima facie* lack of correlation between the deficiencies in nutritional intake and outcomes based on the uniform calorie norm-based measure of PoU, as is the practice of FAO and Indian agencies. National Institute of Nutrition operating under the umbrella of ICMR prescribes MDER for individuals based on their age, sex, and activity status roughly after every 10-year period (ICMR-NIN, 2009, 2020). Irrespective of the state of residence, the prescription is uniformly applicable to all individuals in India. Viswanathan and Meenakshi (2006) propose a method that permits conversion of the individual-level MDER to household level, using age and sex of the household members and the activity status of the household (also see Chand & Jumrani, 2013). The method can be expressed as follows:

$$MDER_h = \sum_{i=1}^{n} MDER_i \,|_{\text{age,sex}} \tag{1}$$

Note that MDER of an individual in a household depends on age and sex and activity status of the household. All individuals in a household are assumed to have same activity status, according to the principal economic activity of the household. This assumption is mainly due to lack of data on individual-level activity status.

Using Eq. 1, we calculate each household's aggregate MDER ($MDER_h$) and compare it with the actual calorie consumption of the household to check whether the household is deficient in calorie consumption. For this, we utilize data from Consumption Expenditure Survey (CES), conducted by National Sample Survey Office (NSSO) during 2011–12. The CES data is nationally representative and it provides information on quantity and expenditure on approximately 450 items. Given the calorie, fat, and protein contents of the food items and their quantities consumed, a household's total calorie, fat, or protein intake can be estimated.

Then we examine if PoU measured using $MDER_h$ is correlated with the anthropometric outcomes. For this purpose, we use district-level aggregation to ensure a reasonable sample size. We use micro-data from the National Family Health Survey 2015–16 to compute the anthropometric outcomes, which is the closest available survey to 2011–12 CES data. We note that this analysis is based on the uniform national MDER norm and thus we are yet to account for the regional differences in MDER that can occur due to the regional differences in households' contextual environments. This is our next task.

2.2 The Roles of Contextual Factors

We examine the potential independent roles of contextual factors in determining the calorie intake across Indian states. Our goal is to estimate the variation in per capita calorie intakes across Indian states that can be attributed to the prevailing state-level contextual factors. Thus, in addition to household socio-economic and demographic determinants of calorie intake, we account for factors at neighbourhood (meso) and state (macro) level. For example, households from a particular village may have common food consumption practices that affect their calorie intake. Similarly, households from a particular state may be sharing some common characteristics that affect their calorie intakes.

To account for such influences, a multilevel model is more appropriate, which allows for exploring the independent but unobserved effects of neighbourhood (meso)- and state (macro)-level factors on calorie intakes. Also, a multilevel model allows for additional random components based on assumption of spatial clustering of observations at different levels, expressed below:

$$C_{hjk} = \alpha_0 + \beta_1 X_{1hjk} + \beta_2 X_{2hjk} + \cdots + \alpha_k + \gamma_{jk} + \varepsilon_{hjk} \quad (2)$$

C_{hjk} is per capita per day calorie intake of household h in village j in state k, α_0 is the India-level intercept term, X s are socio-economic and demographic factors that can affect calorie intake of households, β s are their corresponding effects, and ε_{hjk} is household-specific idiosyncratic error term. The model in Eq. 2 differs from the standard regression model because of α_k and γ_{jk}. α_k is the random intercept term that captures intercept deviation of a particular state from the national-level intercept (α_0). Therefore, the intercept for state k is $\alpha_0 + \alpha_k$.

While we have not discussed any issue concerning village-level calorie intake pattern, it is important to account for potential village-level clustering of the households. γ_{jk} is an additional random intercept term that accounts for intercept variation by village j situated in state k. Thus, the intercept for village j is $\alpha_0 + \alpha_k + \gamma_{jk}$. The estimate of variances associated with the contextual random intercept terms (α_k and γ_{jk}), expressed as share of the total variance in calorie intake, will indicate their relative importance.

Further, another benefit of using a multilevel model is that we can introduce independent variables at meso- and macro-levels. After estimating Eq. 2 and the variances of the random components, we also estimate the following specification:

$$C_{ijk} = \alpha_0 + \beta_1 X_{1ijk} + \beta_2 X_{2ijk} + \cdots + \pi_1 S_{1k} + \pi_2 S_{2k} + \cdots + \alpha_k + \gamma_{jk} + \varepsilon_{ijk} \quad (3)$$

Equation 3 is essentially same as Eq. 2 except for additional independent variables operating at state level (S). We note that S variables are invariant for all households from a particular state. In other words, the values of S change for states and not for households within a state.

We are interested in the values of variance of state-level random component, i.e. $Var(\alpha_k)$ in Eqs. 2 and 3 to examine the roles of S variables in determining the calorie intakes. If S variables are successful in significantly reducing $Var(\alpha_k)$ from Eqs. 2 to 3, we can establish that S variables are indeed the contextual factors that also determine calorie intake of households. Since S variables are above and beyond the individual household influences, they are exogenous to households and are affecting their calorie intakes. Therefore, presence or absence of these environmental factors will necessitate households to consume higher or lower calorie.

To estimate Eqs. 2 and 3, we utilize data on household- and state-level characteristics, which are below.

Household characteristics: We use monthly per capita consumption expenditure (MPCE) as a measure of the economic status of a household. In the absence of income or asset information in CES data, MPCE is the best available measure of a household's economic status. It is well known that economic status measures are often skewed in distribution. As a result, we apply a compression of the order of 0.4 (i.e. $MPCE^{0.4}$) and use it instead of MPCE. Further, given a non-linear relationship between economic status and calorie intake, we include a square term for $MPCE^{0.4}$. We use mean years of schooling of adults in a household as proxy of its educational status. Physical nature of occupation of a household may be an important determinant in its calorie intake. Households with occupations demanding physical exertion are expected to have higher calorie intake. Therefore, we account for physical nature of occupation, which is captured by a binary variable that takes the value 1 if the household's major source of income is a physically demanding occupation, otherwise it takes the value 0. Information on physical activity status of a household is derived from the household's principal occupation reported in the form of National Classification of Occupation (NCO-2004) category codes.

Among demographic characteristics of a household, we use household size, and household head's gender and age. We also control for socio-religious status of a household. For Hindus, we use caste categories such as SC, ST, and other-Hindus. For Muslims, Sikhs, and Christians, we include separate dummy variables. According to the existing literature, household size is inversely related to calorie intake. Household head's age is expected to be positively related to calorie intake. Further, a positive association between calorie intakes and female-headed households has been documented. We also account for two additional factors that may have direct positive effects on calorie intakes (i.e. possession of cultivable land and access to PDS).

Contextual factors: To capture environmental determinants of calorie intake, we use state-level rural/urban-specific prevalence rate of stomach problems, malaria, skin disease, and fever due to a disease other than malaria experienced within 365 days as proxy measures for an infectious environment. These variables have been calculated using micro-data from the 'Drinking Water, Sanitation, Hygiene and Housing Condition' survey, conducted by NSSO in 2012. We have also account for health infrastructure and mechanization of state economies. However, the latter are expected to be highly correlated with each other. As a result, including them separately in Eq. 3

may produce imprecise estimates. Thus, we use state-level MPCE, calculated separately for rural and urban areas, as the composite index for health infrastructure and mechanization of a state economy.

2.3 Adjustment of the MDER

We adjust the MDER to account for the variation in the contextual environments of the states, using the following procedure:

$$\textit{State Adjusted MDER}_h = \sum_{i=1}^{n} \textit{MDER}_i + \left[\pi_1\left(S_{1k} - \overline{S_1}\right) + \pi_2\left(S_{2k} - \overline{S_2}\right)\right] * \textit{HHSize}_h \qquad (4)$$

where $\overline{S_1}$ is rural (or urban) India-level mean prevalence rate of infections; $\overline{S_2}$ is rural (or urban) mean MPCE of India, representing national-level mean of contextual or macro-environment variables; S_{1k} and S_{2k}. *HHSize* is household size. Multiplication of $\left[\pi_1\left(S_{1k} - \overline{S_1}\right) + \pi_2\left(S_{2k} - \overline{S_2}\right)\right]$ with household size is required because regression co-efficient is derived using per capita calorie intake as dependent variable. $\textit{StateAdjustedMDER}_h$ computed in this manner is likely to be higher than the $\textit{MDER}_h$ for households in the states with worse than average levels of S and vice versa. Accordingly, PoU measures will also be impacted. States where $\textit{StateAdjustedMDER}_h$ is greater than the $\textit{MDER}_h$, PoU will increase, while the opposite is expected for the states where $\textit{StateAdjustedMDER}_h$ is less than $\textit{MDER}_h$.

Finally, we examine if PoU measured using $\textit{StateAdjustedMDER}_h$ is correlated with the anthropometric outcomes. For this also, we use district-level data.

3 Results

3.1 Correlation Between the Conventional Measure of PoU and Anthropometric Outcomes

We first re-establish that the conventional measure of PoU is not strongly correlated with the anthropometric outcomes, such as the prevalence of stunting, wasting, under-5 mortality rate, and the prevalence of adult underweight (BMI < 18.5), shown in Fig. 1. While the measures of the anthropometric outcomes are objective and do not suffer from serious measurement errors, the measurement of PoU involves assumptions about caloric requirements of the relevant population which may often be subjective. The choice of a benchmark or MDER is critical to the measurement of PoU, which differs across countries. Given significant variations in socio-economic

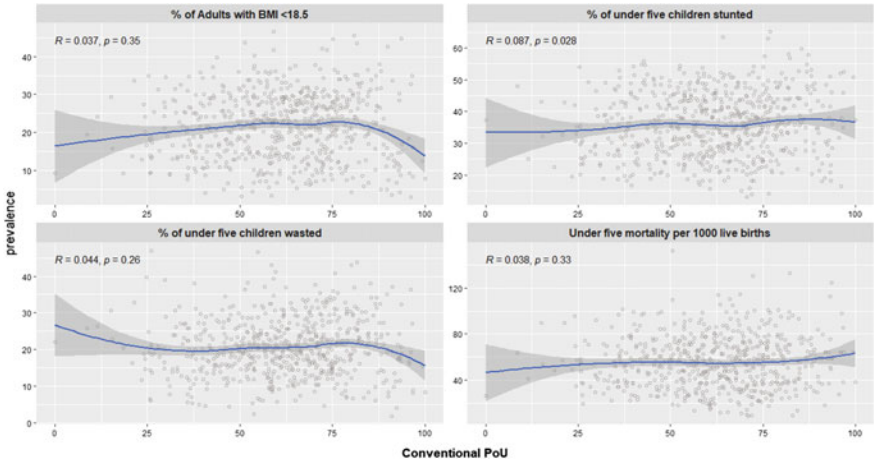


Fig. 1 Correlation between the conventional measure of PoU and the anthropometric outcomes. *Source* Estimated from National Family Health Survey 2015–16 data

and demographic characteristics across Indian states, as discussed earlier, it is likely that the uniform national norm for MDER is mistaken.

Figures 2 and 3 clearly show that Kerala and Tamil Nadu, despite having higher levels of economic affluence and superior anthropometric outcomes, have lower per capita calorie intake compared to the poorer states of India, Bihar and Odisha. This result lends credence to the idea that the lower per capita calorie intake is perhaps driven more by the lower calorie needs in these states rather than the economic circumstances that could constrain household food expenditure.

This is further corroborated by significant difference in the calorie consumed in different regions. Figure 4 shows that the share of fat and protein (non-carbohydrate) in total calorie intake is higher, on average, in the states that have lower calorie intake, and this applies to economic deciles as well. Moreover, the states with lower calorie intakes also have higher expenditure on per unit calorie for every economic class in the rural areas. These results provide strong support for the argument that lower calorie intake in Kerala and Tamil Nadu is because of lower needs rather than economic constraints.

Next, using multivariate statistical analysis, we further reaffirm the calorie consumption 'Puzzle' in India. Also, we establish the extent to which calorie consumption can be attributed to macro-environmental factors (e.g. disease environment, health infrastructure and level of mechanization in the economy).

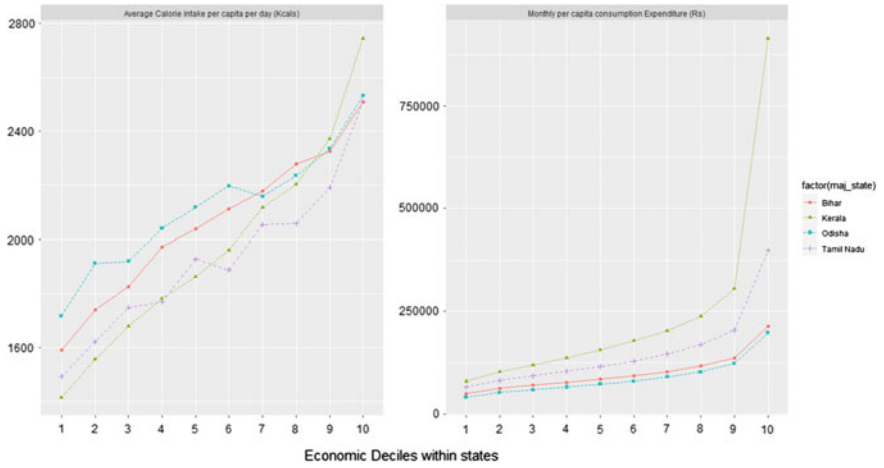


Fig. 2 Per capita calorie intake per capita per day in rural areas, 2011–12. *Source* Calculated from micro-data of NSSO's consumption expenditure survey 2011–12

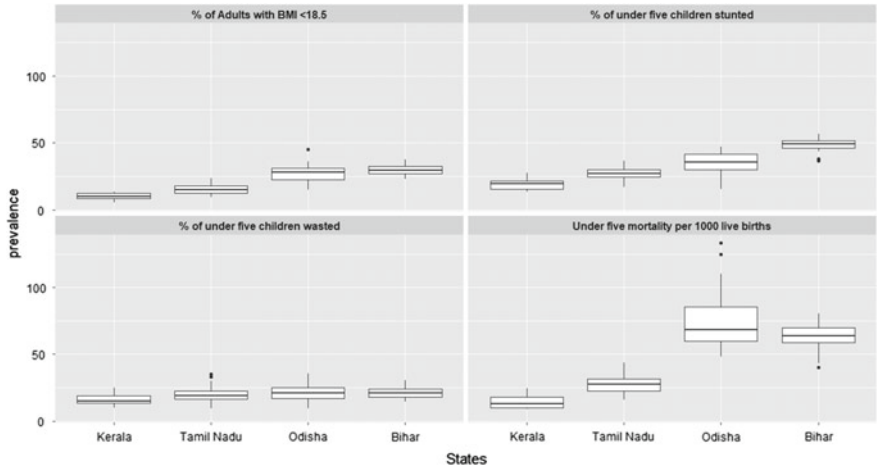


Fig. 3 Distribution of anthropometric outcomes across districts of states, 2015–16. *Source* Estimated from National Family Health Survey 2015–16 data

3.2 Contribution of Macro-environmental Factors

We estimate and examine effects of macro-environment factors on calorie intake, separately for the rural and urban India. We estimate two specifications for rural India and two specifications for urban India. In the first specification, we do not account for the variation across Indian states in their macro-environments, but we do so in the second specification.

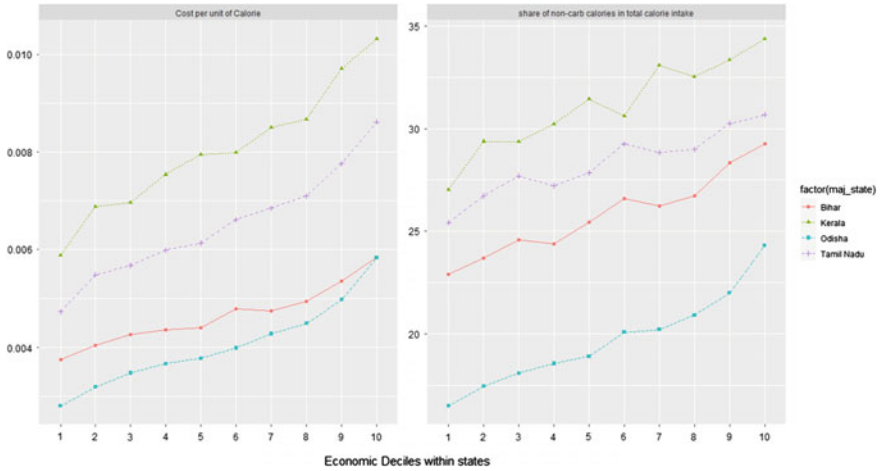


Fig. 4 Cost per unit of calorie and share of non-carb (fat and protein) calories in rural areas of select states by economic class, 2011–12. *Source* Calculated from micro-data of NSSO's consumption expenditure survey 2011–12

Table 1 provides component-wise variances and their relative shares in the total variance of the calorie intake. Importance of the contextual or macro-environmental factors can be inferred from the fact that the variance of random intercept for states is approximately 8.3% of the total variance of per capita per day calorie intake in rural India (Model 1.1). Even in urban India, the share of state random intercept variance is approximately 5.13% (Model 2.1). Interestingly, with the inclusion of macro-environment factors (i.e. infectiousness of environment and state average MPCE), the variance of state-level intercept reduces to less than 1% without having any major effect on PSU and individual-level random components' variance share (Models 1.2 and 2.2). This implies that our macro-environment variables capture the variance at state level.

Table 2 presents the results from the estimation of Eqs. 2 and 3 in Sect. 2. We present the results separately for the rural and urban India. The results are broadly consistent across two specifications and rural/urban India. As expected, the economic status of a household, captured by MPCE, has a strong non-linear positive effect on its calorie intake, but with a decreasing marginal effect. Note that MPCE has been compressed to the degree of 0.4 to treat the skewness in its distribution. Interestingly, when MPCE is aggregated at state level, it has the opposite effect. Recall that we use state average MPCE as the proxy for state health infrastructure and mechanization level of state economy. While other socio-economic factors such as physical nature of occupation of the households necessitate higher calorie consumption, the higher levels of education of households are negatively associated with their calorie intakes.

Among demographic factors, household size has an inverse relationship with calorie intake, which is consistent with the previous findings (Deaton & Paxson,

Table 1 Variance in calorie intake attributable to different components of multilevel models

Model component	Rural India				Urban India			
	Without macro-environment factors		With macro-environment factors		Without macro-environment factors		With macro-environment factors	
	Model 1.1		Model 1.2		Model 2.1		Model 2.1	
	Component variance	Share in total variance	Component variance	Share in total variance	Component variance	Share in total variance	Component variance	Share in total variance
Model								
Explained by covariates	115,661.36	31.38	142,683.64	38.71	157,932.41	38.34	175,958.35	42.72
Random intercept for state	30,443.95	8.26	3425.16	0.93	21,138.69	5.13	3106.14	0.75
Random intercept for PSU	41,558.39	11.27	41,552.60	11.27	46,271.40	11.23	46,281.02	11.24
Residual	180,974.20	49.09	180,976.50	49.09	186,565.60	45.29	186,562.60	45.29
Total	368,637.90	100.00	368,637.90	100.00	411,908.10	100.00	411,908.10	100.00

Source Computed from regression results reported in Table 2

Table 2 Regression results for rural and urban India

	Rural		Urban	
	Without macro-environment factors	With macro-environment factors	Without macro-environment factors	With macro-environment factors
Model number →	*Model 1.1*	*Model 1.2*	*Model 2.1*	*Model 2.2*
$MPCE^{0.4}$	18.03^{***} (111.62)	18.04^{***} (111.70)	18.27^{***} (76.11)	18.28^{***} (76.15)
$(MPCE^{0.4})^2$	-0.0181^{***} (−57.06)	-0.0181^{***} (−57.11)	-0.0252^{***} (−43.52)	-0.0252^{***} (−43.54)
Household size	-51.00^{***} (−48.66)	-50.97^{***} (−48.64)	-71.12^{***} (−51.72)	-71.07^{***} (−51.70)
Holds PDS card	87.90^{***} (16.92)	87.98^{***} (16.96)	85.22^{***} (12.13)	85.57^{***} (12.20)
Area of cultivable land	17.69^{***} (16.32)	17.71^{***} (16.35)	xx	xx
Physical occupation	34.96^{***} (5.85)	35.03^{***} (5.87)	42.70^{***} (6.92)	42.52^{***} (6.89)
Mean years schooling adults	-9.156^{***} (−13.63)	-9.199^{***} (−13.70)	-10.66^{***} (−13.69)	-10.69^{***} (−13.73)
Female-headed household	29.15^{***} (4.19)	29.22^{***} (4.20)	34.39^{***} (4.31)	34.45^{***} (4.31)
Age: head of household	2.949^{***} (17.88)	2.945^{***} (17.86)	2.637^{***} (13.08)	2.627^{***} (13.04)
Non-SC/ST Hindu	Ref category	Ref category	Ref category	Ref category

(continued)

Table 2 (continued)

	Rural		Urban	
	Without macro-environment factors	With macro-environment factors	Without macro-environment factors	With macro-environment factors
Muslims	−44.70*** (−5.29)	−45.64*** (−5.41)	11.50 (1.26)	11.44 (1.25)
Christian	−25.85 (−1.66)	−26.27 (−1.68)	−9.408 (−0.56)	−9.312 (−0.55)
Sikh	68.03** (2.82)	66.99** (2.82)	14.88 (0.66)	13.20 (0.58)
Hindu-SC	−26.60*** (−4.25)	−26.62*** (−4.25)	7.950 (0.92)	7.807 (0.91)
Hindu-ST	2.983 (0.33)	2.734 (0.30)	31.23* (2.05)	30.87* (2.03)
Others	−9.228 (−0.35)	−9.545 (−0.36)	−22.64 (−1.05)	−22.53 (−1.05)
State MPCE	xx	−0.383*** (−5.55)	xx	−0.259*** (−4.24)
Infectious environment	xx	704.2*** (6.00)	xx	651.3*** (4.67)
Intercept	463.7*** (9.95)	376.6*** (3.76)	458.5*** (10.45)	522.9*** (4.21)
Variance (state random intercept)	5.162*** (29.87)	4.069*** (22.31)	4.979*** (28.52)	4.021*** (20.91)

(continued)

Table 2 (continued)

	Rural		Urban	
	Without macro-environment factors	With macro-environment factors	Without macro-environment factors	With macro-environment factors
Variance (PSU random intercept)	5.317*** (369.78)	5.317*** (369.76)	5.371*** (314.21)	5.371*** (314.24)
Variance (individual error component)	6.053*** (1737.69)	6.053*** (1737.68)	6.068*** (1441.36)	6.068*** (1441.38)
N	47,164	47,164	32,439	32,439

t—statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source Estimated from NSSO's CES 2011–12 data

1998). Female-headed households have significantly higher calories than male-headed households. Age of the head of household has a positive and significant effect on calorie intake. Among the socio-religious groups, we find that Scheduled Tribes (STs) and Scheduled Castes (SCs), Sikhs, and Muslims have significantly higher calorie intakes than the upper-caste Hindus. However, the later results are limited only to the rural areas.

We also control for other two important factors that can have direct effects on calorie intakes (e.g. access to ration card for accessing food from public distribution system and availability of cultivable land). As expected, both have positive and significant effects on calorie intake. Naturally, we do not control for the availability of cultivable land for the urban households.

While the individual economic status has a strong positive effect on calorie intake, the state economic status has a negative effect on calorie intake. This is primarily because state-level improvement in economic status is strongly correlated with the improvements in health-related infrastructure and mechanization of state economy. Infectiousness of environment, our key contextual variable, measured as the prevalence rate of infectious diseases, in a state has a strong positive effect on calorie intake. This suggests that state-level disease prevalence is an important predictor of a household's calorie intake.

In sum, from Table 2, the macro-level context of the calorie intake in India is attributable to the macro-level environmental context.

This is key to our argument that a large proportion of regional variation in calorie intake is driven by differences in disease environment and level of health infrastructure and mechanization of the regional economy. Thus, the use of a nationally uniform MDER to assess the prevalence or intensity of calorie deficiency across states is bound to give a distorted picture of the reality.

3.3 Adjusted MDER

An advantage of multilevel models is that they allow us to estimate different intercepts corresponding to different levels of factors. To our analysis, macro-level intercept deviations are of particular interest because they show the relative position of each state after accounting for household-level covariates of calorie intake (see Fig. 5, i.e. predicted random intercepts for states from Models 1.1. and 2.1). That is, a state's higher negative (positive) intercept deviation from the overall (national) intercept indicates the prevalent macro-environmental context in state, which necessitates lower (higher) calorie intake. Also, as discussed in Sect. 3.2, we examine the extent of compression in bandwidth of intercept deviations after we adjust for macro-environment factors operating at state level (i.e. infectiousness and state of health infrastructure and mechanization) in addition to household covariates from Models 1.2. and 2.2.

Figure 5 shows the random intercept deviations of each state from the national-level intercept, both for rural and urban. In both rural and urban areas of Kerala and

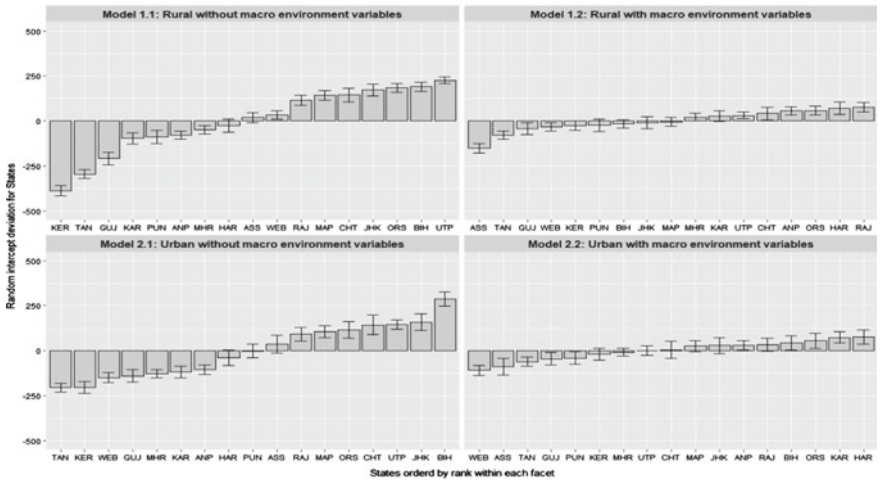


Fig. 5 Random intercept deviation of states from national-level intercept. *Note* ANP = Andhra Pradesh, ASS = Assam, BIH = Bihar, CHT = Chhattisgarh, GUJ = Gujarat, HAR = Haryana, JHK = Jharkhand, KAR = Karnataka, KER = Kerala, MAP = Madhya Pradesh, MHR = Maharashtra, ORS = Orissa, PUN = Punjab, RAJ = Rajasthan, TAN = Tamil Nadu, UTP = Uttar Pradesh, WEB = West Bengal. *Source* Derived from the in Table 2

Tamil Nadu, we find that their macro-environmental context induces households to consume fewer calories than the national average. On other hand, the situation is the exact opposite in Bihar, Uttar Pradesh, and Orissa. For instance, in rural (urban) Kerala, an average household consumes 388 (204) fewer calories than the national average. In contrast, in rural (urban) Bihar, an average household consumes about 191 (288) more calories than the national average. However, once we adjust for the macro-environment of the states, the deviations become insignificant for many of the states, which are reflected in significant compressions of the bandwidths of the intercept deviations of states. This implies that the macro-environment of a state has a significant effect on household calorie intake. Therefore, the uniform MDER needs to be adjusted for a more accurate estimate of prevalence or intensity of calorie deficiency.

Using the formula in Eq. 4 in Sect. 2.3, we arrive at the state-adjusted MDER. We calculate PoU using both the uniform national MDER and our state-adjusted MDER to examine the change in rank order of states. We rank the states in the increasing order of PoU levels, assigning the first rank to the state with the lowest PoU.

In Table 3, we present the result. Accordingly, Kerala, Tamil Nadu, Karnataka, Gujarat, and Telangana have the highest level PoU if we consider the uniform national MDER. However, their ranks improve if we use our state-adjusted MDER. In contrast, ranks of Bihar, Uttar Pradesh, Jharkhand, and Chhattisgarh become worse when we move from the uniform MDER to the state-adjusted MDER. Thus, the measure of PoU aligns better with the realities of everyday life across Indian states.

Table 3 State-level estimates of PoU and ranking-based different MDER norms

State	Rural				Change in rank [*col (4) minus col (2)*]	Urban				Change in rank [*col (9) minus col (7)*]
	National uniform MDER		State-adjusted MDER			National uniform MDER		State-adjusted MDER		
	PoU	Rank	PoU	Rank		PoU	Rank	PoU	Rank	
Col. No.	1	2	3	4	5	6	7	8	9	10
Andhra Pradesh	64.5	8	61.2	3	−5	46.4	4	34.6	1	−3
Assam	77.5	14	91.1	17	3	58.3	12	67.8	16	4
Bihar	63.0	6	82.5	14	8	46.4	5	64.1	15	10
Chhattisgarh	73.4	12	85.7	16	4	51.8	7	60.2	13	6
Gujarat	81.2	17	77.4	9	−8	53.4	9	42.6	3	−6
Haryana	60.8	4	59.9	2	−2	42.8	2	37.9	2	0
Jharkhand	62.8	5	82.5	15	10	51.4	6	59.8	12	6
Karnataka	76.5	13	74.0	8	−5	62.2	17	45.2	5	−12
Kerala	78.3	15	62.2	4	−11	61.8	16	47.9	9	−7
Madhya Pradesh	63.1	7	78.0	10	3	58.0	11	61.5	14	3
Maharashtra	68.8	10	70.2	6	−4	57.0	10	46.9	8	−2
Odisha	67.0	9	80.9	13	4	52.4	8	53.4	10	2
Punjab	52.9	2	56.7	1	−1	42.8	1	44.8	4	3
Rajasthan	51.7	1	63.3	5	4	44.0	3	46.4	6	3
Tamil Nadu	80.8	16	73.0	7	−9	61.5	15	46.9	7	−8
Uttar Pradesh	60.1	3	80.6	12	9	58.6	13	68.3	17	4
West Bengal	69.5	11	79.7	11	0	60.6	14	54.3	11	−3

Source Calculation based NSSO's CES Micro-data 2011–12

To test the correlation of PoU, based on the two alternative MDERs, with various anthropometric outcomes, we estimate district-level PoU using the state-adjusted MDER. Then we combine this data with the district-level data on the anthropometric or nutritional outcomes. Figure 6 presents scatter plot and Pearson's correlation coefficients between alternative PoU measures and respective prevalence of deficiencies in anthropometric measures. Correlations between the uniform national MDER-based PoU with the anthropometric health measures are statistically insignificant. In contrast, the corresponding correlations are statistically significant for the state-adjusted MDER except for prevalence of wasting (body mass faltering). Wasting of children has been a blind spot in India's nutrition story, as we have high prevalence of wasting even in the states that perform better in terms of stunting (height faltering). India has consistently remained an outlier nation with regard to wasting, performing worse than most Central African countries (Siddiqui et al., 2021).

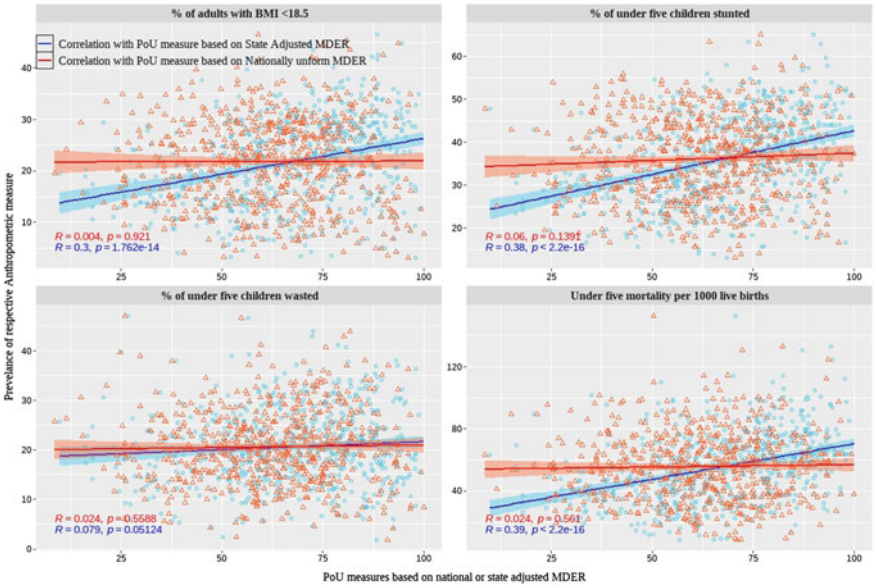


Fig. 6 Scatter plot and Pearson's correlation coefficients between alternative PoU measures and respective prevalence of deficiencies in anthropometric measures. *Source* District-level Anthropometric measures were obtained from NFHS 2015–16 micro-data and PoU measures were obtained NSSO's CES 2011–12 data

Given our analysis and results, it is clear that the uniform calorie norm or MDER standard in India needs to be corrected for accurately estimating PoU.

4 Conclusions

In this study, we attempt to provide a better measurement of PoU by proposing and using a state-adjusted measure of MDER. We start by highlighting the Indian calorie consumption 'puzzle', which has three distinct aspects. First, while per capita individual income has been increasing in India, the per capita calorie intake has been declining over time. Second, the states with better health and nutritional outcomes have lower per capita calorie intakes, and vice versa. Third, the states with lower nutritional outcome deficiencies have higher calorie deficiencies.

In recent years, studies have attempted to explain this puzzle. Among the alternative explanations, the roles of spatial variations in the environmental or contextual factors appear to be compelling. For instance, it has been argued that people living in less healthy environment consume more calories even if they are poor. More specifically, it has been documented that about 8–10% of the total variation in the per capita calorie intake across Indian states can be explained by the interstate variations in disease environment and health infrastructure. Another explanation for the Indian

calorie consumption puzzle is the role of mechanization of state economies. Studies have shown that one-third of the decline in the calorie intake in India can be attributed to the reduced physical activity and mechanization of work environment. This means that calorie needs of people may vary according to the epidemiological environments in which they live, which will be contrary to the uniform MDER prescribed by ICMR.

In this study, we revisit the Indian calorie consumption puzzle, and conduct the following analyses. First, we present and utilize an empirical strategy to examine the roles of the contextual factors in determining per capita calorie intakes across states. Second, we describe and utilize a methodology to recalibrate the uniform national MDER to impute state-specific MDER, by accounting for the calorie intake that can be attributed to the contextual factors.

Our important findings are as follows. First, we confirm the Indian calorie consumption puzzle. Second, we replicate the finding in the literature that the measure of PoU using the uniform MDER is not significantly correlated with the anthropometric health outcomes. Third, we show that the variations in the contextual macro-environment significantly explain the variation in calorie intakes across states. Fourth, we show that the state-adjusted MDER is significantly and strongly correlated with the anthropometric health outcomes.

There are several implications of our findings. First, the uniform national MDER needs to be revised to reflect state-level variations of the contextual macro-environments (e.g. disease environment, health infrastructure, and mechanization of economies). Second, the Indian calorie consumption puzzle is not really a puzzle, because it can be significantly explained by regional variations in the contextual environments for calorie consumption needs. Finally, to estimate a more accurate estimate of PoU in India and the world, we recommend that state-adjusted MDER is used by Indian agencies and FAO.

Acknowledgements This research was financially supported by SPANDAN (System of Promoting Appropriate National Dynamism for Agriculture and Nutrition) housed at Indira Gandhi Institute of Development Research Mumbai (IGIDR). The SPANDAN initiative is supported by Bill and Melinda Gates Foundation.

Professor Manoj Panda, Prof. Brinda Viswanathan, and Prof. Mahadera Dev have commented on the earlier versions of the paper during three presentations that were made at IGIDR. These comments have improved our understanding and draft of the paper significantly.

Authors are also thankful to Ronald Donato and Jaya Jumrani as a significant progress on this line of research was made during a collaborative work on calorie puzzle.

References

Ahluwalia, M. S. (2000). Economic performance of states in post-reforms period. *Economic and Political Weekly, 35*(19), 1637–1648.

Baddeley, M., McNay, K., & Cassen, R. (2006). Divergence in India: Income differentials at the state level, 1970–97. *The Journal of Development Studies, 42*(6), 1000–1022.

Basole, A., & Basu, D. (2015). Fuelling calorie intake decline: Household-level evidence from rural India. *World Development, 68*, 82–95. https://doi.org/10.1016/j.worlddev.2014.11.020

Budge, S., Parker, A. H., Hutchings, P. T., & Garbutt, C. (2019). Environmental enteric dysfunction and child stunting. *Nutrition Reviews, 77*(4), 240–253.

Chand, R., & Jumrani, J. (2013). Food security and undernutrition in India: Assessment of alternative norms and the income effect. *Indian Journal of Agricultural Economics, 68*(1), 39–53.

Cherodian, R., & Thirlwall, A. P. (2015). Regional disparities in per capita income in India: Convergence or divergence? *Journal of Post Keynesian Economics, 37*(3), 384–407.

Deaton, A., & Dreze, J. (2009). Food and nutrition in India: Facts and interpretations. *Economic and Political Weekly, 44*(7), 42–65.

Deaton, A., & Paxson, C. (1998). Economies of scale, household size and the demand for food. *The Journal of Political Economy, 106*(5), 897–930. https://doi.org/10.1086/250035

Desai, S., & Thorat, A. (2013). Beyond the great Indian calorie nutrition debate. *Economic and Political Weekly, 38*(45–46), 18–22.

Duh, J., & Spears, D. (2017). Health and hunger: Disease, energy needs, and the Indian calorie consumption puzzle. *The Economic Journal, 127*(606), 2378–2409.

Eli, S., & Li, N. (2013). *Can caloric needs explain three food consumption puzzle? Evidence from India.* https://www.dartmouth.edu/neudc2012/docs/paper_263.pdf.

Eli, S., & Li, N. (2021). Caloric intake and energy expenditures in India. *The World Bank Economic Review, 35*(4), 1057–1075.

Gaiha, R., Jha, R., & Kulkarni, V. (2013). Demand for nutrients in India: 1993 to 2004. *Applied Economics, 45*(14), 1869–1886.

ICMR-NIN. (2009). *Nutrient requirements and recommended dietary allowances for Indians.* ICMR-National Institute of Nutrition.

ICMR-NIN. (2020). *Nutrient Requirements for Indians, Recommended Dietary Allowances (RDA) and estimated average requirements.* ICMR-National Institute of Nutrition.

Meenakshi, J. V. (2012). Undernutrition. In K. Basu & A. Maertens (Eds.), *The New Oxford Companion to Economics in India.* Oxford University Press.

Meenakshi, J. V., & Viswanathan, B. (2017). Estimation of calorie norms and measurement of food intakes: Some implications for the magnitudes of the prevalence of undernutrition in India. In *Perspectives on Economic Development and Policy in India* (pp. 169–189). Springer.

National Sample Survey Office (NSSO). (2014). *Nutritional intake in India, 2011–12*, NSS 68th round, report no. 560(68/1.0/3). Ministry of Statistics and Programme Implementation, Government of India.

Pingali, P., & Aiyar, A. (2018). Diversity in development: Inter-state differences in the India growth story. *World Food Policy, 4*(2), 57–77.

Sanga, P., & Shaban, A. (2017). Regional divergence and inequalities in India. *Economic & Political Weekly, 52*(1), 103.

Siddiqui, M. Z., Biswas, S., & Jose, S. (2021). Alarming hunger in India. Economic & Political Weekly, 56(50), 13–17.

Siddiqui, M. Z., Donato, R., & Jumrani, J. (2019). Looking past the Indian calorie debate: What is happening to nutrition transition in India. *The Journal of Development Studies, 55*(11), 2440–2459.

SOFI. (2021). *The state of food security and nutrition in the world 202: Transforming food systems for food security, improved nutrition and affordable healthy diets for all.* Rome, FAO. Food and Agriculture Organisation of United Nations.

Viswanathan, B., & Meenakshi, J. (2006). *The changing pattern of undernutrition in India: A comparative analysis across regions (Research Paper no. 2006/118).* UNU World Institute for Development Economics Research.

Status of Food Security in Poorest Part of India

Mapping the Food Security Situation in Rural Bihar and Jharkhand: Insights from Two Food Security Atlases

Alakh N. Sharma, Sunil K. Mishra, Tanushree Kundu, Swati Dutta, and Prashant Kumar Arya

1 Introduction

The persisting challenge of under-nutrition in India remains a major hindrance to achieving Sustainable Development Goals (SDGs), both, directly and indirectly, related to hunger and food security as well as other health-related outcomes. This paper provides a spatial overview of dimension specific as well as overall food security in Bihar and Jharkhand. It also explores the status of districts in terms of availability, access, utilization of food, and overall food security, and identifies some important policy variables for food-insecure districts.

In 2008, the Institute for Human Development (IHD) and the United Nations World Food Programme (WFP) together undertook an analysis of the dimensions of food security at the sub-state, or district level, for eight states of India, viz., Odisha, Jharkhand, Chhattisgarh, Madhya Pradesh, Rajasthan, Bihar, Uttar Pradesh, and Maharashtra (WFP-IHD, 2008). In 2018, IHD in partnership with the Indira Gandhi Institute of Development Research (IGIDR), Mumbai, prepared two new food security atlases one for Odisha (IHD-IGIDR, 2018a, b)[1] and the other for Bihar (IHD-IGIDR, 2018a, b) as follow-up work on the Food Security Atlas of Rural India.

Till 2000, both Bihar and Jharkhand formed the same state. In 2000, Jharkhand became a separate state. After the separation, both the states have performed rather well both in economic as well as social spheres. However, in terms of human development indicators, Bihar and Jharkhand have been among the most backward states in India. Bihar (52%) and Jharkhand (42%) also have the highest multidimensional

[1] The paper draws heavily from IHD-IGIRD (2022), IHD-IGIDR (2018a, b). This is being reused with permission.

A. N. Sharma (✉) · S. K. Mishra · T. Kundu · S. Dutta · P. K. Arya
Institute for Human Development, New Delhi, India
e-mail: alakh.sharma@ihdindia.org

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_4

poverty rates among the states (NITI Aayog, 2021). During 2020–21, Bihar and Jharkhand had per capita net state domestic product (NSDP) of ₹31,017 and ₹53,489, respectively, which represent 36% and 62% of the all-India average, respectively. Both of the states face several daunting challenges such as high incidence of poverty, disparities, poor performance of social and human development indicators, etc. Jharkhand's economy is characterized by higher inequality as compared to most other states of the country, including Bihar. Two-fifths of the under-five children in both the states are underweight in rural areas according to the National Family Health Survey (NFHS)-5, as compared to 33% in all of India. Also, in both states, nearly 70% of children in the 6–36-month age group suffer from anaemia. Higher proportion of women in Bihar (27%) and Jharkhand (29%) are found to be thin compared to 21% in all of India as per the NFHS-5. These indicators indicate that malnutrition is high among women and children in both the states. According to the composite SDG Index constructed by NITI Aayog, Bihar and Jharkhand are ranked second last and last among the states in terms of SDG 2 on zero hunger and overall development indices (Government of India, 2020–21). Thus, it is obvious that Bihar and Jharkhand are faced with a huge challenge in achieving higher food and nutrition security.

As far as food security issues in rural Bihar and Jharkhand are concerned, existing studies have used different indicators to assess the food security status of the states. For example, Gulati et al. (2012), classified the various Indian states based on two indices of malnutrition, namely, the Normalized Adult Malnutrition Index (NAMI) and the Normalized Child Malnutrition Index (NCMI). They found that all the eastern states fell in the top two categories of malnutrition, with Bihar faring the worst among them. A similar study conducted by the MS Swaminathan Research Foundation (MSSRF, 2008) classified various Indian states based on a composite index of food security using seven indicators and found that the eastern states such as Chhattisgarh and Jharkhand fell in the category of 'very high' food insecurity, while Bihar and Odisha were grouped in 'high' food insecurity category. Such levels of food insecurity and malnutrition prevalent in the eastern part of India reflect the inability of government-sponsored measures to alleviate food deficiency in the poverty-ridden pockets and show that the programmes have not efficiently reached the targeted beneficiary population. The *Food Security Atlas of Rural Jharkhand* (2008) found that the various districts of Jharkhand fared poorly on nutritional outcomes, with only the more urbanized and industrialized districts performing better. Access to road and irrigation were the two areas in which the state lagged considerably behind the country, while low per capita agricultural productivity was the feature of the state's rainfed agriculture (WFP-IHD, 2008). The Food Security Atlases for Rural Bihar and Rural Jharkhand were revisited in 2018 and 2022, respectively, using the latest data and wherever appropriate using some new variables but based on essentially the same methodologies adopted earlier (see IHD-IGIDR, 2018a, 2018b, 2022). This paper is based on the insights and main findings derived from the two atlases for Bihar and Jharkhand.

The paper is organized as follows: the introduction is followed by Sect. 2 which provides a conceptual framework for the study. Section 3 explains the details of the data and methodology. Section 4 discusses the major findings, and the last section provides the conclusions.

2 Conceptual Framework

Globally, the term food security is used in varied ways (Smith et al., 1993), but the most widely cited definition came from the first World Food Summit (FAO, 1996) which proposed that the food security 'exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'. According to this definition, food security encompasses four aspects: food availability, food accessibility, food utilization, and food stability (FAO, 2006; Gross et al., 2000). 'Food availability' refers to the physical quantity of food of an appropriate quality that is produced domestically and distributed (FAO, 2006). An individual's access to food can be determined by factors such as purchasing power, food prices, legal entitlements, and political will (FAO, 2008). The availability and access to food do not necessarily guarantee the reduction in malnutrition among its population. The third dimension, 'food utilisation' describes whether or not individuals or households can absorb sufficient energy and nutrition from food (FAO, 2018). Hence, food security's life-enforcing power that biological utilization of food consumed gives cannot be ignored which, in turn, influences the health-seeking behaviour, age, and gender-appropriate nutritional requirements as well as by giving access to safe drinking water and sanitation facilities takes care of the basics of entitlements to instil a love of life in all (MoSPI & WFP, 2019). 'Food stability', the final dimension, refers to the situation in which a country, state, district, household, or individual always has sufficient food supplies (Singh & Alka, 2019; Jatav et al., 2021a, 2021b). The most recent definitions of food security are multifaceted. They go beyond economics and physical availability and include social, health, and nutritional aspects. Cook and Frank (2008) opine that food insecurity occurs when people do not have enough food to satisfy hunger and resort to coping strategies such as begging, scavenging, or relying on emergency assistance programmes. Their limited disposable income, limited household resources, and poor socioeconomic status are important factors or indicators of food insecurity (Rush & Rusk, 2009). Ensuring food security and providing access to safe drinking water and modern energy for all remains a key challenge for sustainable development (Rasul & Sharma, 2016).

Jatav et al. (2022) highlighted the key works of Mahadevan and Sandy (2013), Payne et al. (2016), Farrukh et al. (2020a, 2020b), and Swati and Arora (2021) which have used the definition of food security as given by FAO (1996) in context of India.

Mahadevan and Sandy's (2013) study of India's regions focused on the regional implications of social characteristics including caste and religion. The complicated social structure in India, according to their findings, limits the effectiveness of development initiatives like Food for Work and the Public Distribution System (PDS) in tackling challenges associated with food security. The institutions and procedures controlling whole economies and societies have also been noted to have an impact on food-related issues, in addition to food production and agricultural operations (Sen, 1981). The research on food security measures up to this point has mostly underlined how different indicators might represent the multidimensionality of food security in various situations (MoSPI & WFP, 2019). This paper compares the three main dimensions of the food security index and identifies the dimension-specific variables which are critical for food insecurity in the various districts of Bihar and Jharkhand.

3 Objectives, Data, and Methodology

3.1 The Objectives of This Paper Are

- To explore the dimensions, indicators, approaches, and methods of measuring food security in terms of food availability, access, and utilization.
- To analyse the nature and dynamics of the food security situation at the district level and identify the regions/districts which are most affected by food insecurity in rural Jharkhand and Bihar.
- To suggest policy interventions appropriate to improving food security for the food-insecure regions in Jharkhand and Bihar.

3.2 Data

The study uses district-level secondary data to evaluate the food security status of the districts in Bihar and Jharkhand. A total of 15 indicators are used to capture three major dimensions of food security, i.e. food availability, food accessibility, and food utilization (food stability is excluded as there is a lack of data) to compute district-level food security indices (Table 1).

Table 1 Indicators used to compute food security index

Variables	Sources
(A) Availability	
(1) Rainfall variability (100-CV of annual (1989–2018) (%)[1]	Indian Meteorological Dept, Government of India (GoI)
(2) Per capita value of agricultural output (cereal) (2018–19, 2019–20 and 2020–21)	Department of Agriculture, Animal Husbandry and Co-operative, Government of Jharkhand (GoJ)
(3) Percentage of net irrigated area to net sown area (2017–18)	Ministry of Agriculture, GoI
(4) Urbanization rate, 2011[2]	Census of India, 2011
(B) Access	
(1) Percentage other than agricultural labourer to all labourers, 2011	Census of India, 2011
(2) Percentage non-Scheduled Caste (SC) & Scheduled Tribe (ST) population, 2011	Census of India, 2011
(3) Non-dependency ratio, 2011	Census of India, 2011
(4) Average per capita consumption expenditure, 2018–19	PLFS, 2018–19
(5) Casual wage, 2018–19	PLFS, 2018–19
(6) Percentage of village access to paved road, 2011	Census of India, 2011
(C) Utilization	
(1) Percentage household access to safe drinking water, 2019–2021	NFHS, 2019–2021
(2) Number of Primary Health Centre (PHC)/ Community Health centre (CHC) per lakh population (health and family welfare statistics, 2019–20)	Ministry of health and family welfare, GoI
(3) Female literacy rate, 2019–1021	NFHS, 2019–2021
(4) Disease and health behaviour (100-prevalence of diarrhoea (reported) in the last 2 weeks preceding the survey (%), 2019–1021	NFHS, 2019–2021
(5) Percentage of household access to improved toilet, 2019–2021	NFHS, 2019–2021
Outcome indicator	
1. Children under 5 years who are underweight (weight-for-age) (%)	NFHS, 2019–2021
2. Women whose Body Mass Index (BMI) is below normal (BMI < 18.5 kg/m^2) (%)	NFHS, 2019–2021
3. Children age 6–59 months who are anaemic (<11.0 g/dl) (%)	NFHS, 2019–2021

Note 1 & 2—In the case of Bihar, variability in rainfall is not included in index of Bihar, and urbanization is replaced with the percentage of the village having access to a town within 10 km
Source IHD research team

3.3 Methodology

The computation of composite index of food security and its dimensional indices requires normalization of the various component indicators to obtain homogeneity of units. The normalized indicators thus obtained are scale-free or have homogenous units and are therefore comparable and can be aggregated into composite indices. The study has used the Range Equalization Method (REM) or max–min approach to convert indicators to a common scale to normalize indicators into a common range (0–1). The scaled least achievement corresponds to zero, whereas the best achievement corresponds to 1. Under the max–min approach, an index has been constructed for each variable that is calculated by applying the following general REM formula adopted by United Nations Development Programme (UNDP). The district having a higher Food Security Index (FSI) value is considered more food secure as compared to that demonstrated by the districts with the lower index value. Also, Principal Component Analysis (PCA) is used to find out the policy variables for both states. The FSI is a composite index covering three dimensions, i.e. access, availability, and utilization of food.

$$\mathrm{Z_{ij}} = \frac{X_{ij-\mathrm{Min}(X_{ij})}}{\mathrm{Max}(X_{ij}) - \mathrm{Min}(X_{ij})}$$

where Z_{ij} is the variable index value (i) for the jth district, X_{ij} is the actual value of the ith indicator in the jth district, and Max (X_{ij}) and Min (X_{ij}) are the maximum and minimum values of the ith indicator for the jth district, respectively.

After calculating the index of each variable, we averaged them by dividing by the number of districts to get each dimension index, i.e. Availability Index, Access Index, and Utilization Index. Finally, we have averaged these three dimensions to arrive at the composite FSI. Finally, districts are categorized into highly insecure, insecure, moderately secure, secure, and highly secure, based on both dimension-specific and overall FSI. Furthermore, PCA is used to compute the factor loading of each of these indicators to analyse the triggering variables for the food security of the districts.

4 Major Findings

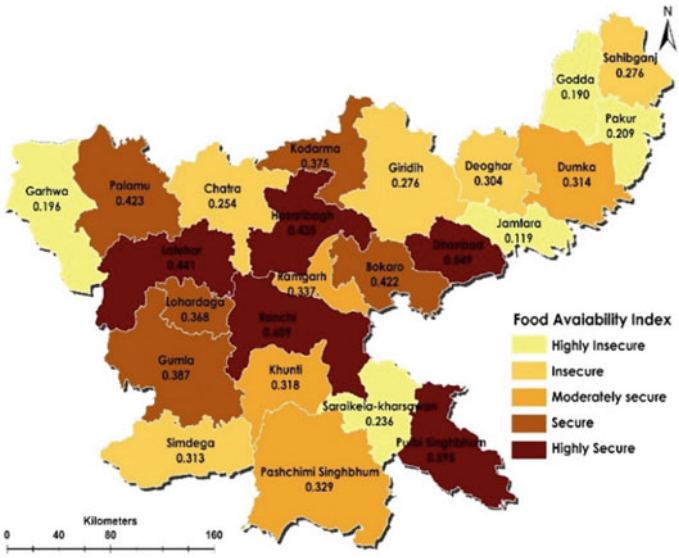
4.1 Food Availability Index

- **Status of Districts in the Food Availability Index of Rural Jharkhand**

The extent of irrigation has in all cases not been translated into the per capita value of cereal output. The districts of Latehar, Palamu, Koderma, and Garhwa, despite having relatively high irrigation coverage, have a modest or low per capita value of

cereal output while the districts of Khunti, Simdega, Gumla, and Purbi Singhbhum, despite having low irrigation (less than 10%). have a high value of cereal output. Irrigation has helped more in stabilizing agricultural production than in increasing it.

The districts which are extremely food secure in terms of the Food Availability Index are Ranchi, Purbi Singhbhum, Dhanbad, Latehar, and Hazaribagh. The districts of Dhanbad, Purbi Singhbhum and Ranchi are highly urbanized and have low variability of rainfall, whereas Ranchi and Purbi Singhbhum districts have registered high per capita value of cereal output. While Hazaribagh is moderately developed in terms of levels of urbanization and extent of irrigation, it has a very low variability of rainfall. However, that has not translated into a higher per capita value of cereal output in the Hazaribagh district. Latehar has the highest proportion of net irrigated area to net sown area and is moderately placed in terms of variability of rainfall and per capita value of cereal output. Except for Dumka, the entire Santhal Pargana region (north-eastern part of Jharkhand) is food insecure to highly insecure with regards to food availability. Godda and Pakur districts are placed as highly food insecure. While Godda has the lowest rate of urbanization in the state, i.e. below 5%, and the per capita value of cereal output is also among the lowest. It is moderately placed in terms of the extent of irrigation. Similarly, Pakur district performs poorly in terms of the per capita value of cereal output as well as the rate of urbanization (7.5%). Garhwa and Jamtara districts have the highest rainfall variability and also depict low levels of urbanization (Map 1, Table 2).



Map 1 District-wise food availability index of rural Jharkhand. *Source* Computed and prepared by the IHD research team

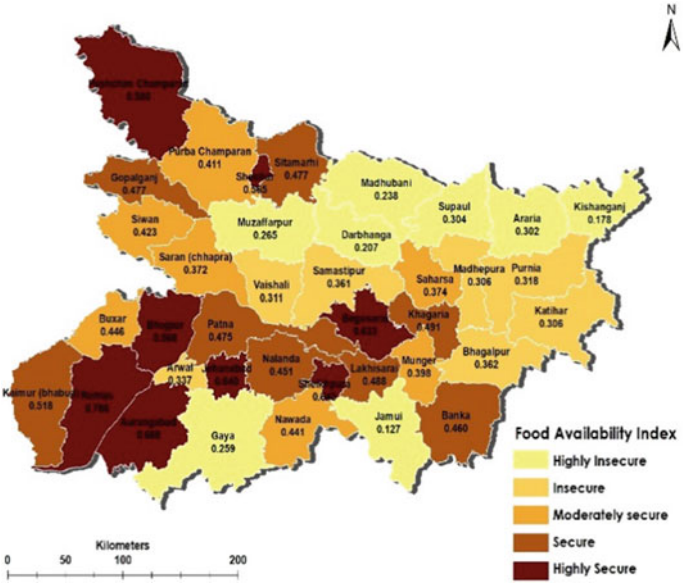
Table 2 Status of districts in food availability index of rural Bihar and Jharkhand

Highly secure	Secure	Moderately secure	Insecure	Highly insecure
Jharkhand				
Ranchi	Palamu	Ramgarh	Simdega	Saraikela-Kharsawan
Purbi Singhbhum	Bokaro	Pashchimi Singhbhum	Deoghar	Pakur
Dhanbad	Gumla	Khunti	Giridih	Garhwa
Latehar	Kodarma	Dumka	Sahibganj	Godda
Hazaribagh	Lohardaga		Chatra	Jamtara
Bihar				
Rohtas	Kaimur (Bhabua)	Nalanda	Bhagalpur	Supaul
Aurangabad	Khagaria	Buxar	Samastipur	Araria
Sheikhpura	Lakhisarai	Nawada	Arwal	Muzaffarpur
Jehanabad	Sitamarhi	Siwan	Purnia	Gaya
Begusarai	Gopalganj	Purba Champaran	Vaishali	Madhubani
Pashchim Champaran	Patna	Munger	Katihar	Darbhanga
Bhojpur	Banka	Saharsa	Madhepura	Kishanganj
Sheohar		Saran		Jamui

Source Computed by IHD research team

- **Status of Districts in the Food Availability Index of Rural Bihar**

Food Availability Index estimates from Bihar reveal that districts of Jamui, Kishanganj, Darbhanga, Madhubani, Gaya, Muzaffarpur, Araria, and Supaul are the most insecure districts in the state. Among these districts, Jamui, Darbhanga, and Madhubani produce very small agricultural output per capita, and they have also relatively low irrigated areas. Additionally, Jamui, Araria, and Gaya have the lowest percentage of villages with access to towns. On the contrary, Rohtas, Aurangabad, Sheikhpura, Jehanabad, Begusarai, Paschim Champaran, Bhojpur, and Sheohar are the districts that come up as highly food-secure districts in terms of availability of food. Among these districts, in Rohtas and Aurangabad, agricultural output is high as well as irrigation facilities are better, while Paschim Champaran has the highest agricultural output. Also, access to towns is better in the districts of Sheikhpura, Begusarai, Bhojpur, and Sheohar. The moderately food-secure districts include Nalanda, Buxar, Nawada, Siwan, Purvi Champaran, Munger, and Saran (Map 2).



Map 2 District-wise food availability index of rural Bihar.

The availability of food, however, depends not only on its production expressed in terms of the per capita value of cereal output but also on the factors which help in the growth of the food market through the growth of non-agricultural income and resultant transport of food from surplus producing areas to deficit areas, and linking habitations to the market.

4.2 Access to Food Index

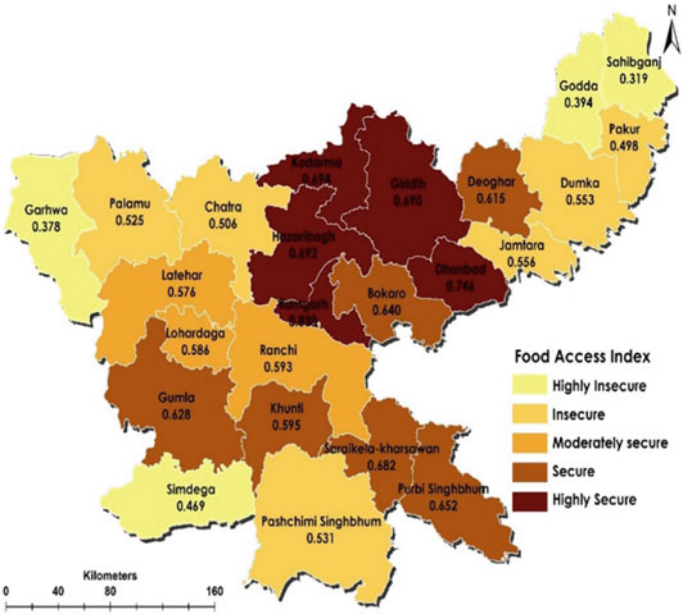
- **Status of Districts in Access to Food Index of Rural Jharkhand**

In terms of accessibility, Ramgarh and Dhanbad districts have emerged as highly food secure in terms of access to food and highly urbanized; they are also marked by a high level of mining and industrial activities. Hence, the non-dependency rate in these districts is very high. In both the districts, mining and industrial activities associated with urban areas offer employment and income opportunities to a large number of its population, as a result of which the monthly per capita expenditure (MPCE) is very high. At the same time, the percentage of villages with access to paved roads and the proportion of non-agricultural workers are also found to be very high in these districts. The performance of these districts across all these component indicators has made them highly secure in terms of access to food. The other three

highly secure districts, namely, Giridih, Hazaribagh, and Koderma have higher casual wage rates and better rural connectivity. On the other hand, Pakur, Sindega, Godda, Garhwa, and Sahibganj districts are at the lower ladder of the Access to Food Index.

The districts of the Santhal Pargana region—Godda, Sahibganj, Jamtara, Dumka, and Pakur—are either highly insecure or food insecure in terms of the composite Access to Food Index. The production and productivity of the agricultural sector in these districts are low. The tribal-dominated districts are moderate to highly insecure in terms of access to food. Simdega district, with over 80% Scheduled Tribe (ST) and Scheduled Caste (SC) population, fares poorly in terms of rural casual wages and rural connectivity, and is therefore ranked as highly insecure in terms of access to food.

Almost the entire North Chotanagpur division, constituting districts of Hazaribagh, Koderma, Giridih, Ramgarh, Bokaro, and Dhanbad, emerged as highly food secure in terms of access to food. This mining-industrial and highly urbanized region is characterized by higher shares of working age population, lower shares of agricultural labourers and ST & SC population, higher casual wage rates, and better rural connectivity. An improvement in access to employment opportunities, through industrialization and urbanization, can go a long way in improving the access to food conditions in highly insecure regions (Map 3, Table 3).



Map 3 District-wise food access index of rural Jharkhand. *Source* Computed and prepared by the IHD research team

Table 3 Status of districts in access to food index of rural Jharkhand and Bihar

Highly secure	Secure	Moderately secure	Insecure	Highly insecure
Jharkhand				
Ramgarh	Saraikela-Kharsawan	Khunti	Jamtara	Pakur
Dhanbad	Purbi Singhbhum	Ranchi	Dumka	Simdega
Kodarma	Bokaro	Lohardaga	Pashchimi Singhbhum	Godda
Hazaribagh	Gumla	Latehar	Palamu	Garhwa
Giridih	Deoghar		Chatra	Sahibganj
Bihar				
Saran	Bhojpur	Darbhanga	Samastipur	Aurangabad
Vaishali	Saharsa	Begusarai	Kaimur (Bhabua)	Sheohar
Siwan	Rohtas	Buxar	Jamui	Araria
Gopalganj	Bhagalpur	Lakhisarai	Khagaria	Banka
Muzaffarpur	Munger	Kishanganj	Sitamarhi	Katihar
Madhubani	Patna	Madhepura	Sheikhpura	Pashchim Champaran
Arwal	Nawada	Nalanda	Supaul	Purnia
Jehanabad		Purba Champaran		Gaya

Source Computed by IHD research team

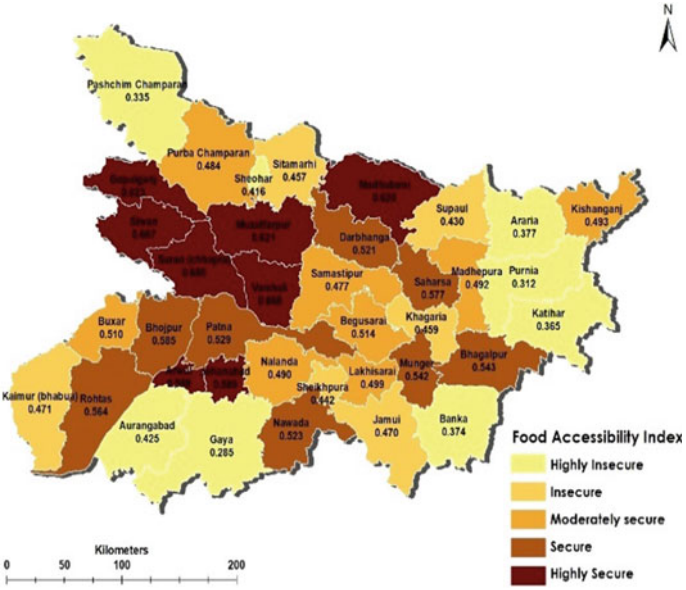
- **Status of Districts in Access to Food Index of Rural Bihar**

Based on the Access to Food Index, Gaya, Purnia, Paschim Champaran, Katihar, Banka, Araria, and Sheohar districts are the most insecure districts in Bihar. The population in these districts have the lowest monthly per capita consumption expenditure and the lowest casual wage rate. Eight extremely food-secure districts include Saran, Vaishali, Siwan, Gopalganj, Muzaffarpur, Madhubani, Arwal, and Jahanabad. Furthermore, these districts have a high non-dependency ratio (Map 4, Table 3).

4.3 Food Utilization Index

- **Status of Districts in Food Utilization Index of Rural Jharkhand**

The result shows that Ranchi, Purbi Singhbhum, Simdega, Saraikela-Kharsawan, and Gumla districts in Jharkhand are the most food secure in terms of utilization or absorption of food. On the other hand, districts of Khunti, Pakur, Ramgarh, Bokaro,

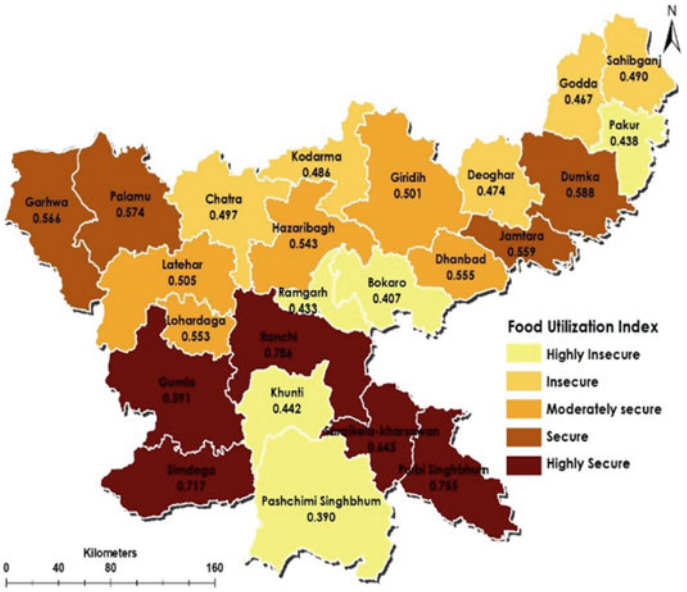


Map 4 District-wise food access index of rural Bihar. *Source* Computed and prepared by the IHD research team

and Pashchimi Singhbhum are found to be highly insecure in terms of the Food Utilization Index.

In terms of the availability of rural health institutions, among the highly secure districts, all five districts have more than 20 Primary Health Centres (PHCs) per lakh population. Ranchi has the highest proportion of households with access to an improved toilet facility and also has among the highest rural female literacy and the lowest prevalence of disease in terms of diarrhoea among children. Purbi Singhbhum district has the lowest prevalence of disease and has among the highest proportions of households with access to improved toilet facilities and availability of rural health institutions. Simdega district has the highest rural female literacy and availability of rural health institutions and the second highest proportion of households with access to an improved toilet facility.

On the other hand, the highly insecure district of Khunti, in terms of food utilization, has among the lowest proportions of households with access to safe drinking water and among the highest prevalence of disease. Pakur has among the lowest rural female literacy rates and lowest proportions of households with access to an improved toilet facility. Ramgarh, which is an otherwise developed district, is also among the highly food insecure districts in terms of food utilization as it has among the lowest proportions of households with access to safe drinking water (Map 5, Table 4).



Map 5 District-wise food utilization index of rural Jharkhand. *Source* Computed and prepared by the IHD research team

- **Status of Districts in Food Utilization Index of Rural Bihar**

In terms of food utilization, the index shows that the districts in the southern region of Bihar are worse off while those in the northern region are relatively better off. The districts of Rohtas, Begusarai, Sheikhpura, Kaimur (Bhabua), Sheohar, Gopalganj, Aurangabad, and Siwan are found to be highly food secure in terms of the Food Utilization Index. These districts also have high female literacy rates. Except for the districts of Aurangabad and Siwan, all other districts in this group have a high proportion of households having access to an improved toilet. All the districts in these categories also have a lower prevalence of diseases among children below 5 years. Purnia, Darbhanga, Sitamarhi, Saharsa, Madhubani, Araria, Jamui, and Supaul districts, on the other hand, are found to be extremely insecure mainly due to low female literacy rates and poor sanitation facilities (Map 6, Table 4).

4.4 Food Security Outcome Index

- **Status of Districts in Food Security Outcome Index of Rural Jharkhand**

The Food Security Outcome Index was arrived at by adding the average of all three indicators. Table 5 indicates the status of the districts in terms of the outcome indicators and Food Security Outcome Index. The Food Security Outcome Index computed

Table 4 Status of districts in food utilization index of rural Jharkhand and Bihar

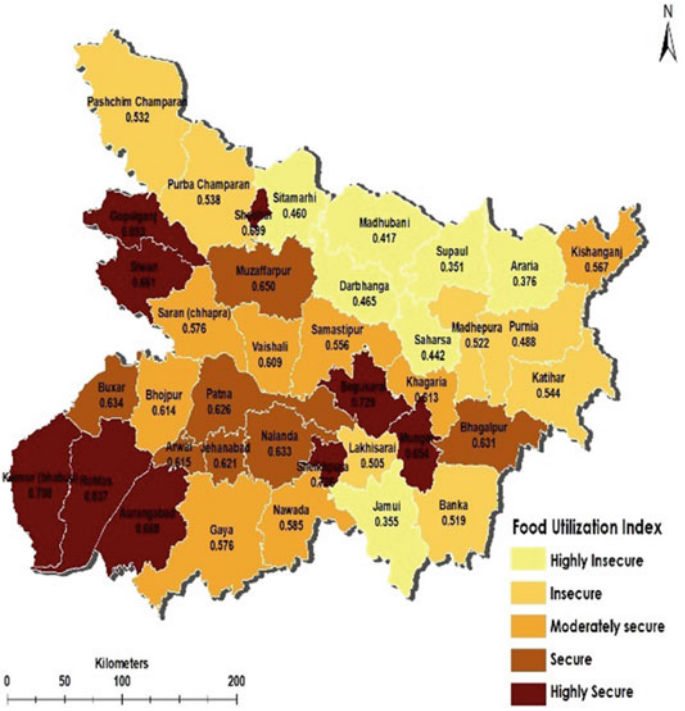
Highly secure	Secure	Moderately secure	Insecure	Highly insecure
Jharkhand				
Ranchi	Dumka	Lohardaga	Chatra	Khunti
Purbi Singhbhum	Palamu	Hazaribagh	Sahibganj	Pakur
Simdega	Garhwa	Latehar	Kodarma	Ramgarh
Saraikela-Kharsawan	Jamtara	Giridih	Deoghar	Bokaro
Gumla	Dhanbad		Godda	Pashchimi Singhbhum
Bihar				
Rohtas	Munger	Arwal	Samastipur	Purnia
Begusarai	Muzaffarpur	Bhojpur	Katihar	Darbhanga
Sheikhpura	Buxar	Khagaria	Purba Champaran	Sitamarhi
Kaimur (Bhabua)	Nalanda	Vaishali	Pashchim Champaran	Saharsa
Sheohar	Bhagalpur	Nawada	Madhepura	Madhubani
Gopalganj	Patna	Gaya	Banka	Araria
Aurangabad	Jehanabad	Saran	Lakhisarai	Jamui
Siwan		Kishanganj	Samastipur	Supaul

Source Computed by IHD research team

through REM is shown in Maps 7 and 8. Based on the three component indicators, the districts of Hazaribagh, Ranchi, Kodarma, Giridih, and Gumla in Jharkhand have emerged as highly secure in terms of the outcome of food security. On the other hand, districts of Jamtara, Dumka, Deoghar, Pakur, and Pashchimi Singhbhum are found to be highly insecure in terms of the Food Security Outcome Index of rural Jharkhand.

Almost all the districts of the Santhal Pargana division are insecure or highly insecure in terms of the outcome of food security owing to a very high proportion of anaemic as well as underweight children. Jamtara district has among the highest proportion of underweight children, while Dumka has the second highest proportion of anaemic children. Deoghar has among the highest proportion of women whose Body Mass Index (BMI) is below normal as well as anaemic children. On the other end of the spectrum, Ranchi district has the second lowest proportion of thin women while Hazaribagh district has the second lowest proportion of anaemic as well as underweight children. Koderma district has the lowest proportion of children aged 6–59 months who are anaemic.

The results underline the fact that children in Jharkhand are at substantially higher risk of chronic and current malnutrition, and child malnutrition is almost a universal challenge across the state with certain pockets of severe malnutrition. Nearly 40%



Map 6 District-wise food utilization index of rural Bihar. *Source* Computed and prepared by the IHD research team

of children under the age of five in Jharkhand suffer from chronic malnutrition (stunting), approximately 39% are underweight, and 22% suffer from wasting as of 2019–2021 (NFHS-5). The prevalence of such levels of food insecurity and malnutrition is a stern reminder that the various government-sponsored measures to alleviate food deficiency in the poverty-ridden pockets of the region have not desirably reached the targeted population. To be nutrition secure, all people should be free from chronic malnutrition and diseases so that the human body can absorb and utilize the food more effectively (Map 7, Table 5).

- **Status of Districts in Food Security Outcome Index of Rural Bihar**

The three most insecure districts in terms of food security outcome in Bihar are Araria, Arwal, and Purnia. These districts lie in the South and South East corners of Bihar and belong to the least developed regions of the state. Also, the incidence of underweight and anaemia among children as well as BMI among women are extremely high in these districts. These districts call for specially targeted policies to improve the outcome of food security-aimed interventions. The secure group contains eight districts, i.e. Gopalganj, Siwan, Pashchim Champaran, Muzaffarpur, Purba Champaran, Madhubani, Sheohar, and Buxar. These districts also have a relatively

Table 5 Status of districts in food security outcome index of rural Jharkhand and Bihar

Highly secure	Secure	Moderately secure	Insecure	Highly insecure
Jharkhand				
Hazaribagh	Khunti	Godda	Bokaro	Jamtara
Ranchi	Dhanbad	Lohardaga	Latehar	Dumka
Kodarma	Garhwa	Palamu	Ramgarh	Deoghar
Giridih	Purbi Singhbhum	Simdega	Saraikela-Kharsawan	Pakur
Gumla	Chatra		Sahibganj	Pashchimi Singhbhum
Bihar				
Gopalganj	Khagaria	Rohtas	Katihar	Jehanabad
Siwan	Bhojpur	Vaishali	Munger	Nawada
Pashchim Champaran	Samastipur	Bhagalpur	Banka	Gaya
Muzaffarpur	Saran	Kishanganj	Sitamarhi	Jamui
Purba Champaran	Darbhanga	Kaimur (Bhabua)	Madhepura	Lakhisarai
Madhubani	Patna	Sheikhpura	Saharsa	Purnia
Sheohar	Begusarai	Supaul	Nalanda	Arwal
Buxar		Aurangabad		Araria

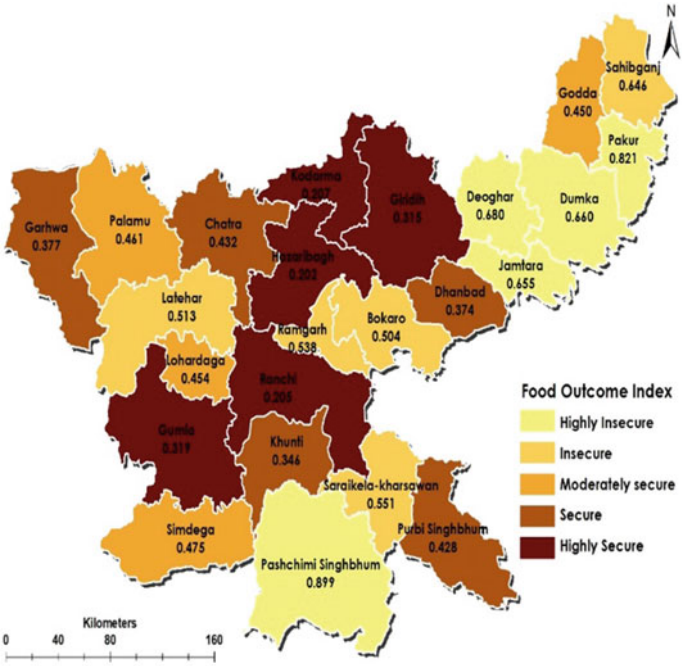
Source Computed by IHD research team

low prevalence of anaemia and underweight among children and BMI among women (Map 8, Table 5).

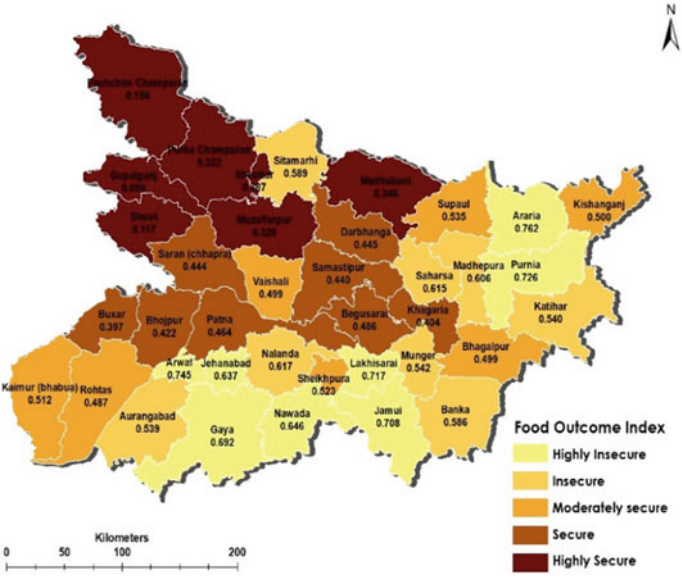
4.5 Food Security Index

- **Status of Districts in Food Security Index of Rural Jharkhand**

Ranking district-level FSI in Jharkhand based on averaging the index values of the three dimensions reveals that Purbi Singhbhum, Ranchi, Dhanbad, Hazaribagh, and Ramgarh districts are highly food-secure districts, whereas Jamtara, Garhwa, Pakur, Sahibganj, and Godda districts are found to be most food insecure. Purbi Singhbhum and Ranchi, which are highly industrialized and urbanized districts, emerged as the most food secure among all the 24 districts of Jharkhand owing to their second position and first position, respectively, in Food Availability Index and Food Utilization Index. Dhanbad, again one of the industrially advanced and the most urbanized district, is placed at the third position in FSI as it occupies the second and third position, respectively, in Access to Food Index and Food Availability Index. Similarly,



Map 7 District-wise food security outcome index of rural Jharkhand. *Source* Computed and prepared by the IHD research team



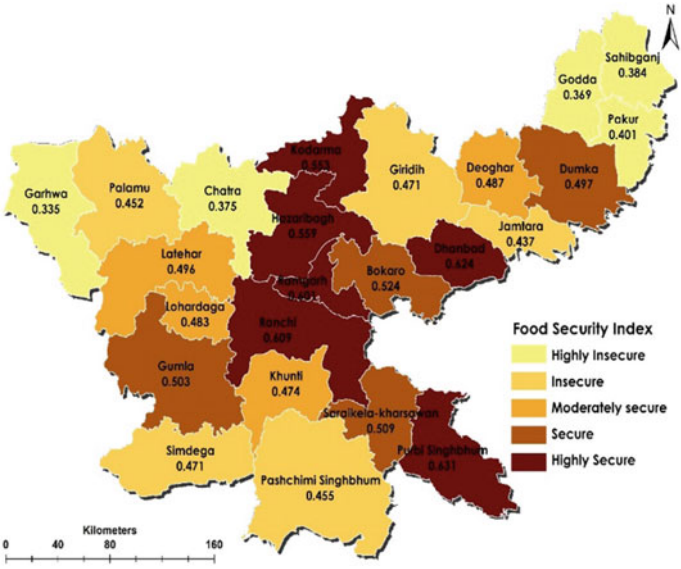
Map 8 District-wise food security outcome index of rural Bihar. *Source* Computed and prepared by the IHD research team

Ramgarh, yet another industrial and urbanized district, occupy the fifth position in terms of being the most food-secure district owing to it being placed at the first position in the Access to Food Index.

On the other hand, Godda, Sahibganj and Pakur districts in the Santhal Pargana region together form the zone of high food insecurity. Godda district is the most food-insecure district and is placed at the last position in FSI. This district is placed at the third lowest position in terms of the Access to Food Index and second lowest in the Food Availability Index. Sahibganj, which is among the most insecure group of districts, recorded the lowest Access to Food. Pakur, which is one of the five most insecure FSI districts, is ranked fourth lowest in Food Availability Index and Food Utilization Index (Map 9, Table 6).

- **Status of Districts in Food Security Index of Rural Bihar**

In terms of FSI, the most secure districts in Bihar are: Rohtas, Begusarai, Jehanabad, Sheikhpura, Gopalganj, Bhojpur, Aurangabad, and Siwan. These districts also belong to the highly secure group in terms of availability dimension. On the contrary, Kishanganj, Katihar, Darbhanga, Gaya, Purnia, Supaul, Araria, and Jamui districts are the most insecure districts in the state in terms of the composite FSI. These districts are also insecure/highly insecure in terms of both availability and access dimensions (Map 10, Table 6).



Map 9 District-wise food security index of rural Jharkhand. *Source* Computed and prepared by the IHD research team

Table 6 Status of districts in food security index of rural Jharkhand and Bihar

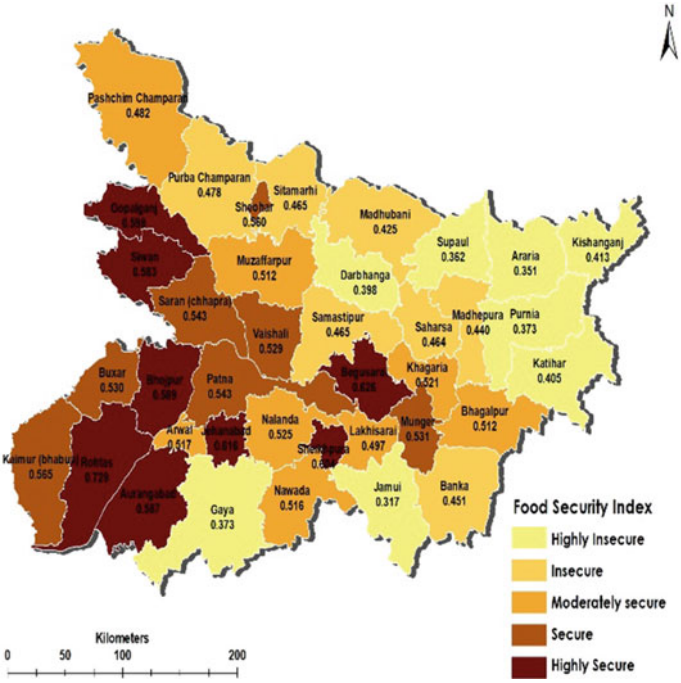
Highly secure	Secure	Moderately secure	Insecure	Highly insecure
Jharkhand				
Purbi Singhbhum	Gumla	Latehar	Dumka	Jamtara
Ranchi	Kodarma	Simdega	Deoghar	Garhwa
Dhanbad	Saraikela-Kharsawan	Giridih	Khunti	Pakur
Hazaribagh	Lohardaga	Bokaro	Chatra	Sahibganj
Ramgarh	Palamu		Pashchimi Singhbhum	Godda
Bihar				
Rohtas	Kaimur (Bhabua)	Nalanda	Purba Champaran	Kishanganj
Begusarai	Sheohar	Khagaria	Samastipur	Katihar
Jehanabad	Patna	Arwal	Sitamarhi	Darbhanga
Sheikhpura	Saran	Nawada	Saharsa	Gaya
Gopalganj	Munger	Muzaffarpur	Banka	Purnia
Bhojpur	Buxar	Bhagalpur	Madhepura	Supaul
Aurangabad	Vaishali	Lakhisarai	Madhubani	Araria
Siwan		Pashchim Champaran		Jamui

Source Computed by IHD research team

4.6 Identifying the Policy Variables

The factor loadings derived from the PCA technique are applied to identify the policy variables which are important in explaining the food insecurity/security among districts which need further intervention in food-insecure areas/districts. The variables, given in Table 7, show the most important indicators that explain food security.

The findings reveal that in the rural areas in Jharkhand, per capita value of agricultural output in terms of cereal crops is one of the important indicators that determines food and nutrition security status of the districts. The second important indicator or policy variable for food and nutrition security is the percentage of workers other than agricultural labourers. If the agricultural labourers have shifted from agricultural sector to non-agricultural sector without reducing the productivity, this would indicate a higher food security status. Female literacy rate is the third important factor determining food security because more aware the mother is, better will be the decision-making and care practices as well as involvement in job market. This directly or indirectly ensures more food security for the household. Availability of health institutions in the locality is the next factor in rank of importance. Higher the density and



Map 10 District-wise food security index of rural Bihar.

access to PHCs/CHCs, higher will be the food security of the household. Access to improved toilet and urbanization are the other key determining factors. Higher the level of urbanization, higher will be the access to basic services and marketing, and the farmers can more easily access different agricultural inputs (Fig. 1).

In Bihar, the availability of other than agricultural labour is the most important policy variable that determines food and nutrition security. The processing of agricultural products will be high if there is a higher scope of non-agricultural employment in rural areas. The non-dependency ratio is the second most important policy variable which determines the food security status of the districts. The third important factor determining food security is the female literacy rate. The fourth determining variable is the low prevalence of diseases among children. The extent of irrigation and availability of health institutions, assessed here in terms of the number of PHCs per lakh population, are also the key determining variables that explain the variability in food security outcomes (Fig. 2).

Table 7 Eigen vectors

Variable	Component	Variable	Component
Jharkhand		*Bihar*	
Per capita value of agricultural output (Cereal)	0.744	Other than agricultural labourers to all labourers	0.720
Other than agricultural labourers to all labourers	0.715	Non-dependency ratio	0.680
Female literacy rate	0.664	Female literacy rate	0.649
No, of PHC/CHC per lakh population	0.659	Disease and health behaviour	0.617
Percentage of households having improved non-shared toilet	0.607	Net irrigated area to net sown area	0.491
Urbanization rate/access to town	0.482	No. of PHC/CHC per lakh population	0.401
Average per capita consumption expenditure	0.391	Percentage of households having improved non-shared toilet	0.358
Percentage of village access to a paved road	0.324	Urbanization rate/access to town	0.340
Rainfall variability (100-CV of annual	−0.068	Per capita value of agricultural output (cereal)	0.248
Casual wage	−0.252	Percentage of village access to paved road	−0.183
Disease and health behaviour	−0.307	Casual wage	−0.286
Net irrigated area to net sown area	−0.504	Percentage household having improved safe drinking water	−0.377
Percentage non-SC & ST population	−0.521	Average per capita consumption expenditure	−0.379
Non-dependency ratio	−0.521	Percentage non-SC & ST population	−0.481
Percentage household having improved safe drinking water	−0.748		

Note Extraction method: principal component analysis
Source Computed by the IHD research team

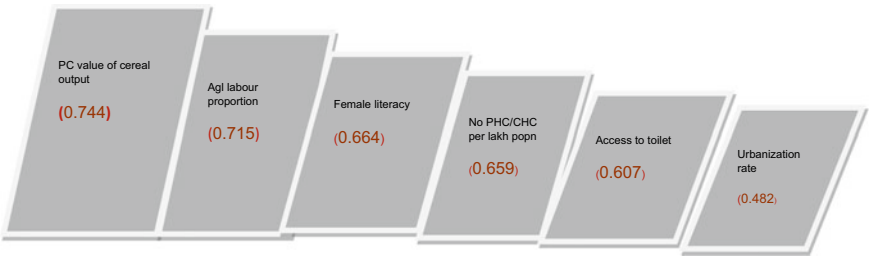


Fig. 1 Priority indicators for food and nutrition security in Jharkhand. *Source* Computed by the IHD research team

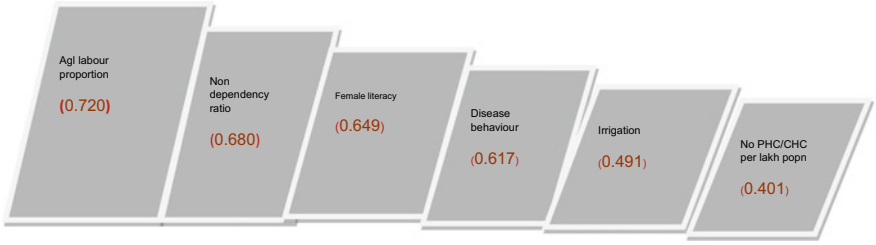


Fig. 2 Priority indicators for food and nutrition security in Bihar. *Source* Computed by the IHD research team

4.7 Identifying the Priority Districts

The priority districts are those districts which fall in the 'insecure' and 'highly insecure' categories of FSI and FSO. The districts termed as 'alarming' are those which are 'insecure' or 'highly insecure' both in FSO and FSI. These districts need attention on an urgent basis for development interventions for enhancing food security (Table 8).

In Jharkhand, the food security condition of Dumka, Deoghar, Pashchimi Singhbhum, Jamtara, Pakur, and Sahibganj districts is found to be the most alarming.

Table 8 Priority districts for food security intervention in rural Jharkhand and Bihar

Alarming (insecure in FSI and FSO)	Need high attention—input (insecure in FSI)	Need high attention—outcome (insecure in FSO)
Jharkhand		
Dumka	Khunti	Bokaro
Deoghar	Chatra	Latehar
Pashchimi Singhbhum	Garhwa	Ramgarh
Jamtara	Godda	Saraikela-Kharsawan
Pakur		
Sahibganj		
Bihar		
Sitamarhi	Purba Champaran	Katihar
Saharsa	Samastipur	Munger
Banka	Madhubani	Nalanda
Madhepura	Kishanganj	Jehanabad
Gaya	Katihar	Nawada
Purnia	Darbhanga	Lakhisarai
Araria	Supaul	Arwal
Jamui		

Source Computed by the IHD research team

The rest of the priority districts which need high attention in terms of food security indicators are Khunti, Chatra, Garhwa, and Godda. On the other hand, the districts of Bokaro, Latehar, Ramgarh, and Saraikela-Kharsawan are the most insecure in terms of outcome indicators and also need more attention.

In Bihar, the districts where the food security condition is found to be alarming are Sitamarhi, Saharsa, Banka, Madhepura, Gaya, Purnia, Araria, and Jamui. The districts which need high attention in Bihar in terms of food security input variables are Purba Champaran Samastipur, Madhubani, Kishanganj, Katihar, Darbhanga, and Supaul. These districts are in the food insecure category in terms of FSI. The districts which are insecure in terms of outcome indicators and need high attention are Katihar, Munger, Nalanda, Jehanabad, Nawada, Lakhisarai, and Arwal.

4.8 Comparative Significance of Food Security Policy Variables

To examine the degree of influence exercised by different variables on the food security scenario in both the states, the strength of the relationship of the food security (input) and food security (outcome) indices to the three component indices, as well as the inter-relationship of the aggregate input and outcome indices have been analysed using the correlation method. In both rural Jharkhand and Bihar, the correlation between utilization index and availability index is high whereas the correlation between utilization index and access index is very low. The FSI also has a high degree of correlation at 1% degree of significance with the availability, and utilization index for both Bihar and Jharkhand. The FSO index is also significantly negatively correlated with FSI in both states (Table 9).

It will be useful to see the inter-relationships between the individual food security variables and the aggregate FSI (input) to assess the strength of the relationship of these variables with the FSI.

- **Food Availability Index**

In Jharkhand, the variables which have been used to develop the Food Availability Index are rainfall variability, per capita value of cereal output, percentage of net irrigated area to net sown area, and urbanization. All four variables reveal a very strong correlation especially rainfall variability (0.732) and urbanization (0.689) with Food Availability Index. Again, the indicators dependency ratio and MPCE, which have been taken for the access dimension, have a strong correlation with Food Availability Index. Female literacy rate also has a strong relation with Food Availability Index.

In Bihar, per capita value of agricultural output ($r = 0.644$), irrigation coverage percentage ($r = 0.746$), percentage of villages with access to town ($r = 0.525$), female literacy ($r = 0.458$) and percentage of households with access to improved non-shared toilet ($r = 0.237$) have a strong and positive correlation with the Food

Table 9 Inter-correlation matrix of input and outcome components of food security indices of rural Jharkhand

	Availability	Access	Utilization	FSI	FSO	FSI PCA
Jharkhand						
Availability	1					
Access	0.451*	1				
Utilization	0.434*	0.010	1			
FSI	0.874**	0.689**	0.622**	1		
Outcome	−0.443*	−0.311	−0.382	−0.516**	1	
Bihar						
Availability	1					
Access	0.004	1				
Utilization	0.669**	0.267	1			
FSI	0.831**	0.482**	0.880**	1		
Outcome	−0.189	−0.344*	−0.333*	−0.369*	1	

Note * —Correlation is significant at the 0.05 level (2-tailed)
** —Correlation is significant at the 0.01 level (2-tailed)
Source Computed by the IHD research team

Availability Index. Since these variables are of key importance for the availability component of food security, to strengthen food security in both these states, policy formulations need to put an equally strong emphasis on the measures that specifically address these variables (Table 10).

- **Access to Food Index**

In Jharkhand, the level of urbanization has a strong correlation with Access Index. Among the six indicators used for Access Index, four indicators—the proportion of agricultural labourers, dependency ratio, MPCE, and access to paved road—have a strong correlation with Access to Food Index. The other variables like urbanization ($r = 0.576$) which is in the Food Availability Index and female literacy ($r = 0.433$) rate which is in the Food Utilization Index have a high degree of correlation with the Access to Food Index.

In Bihar, the correlation of the individual component variables with the Access to Food Index shows that out of six indicators, percentage of agricultural labourers ($r = 0.666$), casual wage rate ($r = 0.506$), and percentage of villages with access to the paved road ($r = 0.440$) have a high degree of correlation with Access to Food Index. The variables such as urbanization and female literacy have a high degree of correlation with the Access to Food Index.

The result reveals that the proportion of agricultural workers has quite a high correlation with the Access to Food Index. Further, female literacy rate, casual wage rate, and the ratio of working-age population also play an important role in the case

Table 10 Correlation matrix of the food security index and indicators in Jharkhand and Bihar

	Availability	Access	Utilization	Overall
Jharkhand				
Rainfall variability	0.732**	0.163	0.098	0.473*
Per capita value of agricultural output (cereal)	0.162	0.032	0.503*	0.299
Net irrigated area to net sown area	0.071	−0.063	−0.119	−0.044
Urbanization	0.689**	0.576**	0.242	0.703**
Percentage of agricultural labourers to total workers	0.348	0.666**	−0.077	0.450*
Percentage of SC and ST populations	−0.100	0.184	−0.228	−0.057
Non-dependency rate	0.401	0.0487*	0.373	0.574**
Monthly per capita consumption expenditure	0.409*	0.516**	0.233	0.534**
Casual wage rate	0.065	0.213	−0.097	0.090
Villages having access to paved road	0.108	0.557**	−0.083	0.278
Percentage of households with access to improved drinking water	−0.288	−0.332	−0.029	−0.308
Number of PHCs/CHCs per lakh population	0.159	0.005	0.423*	0.253
Female literacy rate	0.520**	0.433*	0.556**	0.681**
Disease and health behaviour	0.187	−0.332	0.462*	0.123
Percentage household access to improved non-shared toilet	0.348	0.280	0.599**	0.544**
Bihar				
Per capita value of agricultural output	0.644**	−0.205	0.373*	0.434**
Net irrigated area to net sown area	0.746**	−0.112	0.420**	0.544**
Percentage of villages access to town	0.525**	0.278	0.467**	0.587**
Percentage of agricultural labourers to total workers	0.241	0.603**	0.427**	0.531**
Percentage of SC and ST populations	−0.191	0.259	−0.209	−0.094
Non-dependency rate	0.108	0.487**	0.246	0.340*

(continued)

Table 10 (continued)

	Availability	Access	Utilization	Overall
Monthly per capita consumption expenditure	−0.283	0.397*	−0.205	−0.095
Casual wage rate	−0.043	0.506**	0.088	0.200
Villages having access to paved road	0.077	0.440**	0.264	0.314
Percentage of households with access to improved drinking water	0.237	0.058	0.194	0.233
Number of PHCs/CHCs per lakh population	0.278	−0.159	0.363*	0.244
Female literacy rate	0.458**	0.528**	0.719**	0.744**
Disease and health behaviour	0.232	−0.054	0.505**	0.315
Percentage household access to improved non shared toilet	0.437**	0.194	0.664**	0.588**

Note ** —Correlation is significant at the 0.01 level (2-tailed)
* —Correlation is significant at the 0.05 level (2-tailed)
Source Computed by the IHD research team

of access to food security. Hence, we need to take into account these variables in the policy support to improve the food security situation in the state (Table 10).

- **Food Utilization Index**

In Jharkhand, Food Utilization Index has a strong correlation with the indicators viz., female literacy, access to sanitation, number of PHCs and CHCs, and disease behaviour. All these variables are part of Food Utilization Index. Per capita value of agricultural output, which is an indicator in the Food Availability Index, also has a strong correlation with the Food Utilization Index.

In Bihar, out of five indicators used in the Food Utilization Index, four variables such as female literacy rate, number of PHCs/CHCs per lakh population, disease and health behaviour, and percentage of households with access to improved non-shared toilet have a high degree of correlation with the Food Utilization Index. Access to safe drinking water has a very low correlation with the Food Utilization Index. It is interesting to note that three indicators, i.e. per capita value of agricultural output, net irrigated area to net sown area, and percentage of villages with access to town have a high degree of correlation with the Food Utilization Index. Also, the indicator used in the access index, i.e. the percentage of agricultural labour to the total worker has a high degree of correlation with the Food Utilization Index (Table 10).

5 Conclusions and Policy Implications

This study has used disaggregate-level data to examine the extent and dimensions of food security at the district level in Jharkhand and Bihar using various indicators from secondary data sources. The findings from this study show that there are large inter-district inequalities across all the three dimensions of food security, i.e. availability, accessibility, and utilization. Tables 11 and 12 in the Appendix provide the ranking of the districts on all dimensions of food security. The agricultural economy in both Bihar and Jharkhand is at a very low level of development, the former performing better than the latter. As a result, both the states have been considered food deficit states. Of Bihar's 38 districts, 22 are on the priority list. Districts flagged off as showing alarming levels of food insecurity based on both input and outcome indicators are: Sitamarhi, Saharsa, Banka, Madhepura, Gaya, Purnia, Araria, and Jamui.

Among the 24 districts of Jharkhand, 14 are on the priority list. Region-wise, the entire belt of the Santhal Pargana region has been marked as 'alarming' in terms of its food insecurity situation. All the districts of the Santhal Pargana region, except Godda, have been flagged off as exhibiting alarming levels of food insecurity based on both input and outcome indicators. The food insecurity situation of Dumka, Deoghar, Jamtara, Pakur, and Sahibganj districts from the Santhal Pargana region and Pashchimi Singhbhum district belonging to the Kolhan region has been marked as 'alarming'. Even Godda district from the Santhal Pargana region has been categorized among the districts 'needing high attention' in terms of food security input variables. The districts of Jamtara, Godda, and Pakur suffer from poor food availability with the per capita value of agricultural output (cereals) being low due to high rainfall variability coupled with low intensity of irrigation available. The urbanization rates in these districts are also very low. The districts of Sahibganj, Dumka, Godda, Pakur, and Pashchimi Singhbhum suffer from poor access to food with monthly per capita consumption expenditure being very low owing to high percentage of agricultural labourers in Dumka, Godda, and Sahibganj, weekly causal wages being low and dependency ratio being high in Sahibganj and percentage of STs being high in Pashchimi Singhbhum who have an overall lower socioeconomic condition. Lower percentage of villages have access to paved roads in Godda and Pakur districts. The districts of Deoghar, Godda, Pakur, and Pashchimi Singhbhum suffer from poor utilization of food with female literacy rates being low in Deoghar, Godda, Pashchimi Singhbhum, and Pakur districts and access to improved toilet facility being poor in Pashchimi Singhbhum, Deoghar, and Pakur districts. Pashchimi Singhbhum additionally suffers from a lack of access to safe drinking water and as a result exhibits high prevalence of diseases like diarrhoea which results in poor utilization or absorption of food. The most food-secure districts of Jharkhand are Purbi Singhbhum, Ranchi, Dhanbad, Hazaribagh, and Ramgarh. All these districts are mining-industrial, highly urbanized and developed districts. Together, they form the development corridor of Jharkhand.

The paper has also identified the critical variables which need the utmost attention for ensuring food security in rural areas of Bihar and Jharkhand. The findings reveal that in Jharkhand, per capita value of agricultural output in terms of cereals, percentage of casual labourers in non-agricultural pursuits, female literacy rate, availability of basic health infrastructure in rural areas measured here in terms of number of PHCs/CHCs per lakh population, and access to improved and non-shared toilet facility are crucial indicators that determine the food security status in the rural parts of the districts. In the case of Bihar, the important policy variables that shape the food security status of the districts are the percentage of non-agricultural labourers, non-dependency ratio, female literacy rate, non-prevalence of disease and health behaviour, irrigation facilities, and availability of basic health infrastructure in rural areas, i.e. density of PHCs/CHCs per lakh population.

Overall, the policy focus in this region, comprising Bihar and Jharkhand, should be concentrated in expanding availability of food through better irrigation facilities in this otherwise rainfed region which suffers from high rainfall variability year-on-year, increasing access to food through provision of employment opportunities in non-farm sector which in turn will better the economic dependency ratio, increase the casual wages, and eventually augment the MPCE. Expanding jobs under Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is one such way of providing employment opportunities in rural areas apart from expanding investment in allied sectors, i.e. fishing, livestock rearing, food processing, and processing of Non-Timber Forest Products (NTFPs) in case of Jharkhand. Such an investment will also lead to employment in service sectors such as storage and transport.

The focus should also be on improving the utilization or absorption of food through enhancing the provision of basic health infrastructure, safe drinking water, and access to improved toilet facilities which will reduce the prevalence of diseases like diarrhoea. Improvement of female literacy rates is crucial for the entire region which will go a long way in enriching the households' nutritional intakes owing to better exposure and knowledge about healthy diet, sanitation and hygiene practices, and health behaviour. It can also improve the purchasing power of the household and, in turn, enhance their MPCE. Literacy and adult literacy programmes should be undertaken in priority districts to begin with.

Distribution of millets through PDS can further enhance the nutritional outcomes of the households. Millets, being drought-resistant crop, are most suited for cultivation in these rainfed regions, particularly Jharkhand, with limited irrigation facilities. Jharkhand Government has launched the Millets Mission on priority basis. For the most food insecure areas, there should be procurement of millets for distribution through the PDS. There is also increasing demands for millets in the urban areas, the packaging and processing of which gives additional employment and income opportunities in the food insecure areas of the states.

The identification of priority districts and highlighting the policy variables, which are crucial in such food insecure districts which require urgent attention, can go a long way in providing a detailed roadmap for appropriate government interventions in the insecure districts to improve their condition of food security.

Appendix

Table 11 Ranks of districts on composite food security index and its components in Jharkhand

District	Availability		Access		Utilization		FSI		FSO	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Bokaro	0.422	7	0.640	8	0.407	23	0.490	14	0.504	15
Chatra	0.254	19	0.506	19	0.497	15	0.420	18	0.432	10
Deoghar	0.304	16	0.615	10	0.474	18	0.470	16	0.680	22
Dhanbad	0.549	3	0.746	2	0.555	10	0.617	3	0.374	7
Dumka	0.314	14	0.553	16	0.588	6	0.481	15	0.660	21
Purbi Singhbhum	0.595	2	0.652	7	0.755	2	0.664	1	0.428	9
Garhwa	0.196	22	0.378	23	0.566	8	0.382	21	0.377	8
Giridih	0.276	17	0.690	5	0.501	14	0.490	13	0.315	4
Godda	0.190	23	0.394	22	0.467	19	0.346	24	0.450	11
Gumla	0.387	8	0.628	9	0.591	5	0.532	6	0.319	5
Hazaribagh	0.435	5	0.692	4	0.543	12	0.558	4	0.202	1
Jamtara	0.119	24	0.556	15	0.559	9	0.412	20	0.655	20
Khunti	0.318	13	0.595	11	0.442	20	0.448	17	0.346	6
Kodarma	0.375	9	0.694	3	0.486	17	0.527	7	0.207	3
Latehar	0.441	4	0.576	14	0.505	13	0.500	11	0.513	16
Lohardaga	0.368	10	0.586	13	0.553	11	0.509	9	0.454	12
Pakur	0.209	21	0.498	20	0.438	21	0.382	22	0.821	23
Palamu	0.423	6	0.525	18	0.574	7	0.507	10	0.461	13
Ramgarh	0.337	11	0.830	1	0.433	22	0.544	5	0.538	17
Ranchi	0.609	1	0.593	12	0.786	1	0.663	2	0.205	2
Sahibganj	0.276	18	0.319	24	0.490	16	0.371	23	0.646	19
Saraikela-Kharsawan	0.236	20	0.682	6	0.645	4	0.517	8	0.551	18
Simdega	0.313	15	0.469	21	0.717	3	0.496	12	0.475	14
Pashchimi Singhbhum	0.329	12	0.531	17	0.390	24	0.418	19	0.899	24

Source Computed by the IHD research team

Table 12 Ranks of districts on composite food security index and its components in Bihar

District	Availability		Access		Utilization		FSI		FSO	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Araria	0.302	32	0.377	33	0.376	36	0.351	37	0.762	38
Arwal	0.337	26	0.598	7	0.615	16	0.517	18	0.745	37
Aurangabad	0.668	2	0.425	31	0.669	7	0.587	7	0.539	23
Banka	0.460	15	0.374	34	0.519	29	0.451	28	0.586	26
Begusarai	0.633	5	0.514	17	0.729	2	0.626	2	0.486	15
Bhagalpur	0.362	24	0.543	12	0.631	13	0.512	21	0.499	18
Bhojpur	0.568	7	0.585	9	0.614	17	0.589	6	0.422	10
Buxar	0.446	17	0.510	18	0.634	11	0.530	14	0.397	8
Darbhanga	0.207	36	0.521	16	0.465	32	0.398	33	0.445	13
Gaya	0.259	34	0.285	38	0.576	21	0.373	34	0.692	33
Gopalganj	0.477	13	0.623	4	0.693	6	0.598	5	0.059	1
Jamui	0.127	38	0.470	26	0.355	37	0.317	38	0.708	34
Jehanabad	0.640	4	0.589	8	0.621	15	0.616	3	0.637	31
Kaimur (Bhabua)	0.518	9	0.471	25	0.708	4	0.565	9	0.512	20
Katihar	0.306	29	0.365	35	0.544	25	0.405	32	0.540	24
Khagaria	0.491	10	0.459	27	0.613	18	0.521	17	0.404	9
Kishanganj	0.178	37	0.493	20	0.567	23	0.413	31	0.500	19
Lakhisarai	0.488	11	0.499	19	0.505	30	0.497	22	0.717	35
Madhepura	0.306	30	0.492	21	0.522	28	0.440	29	0.606	28
Madhubani	0.238	35	0.620	6	0.417	35	0.425	30	0.346	6
Munger	0.398	21	0.542	13	0.654	9	0.531	13	0.542	25
Muzaffarpur	0.265	33	0.621	5	0.650	10	0.512	20	0.320	4
Nalanda	0.451	16	0.490	22	0.633	12	0.525	16	0.617	30
Nawada	0.441	18	0.523	15	0.585	20	0.516	19	0.646	32
Pashchim Champaran	0.580	6	0.335	36	0.532	27	0.482	23	0.156	3
Patna	0.475	14	0.529	14	0.626	14	0.543	11	0.464	14
Purba Champaran	0.411	20	0.484	23	0.538	26	0.478	24	0.322	5
Purnia	0.318	27	0.312	37	0.488	31	0.373	35	0.726	36
Rohtas	0.786	1	0.564	11	0.837	1	0.729	1	0.487	16
Saharsa	0.374	22	0.577	10	0.442	34	0.464	27	0.615	29
Samastipur	0.361	25	0.477	24	0.556	24	0.465	25	0.440	11
Saran	0.372	23	0.680	1	0.576	22	0.543	12	0.444	12
Sheikhpura	0.643	3	0.442	29	0.726	3	0.604	4	0.523	21
Sheohar	0.565	8	0.416	32	0.699	5	0.560	10	0.387	7

(continued)

Table 12 (continued)

District	Availability		Access		Utilization		FSI		FSO	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Sitamarhi	0.477	12	0.457	28	0.460	33	0.465	26	0.589	27
Siwan	0.423	19	0.667	3	0.661	8	0.583	8	0.117	2
Supaul	0.304	31	0.430	30	0.351	38	0.362	36	0.535	22
Vaishali	0.311	28	0.668	2	0.609	19	0.529	15	0.499	17

Source Computed by the IHD research team

References

Cook, J. T., & Frank, D. A. (2008). Food security, poverty and human development in the United States. *Annals of the New York Academy of Sciences, 1136*, 193–209.

Farrukh, M. U., Bashir, M. K., Hassan, S., Adil, S. A., & Kragt, M. E. (2020a). Mapping the food security studies in India, Pakistan and Bangladesh: Review of research priorities and gaps. *Global Food Security, 26*, 100370. https://doi.org/10.1016/j.gfs.2020.100370

Farrukh, M. U., Bashir, M. K., Hassan, S., Adil, S. A., & Kragt, M. E. (2020b). Exploring the sustainable food security approach in relation to agricultural and multi-sectoral interventions: A review of cross-disciplinary perspectives. *Geo-Forum, 108*, 23–27. https://doi.org/10.1016/j.geoforum.2019.11.01

FAO. (2006). *Policy brief.* Agriculture and Development Economics Division, Food and Agricultural Organization of the United Nations (FAO).

FAO. (2008). *Climate change and food security: A framework document*. FAO.

FAO. (1996). *Rome declaration on world food security and world food summit plan of action.* World Food Summit 13–17 November 1996.

FAO. (2018). *The state of food security and nutrition in the world 2018. Building climate resilience for food security and nutrition, the state of food security and nutrition in the world*. FAO.

Government of India. (2020–21). *SDG India index & dashboard 2020–21. Partnerships in the decade of action.* NITI Aayog, Government of India and United Nations

Gross, R., Schoeneberger, H., Pfeifer, H., & Preuss, H. J. A. (2000). The four dimensions of food and nutrition security: Definitions and concept. *Nutrition and Food Security*. http://fpmu.gov.bd/agridrupal/sites/default/files/Four_Dimension_of_FS.pdf.

Gulati, A., Kumar, A. G., Shreedhar, G., & Nandakumar, T. (2012). Agriculture and malnutrition in India. *Food and Nutrition Bulletin, 33*(1), 74–86.

IHD-IGIDR. (2018a). *Food security atlas of Rural Bihar*. Institute for Human Development, New Delhi and Indira Gandhi Institute of Development Research. http://www.igidr.ac.in/wp-content/uploads/2021/05/Food_security_atlas_rural_Bihar.pdf.

IHD-IGIDR. (2018b). *Food security atlas of Rural Odisha 2018b.* Institute for Human Development. http://www.igidr.ac.in/wpcontent/uploads/2021/05/Food_security_atlas_rural_Odisha.pdf.

IHD-IGIDR. (2022). *Food security atlas of Rural Jharkhand*. Institute for Human Development, New Delhi and Indira Gandhi Institute of Development Research.

Jatav, S. S., Kumar, A., & Malik, B. B. (2021a). 'Impact of COVID-19 on the livelihood of rural farmers in Uttar Pradesh. *India', Journal of Rural Development, 40*, 94–11. https://doi.org/10.25175/jrd/2021/v40/i1/166505

Jatav, S. S., Surendra, M., Sanatan, N., & Sonali, N. (2021b). Coping to COVID-19 in Uttar Pradesh, India: Evidence from NSSO 76th round data. *Current Urban Studies, 9*, 206–217. https://doi.org/10.4236/cus.2021.92013

Jatav, S. S., Nayak, S., Singh, N. P., & Naik, K. (2022). Measuring and mapping food security status of Rajasthan, India: A district-level analysis. *Frontiers in Sustainable Food System, 6*, 831396. https://doi.org/10.3389/fsufs.2022.831396

Mahadevan, R., & Sandy, S. (2013). 'Is there a role for caste and religion in food security policy? A look at rural India. *Economic Modelling, 31*, 58–69. https://doi.org/10.1016/j.econmod.2012.11.060

MoSPI and WFP. (2019). *Food and nutrition security analysis, India, 2019.* Ministry of Statistics and Programme Implementation and The World Food Programme.

MSSRF. (2008). *Report on the state of food security in Rural India.* MS Swaminathan Research Foundation.

NITI Aayog. (2021). *National multidimensional poverty index: Baseline report.* NITI Aayog.

Payne, H. E., Bobbi, G., Siena, F. D., Cassidy, A. H., Arindam, D., Manisha, K., et al. (2016). Factors associated with food insecurity among women and children in rural Rajasthan, India. *Journal of Gender Agriculture and Food Security, 1*, 23–39. https://doi.org/10.22004/ag.econ.253135

Rasul, G., & Sharma, B. (2016). The nexus approach to water-energy-food security: An option for adaptation to climate change. *Climate Policy, 16*(6), 682–702. https://doi.org/10.1080/14693062.2015.1029865

Rush, E., & Rusk, I. (2009). *Food security for Pacific peoples in New Zealand: A report for the obesity action coalition.* Obesity Action Coalition. http://www.ana.org.nz/sites/default/files/PacificfoodsecurityreportfinalMarch09_3.pdf.

Sen, A. K. (1981). Ingredients of famine analysis: Availability and entitlements. *The Quarterly Journal of Economics, 96*, 433–464. https://doi.org/10.2307/1882681

Singh, S., & Alka, S. (2019). Escalating food security status in the Gujarat state of India. *Asian Journal of Multidimensional Research, 8*, 12–28. https://doi.org/10.5958/2278-4853.2019.00110.1

Smith, M., Pointing, J., & Maxwell, S. (1993). *Household Food Security, concepts and Definitions: An annotated Bibliography*. Institute of Development Studies.

Swati, R., & Arora, K. (2021). Measuring and mapping the state of food insecurity in Rajasthan, India. *Geography Environment Sustainability, 14*, 33–40. https://doi.org/10.24057/2071-9388-2020-67

WFP-IHD. (2008). *Food security atlas of Rural Jharkhand, 2008*. UN World Food Programme (WFP) and Institute for Human Development.

Food Security in Rural Bihar: Some Findings from a Longitudinal Survey

Swati Dutta, Sunil K. Mishra, and Alakh N. Sharma

1 Introduction

Bihar is among the poorest states in the country with a very high incidence of poverty. Although in recent years it has witnessed a high rate of growth, the state continues to be among the economically most backward states, with one of the lowest per capita incomes. During the year 2020–21, the per capita net state domestic product (NSDP) of Bihar (Rs. 46,292) was only 36 per cent of India (Rs. 128,829) (RBI, 2021). More than half of the population in the state is multidimensional poor (NITI Aayog, 2021).

Malnutrition continues to remain a matter of grave concern in Bihar. A total of 43 per cent of the children under the age of five are stunted (low height for age) and 23 per cent of them are wasted (National Family and Health Survey (NFHS)-5, 2019–21). According to the composite Sustainable Development Goal (SDG) Index constructed by NITI Aayog, Bihar stood second last in terms of SDG 2 on zero hunger, and overall development indices of Bihar stood last among the states (Government of India, 2020–21). The findings from the fifth round of NFHS indicate that there is only partial improvement in malnutrition indicators in Bihar. Food insecurity is an important dimension of overall malnutrition and poor health, and more so in a state like Bihar. Food security is a complex phenomenon having multi-pronged dimensions. Food security is the product of four different aspects: food availability, i.e. availability of 'sufficient quantities and quality of food'; food access which indicates households' access to 'adequate resources for acquiring appropriate foods for a nutritious diet'; utilization indicating utilization of food through diet and supporting factors or 'non-food inputs in food security' such as clean water, sanitation, and health care; and finally, stability, emphasizing that 'to be food secure, a population, household or individual must have access to adequate food at all times', given risks such as sudden, unforeseen shocks (FAO et al., 2013). Food security

S. Dutta · S. K. Mishra · A. N. Sharma (✉)
Institute for Human Development, New Delhi, India
e-mail: alakh.sharma@ihdindia.org

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_5

policies in developing countries generally focus on the consumption of adequate calories (Barrett, 2010; Suryanarayana, 2013; Taruvinga et al., 2013). The diversified food consumption pattern is determined by factors such as culture, social, demographic, socio-economic, poverty, geographic locations, income, prices, availability, food production, and storage facilities (Gundersen & Garasky, 2012; Jones et al., 2014; Oyarzun et al., 2013; Sarkar, 2014; Styen et al., 2006).

The level of dietary diversity is the proxy indicator of the quality of food consumption (Jones et al., 2014). Dietary diversity is usually measured by the dietary diversity score which summarizes the number of foods or food groups consumed over a reference period taking into consideration the number of servings of different food groups in conformity with dietary guidelines (Swaindale & Bilinsky, 2006). Dietary diversity scores are meaningful indicators of food and nutrition security measures. These scores can be collected through household surveys and can be used to examine food and nutrition security at individual and intra-household levels. Dietary diversity scores correlate with measures of food consumption, and are a good measure of household food access and caloric availability (D'Souza & Jolliffe, 2010). Some researchers and development agencies have suggested using an alternative aggregate index, the Food Consumption Score (FCS), a proxy indicator based on the three components stated above: dietary diversity, food frequency, and relative nutritional importance of different food groups (WFP, 2008, 2009).

In the discussion on food and nutrition security, public services can also play an important role in ensuring food security and improved nutritional status (Kaushal & Muchomba, 2013; Kochar, 2005; Rahman, 2015). The five main programmes which provide social security in India and have played a crucial role in the reduction of poverty, increasing incomes, and reducing malnutrition are Public Distribution System (PDS), Integrated Child Development Scheme (ICDS), Mid-Day Meal Scheme (MDMS), Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), and pensions for widows and elderly (Drèze & Khera, 2017). The rich literature available cites numerous barriers in access to services, and typical system shortfalls in providing these services, which act as a detriment in realizing the potential of food-based safety-nets and interventions, more so for the vulnerable communities such as the tribal households in economically, and agro-climatically backward regions (Drèze & Khera, 2013, 2015). Studies have also highlighted that public programmes, especially during COVID-19, played a pivotal role in terms of providing food to the needy (Sinha, 2021).

This paper analyses the status of food and nutritional security in rural Bihar since 1998, based on a longitudinal survey conducted by the Institute for Human Development (IHD). Bihar is overwhelmingly rural with about 89% of its population residing in rural areas. A total of 12 villages spread over 7 districts, which are representative of the state, were surveyed in 2016 for building the longitudinal database. These households are part of a previous survey conducted in 1981 (details provided in the next section). The paper evaluates the changes in household expenditure on food items in rural Bihar over 18 years across various socio-economic groups. The main findings of a rapid telephonic survey in these villages conducted by IHD in 2021 to

understand the impact of COVID-19 on households' food security have also been reported.[1]

The paper is organized as follows. After the Introduction, Sect. 2 provides details of the sampling framework and survey instruments of the study along with its methodology. Section 3 provides details of some broad features of the socio-economic change in Bihar between 1998 and 2016 from the survey data. Section 4 brings together the major findings on various aspects of food security, and the last section provides the conclusions and some policy pointers.

2 Methodology: Database and Survey Instruments

2.1 Database and Sample[2,3]

As mentioned in the earlier section, in 1981–1983, the A. N. Sinha Institute of Social Studies, Patna, and the International Labour Organization (ILO) undertook an in-depth study of the dynamics of poverty, labour markets, and development in the state of Bihar. The study was based on a representative sample of 36 villages drawn from 6 clusters of districts that formed the plains of Bihar, and which coincide with the geographical composition of present-day Bihar after the plateau region was made into a separate state of Jharkhand in 2000. Community-level data were collected from these 36 villages, and a census and in-depth household surveys were carried out in 12 villages, carefully selected to reflect the principal characteristics of the different regions of Bihar.

In 1998–99, the IHD, New Delhi, organized a resurvey of the same villages, which examined the pattern of change in production, employment, and social structure. The 1998 survey did not collect data from the same households which were covered in 1981–1983; however, the villages were the same, and extensive community-level and household-level data was collected. In 2009–2011, another round of resurvey was carried out for all the longitudinal households surveyed in the 1998–99 round. A total of 1,000 households were interviewed in this round. However, in this survey consumption and food security were not the major components. The survey in 2016–17 was limited to 12 villages for which detailed information was collected as in the preceding surveys. A detailed listing of all the households was done prior to the detailed household survey, and the main occupation of the household was captured. Altogether, around 1,450 households including 1,000 old resurvey households (as

[1] The survey was conducted for the International Growth Centre (IGC) sponsored project 'Food Security during Pandemic Times: Insights and Perspectives from Rural Bihar', October 2021. Two of the authors of this paper (Swati Dutta and Sunil K. Mishra) had undertaken this study. For details, see https://www.theigc.org.

[2] Sharma (1995, 2005) have used various round of IHD-Bihar longitudinal survey data.

[3] The study is part of IHD-Bihar Research programme also included in Rodgers et al. (2013) and IHD (2004).

in 2009–2011) and additional 450 new households (to make them a representative sample as in 1981 and 1998) were surveyed.[4]

Further, between November 2020 and February 2021 IHD conducted a telephonic survey in the 12 villages to understand the impact of COVID-19 on household food and nutrition security. In this survey, a total of 944 households were covered and the rest of the longitudinal households could not be covered due to their unavailability because of connectivity or refusal to respond.

To understand the broad changes in consumption expenditure and consumption of different food groups, the study has used 862 common households which were covered in both the 1998–99 and 2016 surveys. However, due to the comparability issues, some of the variables in a particular round have been analysed independently. The impact of COVID-19 on households' dietary diversity has been captured as a separate module in the 2021 survey.

2.2 Study Instruments[5]

The survey collected detailed information on the socio-economic background of the households, the demographic pattern of households, income and assets accessed by households, and employment structure within the households. The food security module covered consumption expenditure, food habits, dietary diversity, food frequency, self-assessed food insecurity, and the functioning of different food-based safety net programmes like PDS.

The survey used a 30 days recall method to assess the expenditure of different food items (separated into cereals, pulses, veggies, fruits, animal products, milk, and others) and 365 days recall period for expenditure incurred on different non-food items by the respondents. A retrospective method with a longer (1 year) reference period was followed for recall of past events of food scarcity, seasonal food availability, etc. Dietary assessments were based on precise recalls for the past week as well as 24 h.

The paper has measured food security with some select indicators. A brief description of these indicators is as follows.

Household Dietary Diversity Score (HDDS): HDDS provides a proxy measure of households' food consumption basket. HDDS is calculated based on the number of food items consumed by the household members on the preceding day of the survey. The list of food groups that were collected is cereals (F1), roots and tubers (F2), vegetables (F3), fruits (F4), sweets (F5), beverages and drinks (F6), meat (F7), eggs (F8), milk (F9), fish (F10), pulses (F11), and oils/fats (F12). If the household consumed the particular food item, we assigned a score of 1; else, 0. The score of the HDDS ranges from 0 to 12 so the higher the HDDS, the higher the household's

[4] Alakh N. Sharma (one of the authors of this paper) has been part of the study team in all the rounds of this longitudinal survey since 1981.

[5] Some analysis draws from Mishra et al. (2021). It is being reused with permission.

dietary diversity. HDDS was divided into three broad categories: low dietary diversity score (DDS) (score ≤ 3), medium DDS (4–5), and high DDS (score ≥ 6):

$$\text{HDDS} = F1 + F2 + F3 + F4 + F5 + F6 + F7 + F8 + F9 + F10 + F11 + F12.$$

Food Frequency Score (FFS): FFS is a dietary assessment of the households that captures households' food consumption habits. It collects information on the frequency of days of consumption of different food groups in the past 7 days prior to the survey, i.e. whether the food items were eaten daily (i.e. over 7 days regularly); occasionally (i.e. 3–4 days in a week); rarely (i.e. 1–2 days in a week); or never (0 days in a week). The eight aggregated food groups for this study are staples, vegetables, fruits, animal products (meat/fish/eggs), milk, beans (including nuts and lentils), fats, sweets, and drinks. Each of the food groups was also multiplied by the weight suggested by WFP (2008). This information was collected separately for adults and children:

$$\text{FFS} = 2 * D_{\text{Staple}} + 3 * D_{\text{pulses}} + 1 * D_{\text{vegetables}} + 1 * D_{\text{fruits}} + 4 * D_{\text{meat\&fish\&egg}} + 4 * D_{\text{milk\&milkproduct}} + 0.5 * D_{\text{sugar}} + 0.5 * D_{\text{oil}}$$

where D stands for the number of days for which each food group was consumed during the past days before the survey. The weighted score is divided into three categories: low (0–21), medium (21.5–35), and high (>35), where household FFS is high if both adults and children have high FFS; low if both adults and children have low FFS; and medium for a combination of both high and low FFS.

Household Food Insecurity Experience Scale (HFIES): HFIES was developed by the Food and Agriculture Organization's (FAO) Voice of the Hungry Project for measuring household food security (Ballard et al., 2013). FIES is a direct measure of the severity of household food insecurity that depends on the respondent's direct response to seven brief statements regarding their access to adequate food in the last 12 months. Experience of food insecurity is characterized by uncertainty and anxiety regarding access to food and adjusting the quality of diet due to a shortage of money. The sum of the seven HFIES gives us the food insecurity status of the households where if the score is greater than or equal to 1, then the household is food insecure. A household is identified as severely insecure if the score is between 6 and 7. If the score is between 4 and 5, then the household is moderately food insecure. If the score is between 1 and 3, the household then is mildly insecure.

Required Dietary Allowance (RDA): The energy norms based on which the Planning Commission Task Force (Alagh Committee) poverty lines were derived, and which had been the basis for the poverty lines worked out by the Lakdawala Expert Group, is 2,400 kcal per capita per day in rural areas and 2,100 kcal per capita per day in urban areas. The Rangarajan Expert Group took a considered view that

deriving the food component of the Poverty Line Basket required reference to the simultaneous satisfaction of all three nutrients (energy, protein, and fat). Accordingly, this Expert Group computed the average requirements of energy, protein, and fat on Indian Council of Medical Research (ICMR) norms differentiated by age, gender, and activity for all-India rural and urban regions to derive the normative levels of nourishment and worked out the energy requirement as 2,155 kcal per person per day in rural areas and 2,090 kcal per person per day in urban areas (MoSPI and WFP, 2019).[6] The protein and fat requirements were estimated as 48 g and 28 g per capita per day, respectively, in rural areas. Based on this cut-off, the paper has identified the percentage of households who are deprived in terms of consumption of energy, protein, and fat.

3 Some Salient Features of Socio-Economic Change in Rural Bihar, 1998–2016

Before we discuss food security, it will be interesting to shed light on some broad socio-economic changes that occurred during the 18 years, i.e. between the two survey periods of 1998 and 2016.

3.1 Changes in Caste and Class Structure

The class and caste structure of the society is very important for the rural economy of Bihar. It reflects the pattern of ownership and use of land, and the social and economic relations governing work and employment.

Between 1998 and 2016, there has been a decline in the share of forward and Other Backward Class (OBC)-II (upper backward) households by about 6 and 4 percentage points, respectively. The share of OBC-I (lower backward castes), on the other hand, has increased by 6 percentage points during the same period. The scheduled caste (SC) households are about one-fourth of the total sample, and have witnessed a slight increase of 2.6 per cent in their share. In contrast to the stability of caste and community, there have been substantial changes in the class pattern in the last 18 years. The proportion of agricultural labour cultivating households and landlords has declined by 13 and 7 percentage points, respectively. There has been a marginal decline in the middle peasant households and the proportion of small peasant households has remained the same, but the big peasant households and agricultural labour non-cultivating households have increased. The share of non-agricultural households has increased by 15 percentage points in the 18 years period

[6] ICMR-NIN (2020) although recommended for RDA specific values for rural areas; however, these are not given. Therefore, the study has compared and used ICMR (2010) RDA cut-off for rural areas.

primarily due to a decline in landholding size and relative growth of non-agricultural sources of livelihoods.

3.2 Changes in Ownership of Land and Other Assets

Land is an important asset in the context of rural Bihar though income from the land may not constitute the highest share of total income, especially for those with small plots of land at their disposal. Over the years, as expected there has been a change in the distribution of landholdings. The proportion of landless households increased by 11 percentage points between 1998 and 2016. There has been a marginal decline in the households belonging to the land size of less than 1 acre. Those with 1 to 2.49 acres of land recorded a decline of 6 percentage points and this trend is similar for all categories (Fig. 1).

The caste-wise operational landholding size shows that the SCs have experienced a big increase in landlessness in 18 years from 54 per cent in 1998 to 86 per cent in 2016. Consolidation of holding is rather non-existent in the State. The average landholding was 1.79 acres in 1998, which has come down to 0.77 acres in 2016. The size of average landholdings with certain caste groups like upper castes and OBC-II castes is higher than those with the other caste group. Further, the average size of landholdings with vulnerable social groups like the SCs is much lower than the other caste groups (Table 1).

It is also important to see the composition of the non-land assets in the context of rural Bihar and how the value of the assets has changed between 1998 and 2016 across caste and classes. As can be seen from Table 2, in general the level of value of non-land assets is quite small in Bihar and further it is dominated by dwelling in both periods. The rest of the assets contributed only one-fifth of the monetary value of the assets in both periods.

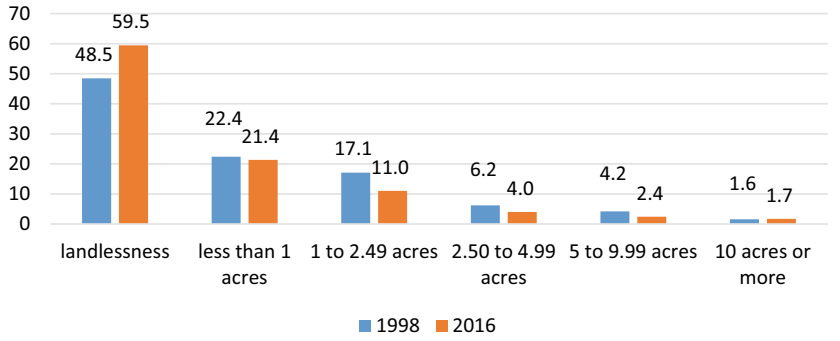


Fig. 1 Changes in land size: 1998–2016 (in %). *Source* IHD-Bihar longitudinal survey, 1998, 2016. *Note* The subsequent figures and tables are based on the various rounds of Bihar longitudinal survey, otherwise stated

Table 1 Changes in ownership of landholdings and landlessness by caste: 1998–2016

Social groups	Landless (%)			Average landholding (Acres)	
	1998	2016	Change	1998	2016
Forward castes	14.96	26.87	11.91	3.20	2.05
OBC-I (upper backward)	62.58	72.46	9.88	0.75	0.43
OBC-II (lower backward)	29.12	36.15	7.03	1.55	1.03
Scheduled castes	54.00	85.43	31.43	0.31	0.12
Muslims	61.62	72.82	11.20	1.14	0.52
Total	44.33	59.40	15.07	1.79	0.77

Source IHD-Bihar longitudinal survey, 1998, 2016

Table 2 Per household value of the asset by type: 1998 and 2016 (at current price in ₹)

	Per household value of non-land assets, 2016 (Rs)	Per household value of non-land assets, 1998 (Rs)
Dwelling	328,322	52,351
Productive asset	9,149	4,731
Other assets	42,650	4,761
Livestock	12,013	4,404
Total	392,134	66,246

Source IHD-Bihar longitudinal survey, 1998, 2016

There has been a substantial increase in the value of the assets except for livestock and productive assets. The largest increase was observed for other assets which include households' amenities like furniture, television, refrigerator, and mobile phones, among others. A much lower increase is observed in the value of livestock and productive assets. In real terms, there is hardly any increase in the value of non-land assets in these two categories. This indicates the lack of capital accumulation over 18 years which is a long-term constraint on the growth in the agricultural sector. Non-agriculturist and small peasant households which followed agriculture labour in households have shown greater improvement in asset values compared to the rest of the groups (Fig. 2). Changes in the value of assets are much higher among OBC-I followed by SC and Muslim households (Fig. 3). In both the cases, it is mostly driven by the increase in the value of other assets. This indicates that as a whole the distribution of assets over time has been in a progressive direction.

Fig. 2 Change in value of assets other than land in Bihar by class: 1998–2016. *Source* IHD-Bihar longitudinal survey, 1998, 2016. *Note* Ratio of value of assets in 2016 to value of assets in 1998

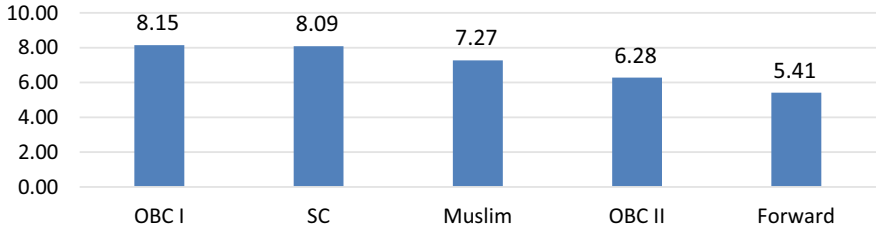


Fig. 3 Changes in the value of assets other than land by caste: 1998–2016. *Source* IHD-Bihar longitudinal survey, 1998, 2016

3.3 Changes in Income and Migration Pattern

Table 3 shows that the average annual income has increased by around 7 times in the nominal term from around ₹2,000 in 1998 to ₹ 141,101 in 2016. Among the caste groups, the Muslims have witnessed the highest increase in income at 9 times during the 18 years, whereas OBC-II and upper caste households have witnessed the lowest increase at 6 and 6.2 times, respectively (Table 3). Class-wise, it is seen that the increase in income is highest for the non-agriculture and small peasant households and the lowest for the large and middle peasant households (Table 4). Like assets, income distribution also seems to be in a progressive direction during the 18-year period.

Migration is an important strategy for households in rural Bihar to reduce livelihood vulnerability as well as to improve the food security condition of the households. It has played a crucial role not just in increasing incomes but also in enhancing social mobility. Between 1998 and 2016, there has been a 20 percentage point increase in the incidence of migration—close to two-thirds of the household migrants in 2016 and 2021 (Fig. 4). Overall, the average annual income per migrant was estimated at Rs 97,744 and the average annual remittance at Rs 48,662. The share of income sent as remittance was about 50 per cent in 2016.

Table 3 Mean annual income by caste/religion (value in Rs): 1998–2016

Caste/Religion	1998–99 (in Rs)	2016 (in Rs)	Ratio 2016/1998
SC/ST	14,248	115,863	8.13
OBC I	13,784	123,343	8.95
OBC II	24,004	145,229	6.05
Muslim	16,817	156,842	9.33
Forward	28,325	175,846	6.21
Average	**20,228**	141,101	6.98

Source IHD-Bihar longitudinal survey, 1998, 2016

Table 4 Mean annual income by class (value in Rs): 1998–99–2016

Class	1998–99 (in Rs)	2016 (in Rs)	Ratio 2016/1998
Agricultural labour	13,311	96,600	7.26
Small peasant	14,240	162,525	11.41
Medium peasant	22,023	108,989	4.95
Large peasant	31,790	145,989	4.59
Landlord	30,674	250,024	8.15
Non-agriculturist	10,764	155,649	14.46
Average	**20,228**	141,101	6.98

Source IHD-Bihar longitudinal survey, 1998, 2016

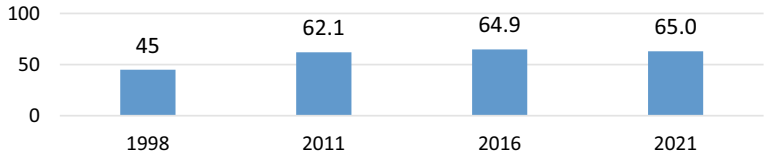


Fig. 4 Proportion migrant households 1998–2021. *Source* IHD-Bihar longitudinal survey, 1998, 2016

4 Changes in Various Dimensions of Food Security in Rural Bihar

The two rounds of surveys carried out in 1998 and 2016 collected somewhat detailed data on various aspects of food security. In this section, we will discuss a few aspects of food security based on the survey data.

4.1 Changes in Consumption Expenditure

The study collected the expenditure on food items on 30 days reference period and non-food expenditure on 365 days recall period. Due to the panel nature of the data set, it is possible to compare the average consumption expenditure in the two time periods and the shift in the allocation of total expenditure in food and non-food items between 1998 and 2016. Overall, the findings throw light upon whether there have been any changes in the allocation of expenditure baskets since 1998. Table 5 shows that the monthly per capita consumption expenditure (MPCE) which was around Rs 453 in 1998 increased to Rs 552 in 2016 in real terms, i.e. on average, there is an increase of 21.85 per cent between the two periods. The median MPCE which was Rs 279 in 1998 increased to Rs 340 in 2016. The data also reveals that non-migrant households have higher MPCE than migrant households. Further, the migrant households experienced a larger increase (1.4 times) in MPCE than the non-migrant households (1.2 times) (Fig. 5). Between 1998 and 2016, household's average food expenditure increased from Rs 279 in 1998 to Rs 290 in 2016, experiencing an increase of 4 per cent.

Table 5 MPCE of the panel households (Rs): 1998–2016

	Mean	Median	P25	P75	Maximum	Minimum
MPCE-2016	552	340	228	581	12,944	70
MPCE-1998	453	279	187	477	10,626	57
Monthly per capita food-2016	290	258	181	357	1855	45
Monthly per capita food-1998	279	209	140	331	3137	40

Source IHD-Bihar longitudinal survey, 1998, 2016
Note Values are in 1998 constant prices

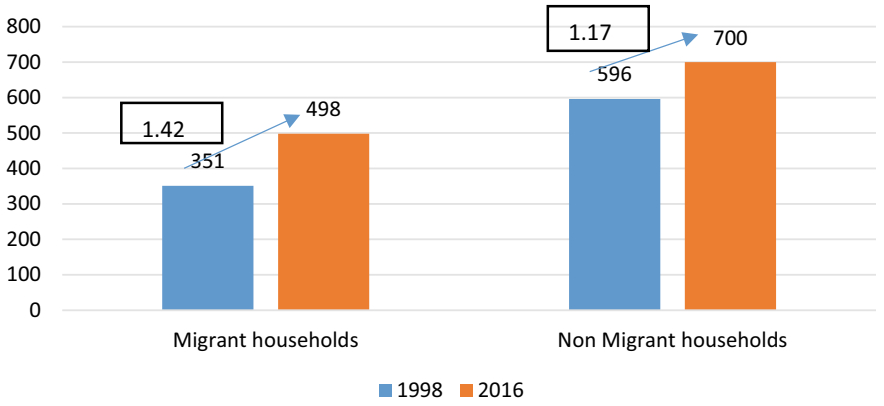


Fig. 5 Changes in MPCE (in Rs at constant prices) by migration status: 1998–2016. *Source* IHD-Bihar longitudinal survey, 1998, 2016

Similar to all India level in rural Bihar also, as the real income of the households increases there is a decrease in the share of expenditures on food items and an increase in the share of non-food items. The median households experienced a 13 per cent increase in household food expenditure, whereas there was a 39 per cent increase in non-food expenditure in 2016 compared to 1998. Across the households, a quarter of them experienced a food expenditure fall of 23 per cent or greater, while three-quarters of them experienced an increase of 73 per cent. Further, at least 25 per cent of the households experienced a non-food expenditure increase by 2.75 times (Table 6).

Irrespective of the caste of the households, there is a decrease in the share of food consumption expenditure between 1998 and 2016. The share of food consumption expenditure was the highest for the households belonging to OBC-I. Data also reveals that the decrease in the share of food consumption expenditure was also highest for households belonging to OBC-I and the lowest for the general caste households (Fig. 6).

Households belonging to different quintile groups of the MPCE distribution represent a series of sub-populations with progressively increasing levels of living. The

Table 6 Changes in food and non-food expenditure, 1998 and 2016

	Ratio of food expenditure*	Ratio of Non-food expenditure*
Mean	1.36	2.19
Median	1.13	1.39
P25	0.77	0.04
P75	1.73	2.75

Source ID-Bihar longitudinal survey, 1998, 2016
Note *—The ratio of 2016 expenditure to 1998 expenditure

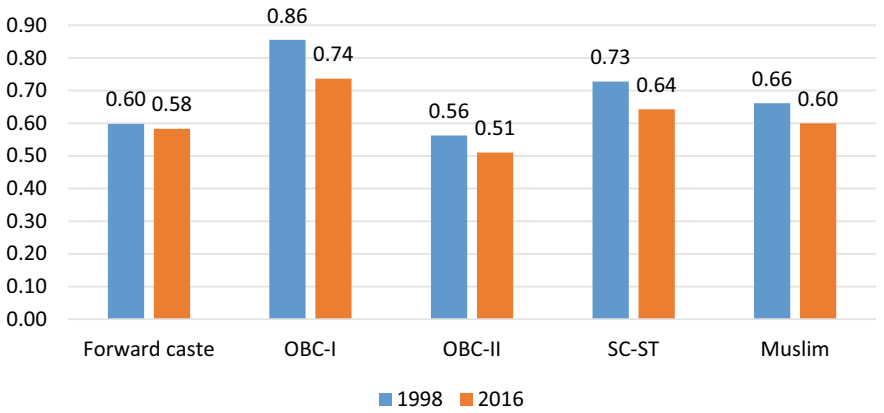


Fig. 6 Changes in share of food consumption expenditure out of total expenditure by caste: 1998–2016. *Source* IHD-Bihar longitudinal survey, 1998, 2016

variation in the budget share of any particular item across MPCE-quintile groups, therefore, enables to study the variation in consumption behaviour with the rise in the level of living. Figure 7 shows that the share of food expenditure out of total expenditure varies from 49 per cent in the richest class to 77 per cent in the poorest class in 2016. This shows a somewhat significant inequality in food expenditure among the consumption expenditure class. Irrespective of the consumption expenditure class, there is a decrease in the share of food expenditure between 1998 and 2016, and it is highest in the middle class (10 percentage points) and lowest in the richer class (6 percentage points).

There is also a significant transition among consumption expenditure classes between 1998 and 2016. Table 7 shows that 28 per cent of the households were shown to belong to the poorest class in both periods. Over one-third of the households that were in the poorest category in 1998 moved upward to the poor expenditure class in 2016. Importantly, 18.5 per cent moved from the poorest class in 1998 to either the richer or richest consumption expenditure class in 2016. On the other hand, over one-fifth of the households that belonged to the richest class in 1998 moved below to either the poorest or poor expenditure class in 2016. About 40 per cent of the households who were richest in 1998 continue to maintain their status as belonging to the richest expenditure class in 2016.

Over time, there has been an increase in the share of all food items at the cost of cereals. In 1998, almost three-fifths of the food expenditure was spent on cereals whereas in 2016 it reduced to 23 per cent, implying a decline of 37 percentage points. The expenditure on pulses, vegetables, meat and eggs, milk, and milk products increased rather significantly (Table 8). Clearly, Engel's law is operating, i.e. as the income of poor people rises consumption of staple food, which is a cheaper source of calories, is likely to decline. A decline in cereal consumption has been substituted with the increased consumption of high-value commodities. The shift away from cereal consumption is significant across all households in different expenditure groups (Table 9). Between 1998 and 2016, the share of expenditure on cereals declined by 28 percentage points in the poorest class and 24 percentage points in the

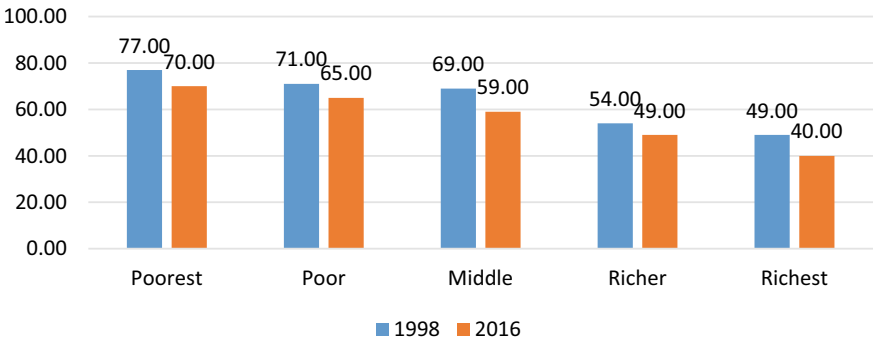


Fig. 7 Changes in share of food consumption expenditure out of total expenditure by class: 1998–2016. *Source* IHD-Bihar longitudinal survey, 1998, 2016

Table 7 Transition in consumption expenditure by class between 1998 and 2016 (in %)

		2016				
		Poorest	Poor	Middle	Richer	Richest
1998	Poorest	28.3	33.0	20.2	12.7	5.8
	Poor	8.5	32.4	28.4	15.7	15.1
	Middle	5.3	10.0	29.1	31.3	24.3
	Richer	6.2	8.5	24.7	33.8	26.8
	Richest	7.6	15.1	16.9	20.9	39.5

Source IHD-Bihar longitudinal survey, 1998, 2016

Table 8 Changes in components of food items expenditure: 1998–2016

	1998	2016
Cereals	59.4	22.8
Pulses	3.7	8.9
Vegetables	9.8	13.5
Meat	4.9	9.3
Eggs	1.0	8.0
Milk and milk products	3.6	10.8
Fruits	2.1	7.4
Edible oil	4.0	6.0
Other	12.0	13.2

Source IHD-Bihar longitudinal survey, 1998, 2016

richest class. Expenditure on pulses increased by 7.2 percentage points in the poorest class and 2.1 percentage points in the case of the richest class. In the case of meat, the share of expenditure increased by 9.6 percentage points in the poorest class and 5.4 percentage points in the richest class. However, in the case of milk and egg, the increase in the share of expenditure was higher for the richest class than the poorest class (Table 9).

4.2 Quantity of Major Food Group Consumption and Required Dietary Allowances

The survey also investigated variations in the consumption of different food items in a month per person between 1998 and 2016 (Fig. 8). It is seen that there is a sharp reduction in the consumption of cereal from 17.5 to 12.4 kg. Also, vegetable consumption reduced from 6 to 2 kg between the same periods. However, households experienced an increase in the consumption of milk from 2.4 to 10 kg. Meat and egg consumption also marked an increase in consumption per month in 2016 compared

Table 9 Changes in pattern of food expenditure by poorest and richest class: 1998–2016

	Poorest		Richest		1998–2016	
	1998	2016	1998	2016	Poorest	Richest
Cereals	69.0	38.0	40.9	13.8	28.1	24.2
Pulses	2.9	7.2	5.8	7.9	7.2	2.1
Vegetables	3.7	5.1	7.6	8.3	5.1	0.7
Meat	2.3	9.6	5.0	10.4	9.6	5.4
Eggs	0.2	3.0	3.0	9.0	3.0	6.0
Milk and milk products	1.7	5.9	5.7	14.2	5.9	8.5
Fruits	1.8	6.0	5.0	7.3	6.0	2.3
Edible oil	2.0	3.0	4.0	5.0	3.0	1.0
Other	16.4	22.0	20.9	24.4	5.6	3.5

Source IHD-Bihar longitudinal survey, 1998, 2016

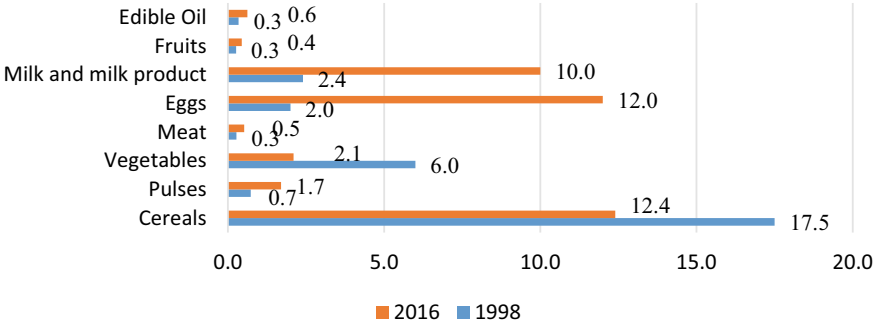


Fig. 8 Changes in quantity of food consumption (per person per month): 1998–2016. *Source* IHD-Bihar longitudinal survey, 1998, 2016

to 1998. Consumption of eggs increased from 2 (per person per month) in 1998 to 12 (per person per month) in 2016. Consumption of fruits and pulses also increased from 0.3 to 0.4 and 0.7 to 1.7 kg, respectively. Overall, there is an improvement, albeit small, in the quality of food consumption.

It will be interesting to see how the consumption of different food items has varied across MPCE classes. It is seen that in both periods, the quantity of cereal consumption reduced whereas consumption of other food items increased when households moved from the poorest class to the better-off economic class. However, the gap between the poorest and richest consumption classes in terms of quantity consumed reduced for all food groups except for the consumption of eggs (Table 10).

The problems of poor nutrition and food insecurity are intertwined. Poor nutritional outcomes are closely linked to food security in India. A large part of the Indian population cannot meet the basic calorie, protein, and fat requirements. Also, a large proportion of the population consumes a diet that lacks adequate dietary diversity, thus affecting their micronutrient intake (MoSPI and WFP, 2019; ICMR-NIN, 2020).

Table 10 Consumption of various food items by socio-economic status of the households: 1998–2016

		Cereals quantity (kg)	Pulses and pulse products quantity (kg)	Vegetable (Kg)	Fruits quantity (kg)	Non-veg (meat and fish) kg	Eggs quantity (no)	Milk and milk products quantity (kg)
1998	Poorest	27.18	0.2	2.55	0.1	0.23	0.78	0.72
	2nd quintile	23.34	0.4	3.04	0.22	0.35	1.09	1.91
	3rd quintile	19.22	0.4	3.66	0.29	0.41	1.25	2.4
	4th quintile	13.2	0.9	7.53	0.37	0.57	1.82	3.4
	Richest quintile	11.21	1.0	8.85	0.56	0.55	2.1	5.23
2016	Poorest	21.2	0.9	1.2	0.3	0.3	2.1	3.1
	2nd quintile	19.2	1.0	1.7	0.4	0.3	4.8	6.6
	3rd quintile	15.21	1.2	2.2	0.5	0.3	9.2	8.1
	4th quintile	10.0	1.4	3.3	0.6	0.4	11.3	11.3
	Richest quintile	8.32	2.5	4.0	0.6	0.7	15.7	12.1

Source IHD-Bihar longitudinal survey, 1998, 2016

Table 11 Changes in per capita per day energy, protein, and fat consumption: 1998–2016[7]

	1998	2016
Per day per person energy (kcal)	2161	2542
Per day per person protein (Gram)	52.7	55.3
Per day per person fat (Gram)	29.5	39.9

Source IHD-Bihar longitudinal survey, 1998, 2016

Therefore, we have analysed the households' required dietary allowances and how it varies across the socio-economic class. It is estimated that per day per capita energy consumption which was 2161 kcal in 1998 increased to 2542 kcal in 2016. The consumption of fat also increased from 29.5 g in 1998 to 40 g in 2016. However, the consumption of protein increased only marginally from 52.7 g in 1998 to 55 g in 2016 (Table 11).

[7] According to NSSO 68th round (2011–12), calories, protein, and fat consumption in rural Bihar was 2242 kcal, 62.9 g, and 39 g, respectively. The corresponding figures for NSSO 55th round (1999–2000) were 2121 kcal, 58.7 g, and 26.6 g, respectively.

The data disaggregated by MPCE-quintile class reveals that there is a drastic increase in per capita consumption of energy, protein, and fat from the poorest MPCE-quintile class to the richest class. In 2016, the consumption of energy in the richest MPCE-quintile class is 1.6 times higher than the consumption of energy in the poorest MPCE class. In the case of protein, it is seen that the consumption of protein is 2.05 times higher in the richest class than in the poorest class. The consumption of fat is also 3.05 times higher in the richest class than in the poorest class. The gap between the poorest and richest classes in terms of consumption of energy, protein, and fat reduced in 2016 compared to 1998 (Table 12).

Among the caste groups, per day per capita energy intake, as well as those of protein and fat, was lowest among OBC-I and SC groups in 1998. On the other hand, in 2016 calorie intake was the highest among the SC households, while the consumption of protein and fat was the lowest among them. Also in both 1998 and 2016, protein intake was the highest among the forward caste and Muslim groups. It is also seen that between 1998 and 2016 calorie intake was almost the same among the forward caste households, but among OBC-I households and SC households, it increased by approximately 700 to 900 kilo calories (kcal) (Table 13).

Table 12 Per capita per day energy, protein, and fat consumption by MPCE-quintile class: 1998–2016

	1998	2016	1998	2016	1998	2016
	Per day per person energy (kcal)		Per day per person protein (Gram)		Per day per person fat (Gram)	
Poorest	1700	1900	27	37	14	19
Poor	1790	2158	39	48	23	28
Middle	2100	2300	47	54	27	33
Richer	2361	2661	58	64	39	43
Richest	2890	3106	66	76	48	58

Source IHD-Bihar longitudinal survey, 1998, 2016

Table 13 Per capita per day energy, protein, and fat consumption by caste, 1998–2016

	1998	2016	1998	2016	1998	2016
	Per day per person energy (kcal)		Per day per person protein (Gram)		Per day per person fat (Gram)	
Forward caste	2361	2424	54	58	33	36
OBC-I	1875	2664	39	54	25	37
OBC-II	2120	2375	44	56	33	44
Scheduled caste	1986	2869	40	51	22	27
Muslims	2000	2428	51	59	36	39

Source IHD-Bihar longitudinal survey, 1998, 2016

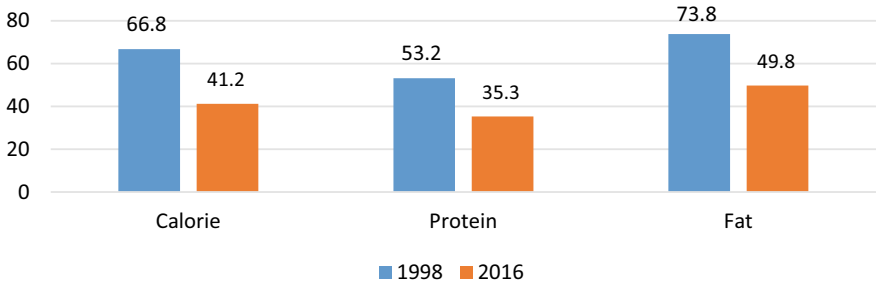


Fig. 9 Percentage of households deprived of required dietary allowance: 1998–2016. *Source* IHD-Bihar longitudinal survey, 1998, 2016

We have identified the percentage of households who are deprived in terms of consumption of energy, protein, and fat based on the cut-off given by the Task Force committee (see the methodology above). In Bihar, calorie deprivation (i.e. population consuming less than 2200 cal) was calculated as 78 per cent (Nayyar & Nayyar, 2016) based on the NSSO 61st and 68th consumption expenditure rounds. The survey data reveals that the percentage of household members with below-recommended calorie intake decreased from 67 per cent in 1998 to 41 per cent in 2016 (decrease of 25.6 percentage points). Also, protein deprivation reduced by 18 percentage points, and fat deprivation reduced by 24 percentage points (Fig. 9).

By MPCE-quintile class, it is observed that in 2016, 52 per cent of households in the poorest MPCE-quintile were deprived in energy consumption, 45 per cent in protein consumption, and 62 per cent in fat consumption. This indicates the severe nutrition shortage among the households that belong to the poorest MPCE-quintile class. It is also seen that the household's deprivation level improves with the increase in the MPCE-quintile class. On the other hand, it is observed that one-third of the households in the richest MPCE class are deprived of energy consumption. Further, 27 per cent of the richest households are deprived of protein and 35 per cent are deprived of consumption of fat. Between 1998 and 2016, the reduction in energy deprivation was highest in the middle quintile class (30 percentage points) followed by the poorest (25 percentage points), and poor quintile class (21 percentage points). The reduction in protein deprivation is also highest in the two bottom MPCE-quintile classes and lowest in the middle quintile class (Table 14).

In both periods, energy, protein, and fat deprivation were highest among the SC group and lowest among the forward castes. The reduction in deprivation of protein and fat is highest among SC and Muslim households, while the reduction in energy deprivation is highest among the forward caste households (Table 15).

Table 14 Percentage of households deprived of required dietary allowance by MPCE-quintile class: 1998–2016

	1998			2016		
	Calorie	Protein	Fat	Calorie	Protein	Fat
Poorest	77	68	85	52	45	62
Poor	72	67	74	51	38	60
Middle	69	51	71	39	48	48
Richer	52	45	67	38	35	44
Richest	39	38	54	30	27	35

Source IHD-Bihar longitudinal survey, 1998, 2016

Table 15 Percentage of households deprived of required dietary allowance by caste: 1998–2016

	1998			2016		
	Energy	Protein	Fat	Energy	Protein	Fat
Forward caste	39	41	52	21	24	39
OBC-I	68	55	67	55	39	52
OBC-II	52	48	62	41	31	45
Scheduled caste	74	65	79	65	42	55
Muslims	62	47	62	49	29	40

Source IHD-Bihar longitudinal survey, 1998, 2016

4.3 Perception of Households About Food Security

A few qualitative questions were also canvassed in the survey about the perceptions of the households about food security. Less than 10 per cent of the households reported insufficiency of food in any month of the year. The insufficiency of food reported was highest among the SC households (16 per cent) and casual worker households (23 per cent). Overall, the consumption of two meals per day has increased from 78 per cent in 1998 to 82 per cent in 2016. For SC households, it increased from 53.5 per cent to 71 per cent, an increase of 17.5 percentage points. The proportion of OBC-I households having 2 meals increased by 13 percentage points in 2016 compared to 1998. However, in the case of forward caste, OBC-II, and Muslim households, there was only a small increase of 3 percentage points.

There are also significant changes in the proportion of households having two meals in a day across MPCE-quintile class. There is an increase of 20 percentage points in the proportion of households who had two meals in the poorest class in 2016 compared to 1998, while in the richest class the proportion increased by 6.8 percentage points (Table 16).

The survey also asked about the frequency of consumption of different food items by the household within the 7 days before the survey (Table 17). In both 1998 and 2016, cereal and edible oil were consumed regularly by all households.

Table 16 Percentage of households who had full meals a day: 1998–2016

MPCE quintiles	1998	2016	Percentage change
Poorest	60.1	79.9	19.8
Poor	71.5	80.1	8.6
Middle	76.7	84.6	7.9
Richer	77.9	85.1	7.2
Richest	80.4	87.2	6.8
Total	75.0	82.3	7.3
Caste			
Forward	89.5	92.2	2.7
OBC-I	70.4	83.7	13.3
OBC-II	80.3	83.4	3.1
SC	53.5	71.0	17.5
Muslims	78.1	81.5	3.4

Source IHD-Bihar longitudinal survey, 1998, 2016

Table 17 Changes in the frequency of food group consumption in Rural Bihar (in %): 1998–2016

	1998			2016		
	Regularly	Occasionally	Rarely	Regularly	Occasionally	Rarely
Cereals	100	0	0	100	0	0
Pulses	3	8	89	22	38	40
Vegetables	45	49	6	55	32	13
Meat	3	7	90	30	44	26
Eggs	2	8	90	85	8	7
Milk and milk products	11	22	67	61	33	6
Fruits	0	19	81	25	49	26
Edible oil	99	1	0	100	0	0

Source IHD-Bihar longitudinal survey, 1998, 2016

In the case of pulses, 89 per cent of the households consumed them rarely in 1998, whereas over one-fifth of such households regularly consumed them in 2016. Meat and eggs were consumed rarely in 1998. However in 2016, over four-fifths of the households consumed eggs regularly and 74 per cent consumed meat either regularly or occasionally. In 1998, about two-thirds of the households consumed milk or milk products rarely, and over four-fifths consumed any fruits rarely in 1998. But in 2016, three-fifths of the households consumed milk and one-fourth of the households consumed fruits regularly. Clearly in 18 years, there has been a rather significant improvement in the consumption of quality food.

Table 18 Food groups consumption by households in the last 24 h (N = 1000), 2016 (in %)

Cereals	100
Pulses	62
Roots and tubers	20
Vegetables	92
Fruits	10
Milk and milk products	54
Eggs	8
Fish	9
Meat	5
Sweets	23
Oil/spices/fat	98
Drinks and beverages	73

Source IHD-Bihar longitudinal survey, 2016

Household Dietary Diversity and Food Frequency Score

In 2016, the survey canvassed a detailed module on households' consumption of different food groups which allows us to analyse the food consumption pattern of the households and how it varies across the socio-economic class. The HDDS is calculated based on different number of food groups. The mean HDDS was 6.03 (SD 1.7). All the households consumed cereals, oils, and spices/fat on the day before the survey (Table 18). In all, 92 per cent of the households consumed vegetables, 20 per cent consumed roots and tubers, and 62 per cent of the households consumed pulses. The least reported consumption group is fish (9 per cent), eggs (8 per cent), meat (5 per cent), and fruits (10 per cent). When HDDS is split into three categories (high/medium/low dietary diversity), 53 per cent of households are found to have low dietary diversity, 28 per cent have medium dietary diversity, and about 19 per cent were found to have high dietary diversity.

As regards the FFS, the mean FFS is 42.86 (SD 1·49) for adults and 39.21 (SD 12.14) for children. Based on the FFS, approximately one-third of the households lie at the low aggregate. FFS-based classification shows that almost half of the households cluster at moderate levels of food frequency (Fig. 10).

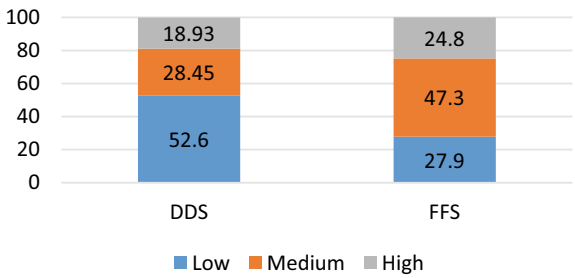


Fig. 10 Household food security status by HDDS and HFFS:2016. *Source* IHD-Bihar longitudinal survey, 2016

Caste-wise analysis shows that the upper castes demonstrate a lower proportion of households having low DDS. Among the OBC-I caste, which is considered to be the poorest among the OBC category, half of the total households fall in the lower DDS group, whereas about one-fifth of the total households remained in the high DDS group. Among the OBC-II, 33 per cent of the total households remained in the low DDS category and one-fifth of the households belong to high DDS. More than three-fourths of the total SC households demonstrate low DDS, whereas 11 per cent belonged to the higher DDS category. It is also seen that 54 per cent of the Muslim households belonged to the low DDS category. FFS of the households revealed that the percentage of households with low FFS is lowest among the forward caste households and highest in the scheduled caste households (Table 19).

Household socio-economic well-being has a clear and strong influencing pattern with different food security measures considered in this paper. In terms of dietary diversity, which indicates the qualitative aspects of food security, the proportion of households with higher dietary diversity or higher food frequency scores steadily increases across the MPCE-quintile groups.

The other important point which emerges from the analysis is that food insecurity is not only limited to the poorest MPCE class. 34.5 per cent of the households in rural Bihar in the two upper MPCE quintiles, representing the top 40 per cent of the expenditure distribution, is found to have low DDS and 22 per cent of the households belonging to the two richest MPCE classes also have low FFS (Table 20).

We have also constructed DDS by household's educational level of the households. It can be seen that with the better educational level of households, DDS improves (Table 21). With the higher secondary and above level of education, 38 per cent of the households have low DDS, whereas if household members are illiterate then 65 per cent of them have low DDS. There is also a 26 percentage point increase in the percentage of households with high DDS if households have higher secondary and above levels of education as against if households' members are illiterate.

For household food frequency scores, it is seen that almost half of the households have a low FFS if households' members are illiterate whereas only 11 per cent of the households have a low FFS if households' members have a higher secondary and above level of education. Further, among households with high FFS, the score is

Table 19 Household dietary diversity and food frequency score by caste (in %)

	DDS			FFS		
	Low	Medium	High	Low	Medium	High
Forward Caste	31.43	39.45	29.12	13.53	46.99	39.48
OBC-I	50.28	32.55	17.17	23.11	47.90	28.99
OBC-II	33.00	47.40	19.70	14.94	57.14	27.92
Scheduled Caste	76.70	12.30	11.00	49.31	40.25	10.44
Muslims	53.90	23.90	22.20	18.87	48.11	33.02

Source IHD-Bihar longitudinal survey, 2016

Table 20 Different measures of household food insecurity by MPCE-quintile class (in %)

		MPCE-quintile class				
		Poorest	Poor	Middle	Richer	Richest
HDDS	Low	39.1	35.5	24.7	22.9	11.6
	Medium	52.4	54.1	68.7	62.8	57.2
	High	8.5	10.4	13.5	14.6	31.5
HFFS	Low	56.9	49.5	37.4	14.8	7.6
	Medium	32.2	38.4	50.4	60.2	65.6
	High	11.0	12.3	13.1	25.1	26.7

Source IHD-Bihar longitudinal survey, 2016

Table 21 Household food insecurity measure by highest education level of the households and income source (in %)

	HDDS			HFFS		
	Low	Medium	High	Low	Medium	High
Highest education level of the household						
Illiterate	65.3	27.5	7.2	48.1	37.7	14.3
Primary	59.6	29.2	11.2	41.9	40.7	17.4
Middle	48.2	37.3	14.5	30.3	45.4	24.3
Secondary	44.2	33.6	22.2	23.1	53.8	23.1
Higher secondary and above	38.2	28.5	33.3	11.2	57.8	31.0
Main income source						
Self-employed	59.2	28.7	12.1	37.5	50.7	11.8
Casual workers	62.1	27.8	10.1	32.2	42.3	25.5
Salaried workers	39.2	26.7	34.1	19.0	37.0	44.0
Remittances dependent	41.2	40.6	18.2	29.0	45.6	25.4

Source IHD-Bihar longitudinal survey, 2016

more than 2 times higher for a household with a higher secondary and above level of education as compared to illiterate households. It may be mentioned that education level is closely associated with the socio-economic status of the households.

Concerning the main income source of the households, it is seen that low HDDS is highest among casual wage households followed by self-employed households. Household with high HDDS is more than 2.8 times higher for households dependent on salary than households dependent on self-employment. In the case of FFS, it is seen that a household with low FFS is almost 2 times lower for household depending on salary as compared to a household that depends on self-employment. Further, households, with high FFS, are 3.7 times higher for households depending on salary as compared to a household that depends on self-employment and 2.7 times higher as compared with casual wage-dependent households. The households with salary

work have better DDS than the rest of the households. The households that depend on remittances belong to medium DDS as well as FFS.

4.4 Food Security and Public Programmes: The Role of PDS

The survey collected data on utilization, benefits received, and perceptions on quality aspects or relative contribution of the PDS from the viewpoint of ensuring or influencing FSN outcomes. As far as PDS is concerned, two-thirds of below poverty line (BPL) households received foodgrains from PDS. While the availability of staples—mostly rice and wheat—through PDS not only helps households to overcome the persistent risks of food shortages but also helps the household to reduce their budgetary outlays on staples and afford a more varied diverse diet, the analysis shows that households with high reliance on PDS supplies appear to have high DDS and FFS. Further, deprivation in terms of calorie protein and fat is also low when households have a high reliance on PDS supplies. The finding supports the importance of PDS in influencing positive food security outcomes in the households (Table 22).

Table 22 Food insecurity and utilization of public programme: 2016 (in %)

		Insufficient	Partial	High reliance
DDS	Low	62.5	58.8	30.4
	Medium	21.3	16.9	49.9
	High	16.3	24.3	14.8
FFS	Low	43.8	27.1	17.1
	Medium	36.3	43.3	51.4
	High	15.0	20.6	38.5
RDA	Calorie deprived	48.8	43.9	43.0
	Protein deprived	39.8	30.2	26.8
	Fat deprived	55.5	42.8	32.4

Source IHD-Bihar longitudinal survey, 2016
Note High reliance: PDS supplies supports more than 2–3 weeks of food grains requirement; Partial: PDS supports more than 2 weeks of food grains requirement; and Insufficient: PDS has insignificant contribution due to irregular supply

5 Impact of COVID-19 on Household Food Security

This section is based on a telephonic survey conducted from November 2020 to February 2021 to understand the impact of COVID-19 on households' food security in rural Bihar. The surveyed households were part of households that were surveyed in 2016.

It has been found that the households reallocated expenditure from non-essential to essential items during the COVID-19 outbreak. The share of non-food expenditure has declined, whereas essential items like food have gained in their share in total expenditure. Figure 11 shows that the share of food consumption expenditure has increased from 53 per cent in 2016 to 71 per cent in 2021 showing an 18 percentage point increase, whereas the share of non-food consumption expenditure reduced by 18 percentage points (47 per cent in 2016 to 29 per cent in 2020).

Figure 12 shows the changes in the consumption of various food items before and during the COVID-19 outbreak. There is a significant decline in the percentage of households that consume vegetables, pulses, meat, and sweets, during COVID-19. During the same period, the percentage of households consuming roots and tuber and eggs has increased. The highest level of consumption was cereals in both periods.

The DDS has been estimated for panel households for both points of time (2016 and 2021). Figure 13 shows that the percentage of households in the low DDS has reduced from 45 per cent in 2016 to 26 per cent in 2021, whereas the medium DDS has increased by about 25 percentage points in 2021 compared to 2016. On the other hand, the proportion of households in the high DDS has reduced from 23 per cent to 17 per cent—a reduction of 6 percentage points.

As shown in Fig. 14, in about a third of the households (33 per cent), adults had low levels of food frequency scores in 2016 which reduced to 12 per cent in 2021. Similarly, 33 per cent of households' children had low levels of FFS in 2016 which reduced to 22.4 per cent in 2020. On the other hand, in about one-third of households, the adult had a high FFS in 2016 which reduced by 4 percentage points, while in about a third of households, where the child had a high FFS in 2016, it reduced by about 7 percentage points. Over the period among the households, the adult and

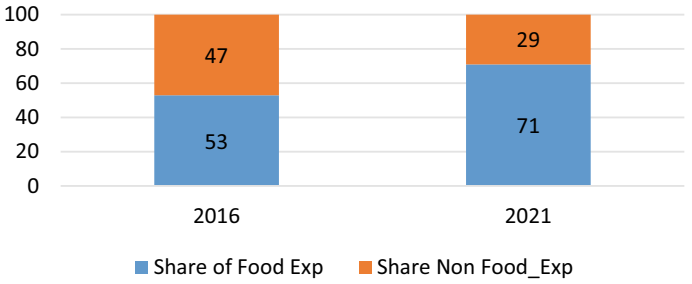


Fig. 11 Changes in share of food and non-food consumption expenditure, 2016–2021 (%). *Source* IHD-Bihar longitudinal survey, 2016, 2021

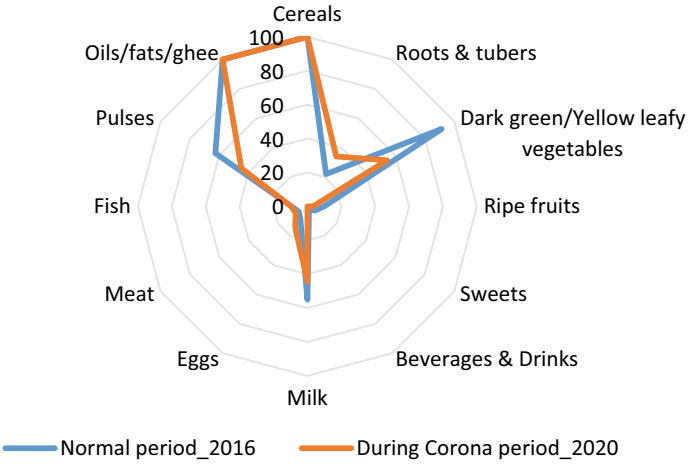


Fig. 12 Percentage of households consumed each food group in 2016 and during COVID-19. *Source* IHD-Bihar longitudinal survey 2016, 2021

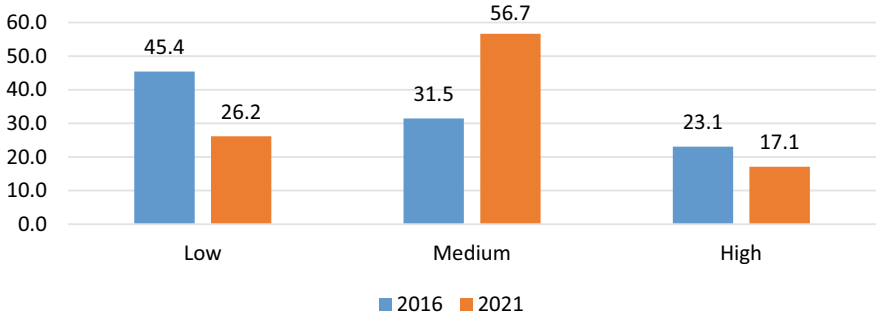


Fig. 13 HDDS in 2016 and 2021 (in %). *Source* IHD-Bihar longitudinal survey, 2016, 2021

child who stayed in the middle FFS have increased by 25 percentage points and 17 percentage points, respectively.

Table 23 highlights the food insecurity situation of the households before and during the COVID-19 outbreak. The upper part of this table presents the households' self-perception on food insecurity which is derived from the 8 items of the HFIES module of the households. It is obvious that food insecurity has worsened during the period of pandemics compared to a normal period. For instance, during COVID-19 more than half of the respondents were worried about the household not having enough food. Approximately 60 per cent of the households also worried about not being able to eat a variety of food during COVID-19. However, approximately one-fifth of the households faced these problems in the normal period also. Further, one-fourth of the households only consumed a few items of food during the COVID-19 pandemic as against only 11 per cent of such households in the normal period.

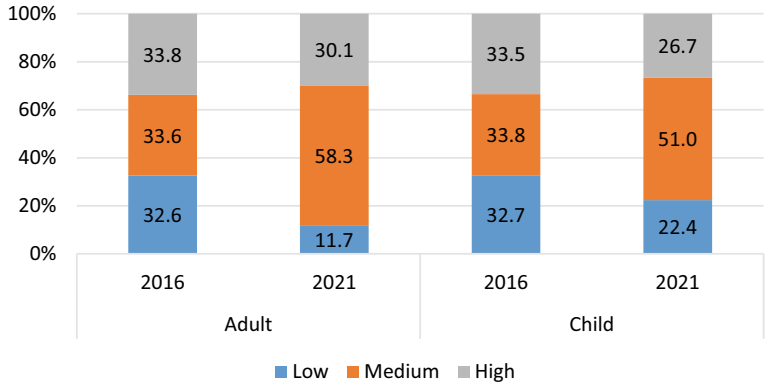


Fig. 14 FFS among adults and children in 2016 and 2021 (in %). *Source* IHD-Bihar longitudinal survey, 2016, 2021

Table 23 Food security situation before and during COVID-19 period (in %)

Items of HFIES	2016	2021	P value
Worried that household would not have enough food	18.00	56.90	0.002
Not able to eat a variety of food	16.43	58.36	0.001
Ate only a few kinds of food items	10.64	25.00	0.000
Skipped a meal	1.00	12.00	0.02
Ate less amount of food	8.00	44.00	0.000
Felt hungry	2.00	10.70	0.01
Without eating the whole day	1.00	5.34	0.001
Food insecurity status			
Mild food insecure	38	20.00	0.000
Moderately food insecure	39	45.00	0.01
Severely food insecure	23	35.00	0.000

Source IHD-Bihar longitudinal survey, 2016, 2021

The lower part of Table 23 shows the result of the 3 food insecurity measures that were constructed from the above 7 items of HFIES module. Compared to the normal period, the percentage of moderately insecure households increased by 6 percentage points from 39 per cent in 2016 to 45 per cent in 2021. The percentage of severely insecure households also increased by 12 percentage points from 23 per cent in 2016 to 35 per cent in 2021. However, during the same period the percentage of households with mild insecure reduced by 18 percentage points.

As mentioned earlier, migration is an important source of livelihood strategy for households in rural Bihar. About 63 per cent of households had at least one migrant worker in 2021. It is observed that 92 per cent of migrant workers were being affected by COVID. As such it is important to see whether the food security of the

migrant households got affected during COVID-19. Table 24 shows that percentage of households consuming less than 3 food groups is higher among non-migrant households in both periods. Between 2016 and 2021, there is an 11 percentage point decline among households belonging to high DDS (more than 6 food items) among migrant households. However, the proportion of non-migrant households belonging to high DDS remained the same in both 2016 and 2021. The shortage of food and lesser variety of availability of food are the major sources of worry among migrant households than non-migrant households in 2021. However, in 2016 the proportion of households that were worried about food shortage and less variety of food was much higher among non-migrant households than migrant households. Overall, COVID-19 adversely affected migrant households much more than non-migrant households (Table 25).

Table 24 Changes in dietary diversity among migrant and non-migrant households (in %): 2016–2021

	2016			2021		
	Low	Medium	High	Low	Medium	High
Migrants	42.3	30.8	26.8	25.1	59.1	15.8
Non-migrants	50.3	32.4	17.3	27.2	54.4	18.4

Source IHD-Bihar longitudinal survey, 2016, 2021

Table 25 Changes in self-perception about food security among migrant and non-migrant households (in %): 2016–2021

Items of HFIES	2016		2021	
	Migrant	Non-migrant	Migrant	Non-migrant
Worried that household would not have enough food	14.0	22.0	58.6	51.5
Not able to eat a variety of food	12.0	20.0	62.0	54.0
Ate only a few kinds of food items	9.0	11.0	32.0	20.0
Skipped a meal	1.0	1.0	17.0	8.1
Ate less amount of food	8.0	9.0	48.0	39.0
Felt hungry	2.0	2.0	11.4	9.8
Without eating the whole day	0.0	1	6.2	3.9

Source IHD-Bihar longitudinal survey, 2016, 2021

5.1 Effectiveness of the Government Programme in Supplementing Food and Nutrition Shortages During COVID-19

Respondents were also asked whether PDS foodgrains had enabled the households to mitigate the risk of food shortage during the pandemic. Figure 15 shows that 21.8 per cent of the households do not have ration cards and therefore they did not receive any ration from PDS in both periods. Compared to the normal period, the PDS ration supported the households to tide over the difficulties of life in a much decent way. Two-fifths of the households responded that the PDS ration only fulfilled less than 2 weeks of ration in the pre-COVID period. However, one-fourth of the respondents told that during the COVID period, the PDS ration supported more than 3 weeks of requirements, and another 36 per cent of the respondents reported that rations were enough to meet 2–3 weeks of requirements.

The respondents were also asked to what extent Take Home Ration (THR) from Anganwadi Centre (AWC) supported the nutrition requirements of the child. Figure 16 shows that there is a worsening in the nutrition support from AWC during the post-COVID period. More than one-third of the respondents reported that in the pre-COVID period, THR supported the child's food intake by giving him more than half of the food the child consumed daily; and an additional 45 per cent reported THR supported the child's food intake by supplying him only light meals, whereas 82 per cent of the respondents reported that in the post-COVID period, THR supported an insignificant portion of the child's normal dietary requirements due to its irregular supply.

Mid-Day Meal Scheme plays an important role in improving the nutritional level of primary school-going children by providing meals at timely intervals during school. In our sample, 60 per cent of the eligible beneficiaries received the mid-day meal as scheduled during COVID. Of those who received mid-day meals timely, 79 per cent have received it only sometimes, 17 per cent of them received it only rarely,

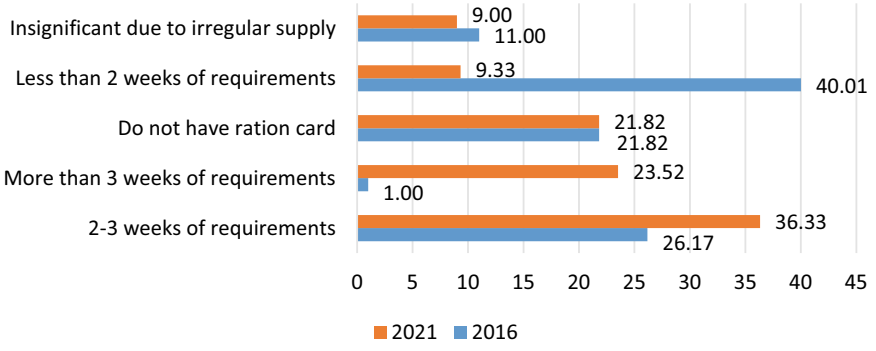


Fig. 15 PDS support during COVID-19 outbreak (in %). *Source* IHD-Bihar longitudinal survey, 2016, 2021

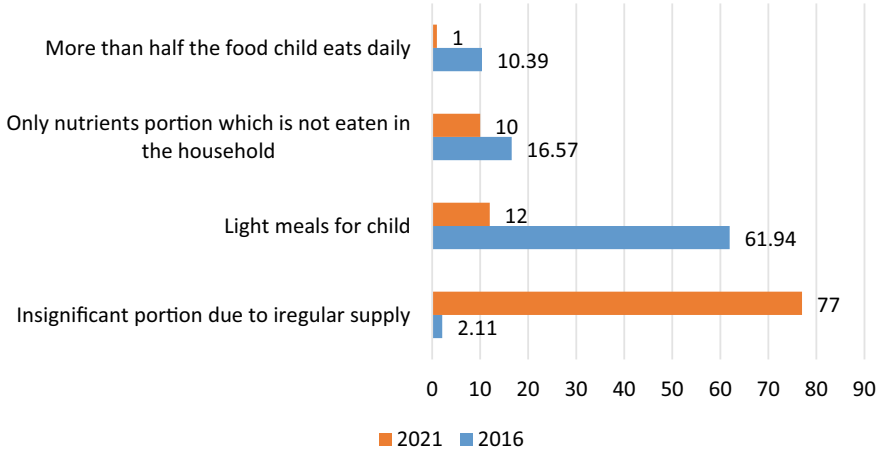


Fig. 16 THR from AWC supports during COVID-19 Outbreak (in %). *Source* IHD-Bihar longitudinal survey, 2016, 2021

and the rest of them received it regularly. However, 77 per cent of them opined that Mid-Day meals supported an insignificant portion of child nutrition due to its irregularity in scheduled distribution. However, the majority of the respondents reported that Mid-Day meals were used to support the food requirements of the child to the extent of light meals for the child in the pre-COVID period (Fig. 17).

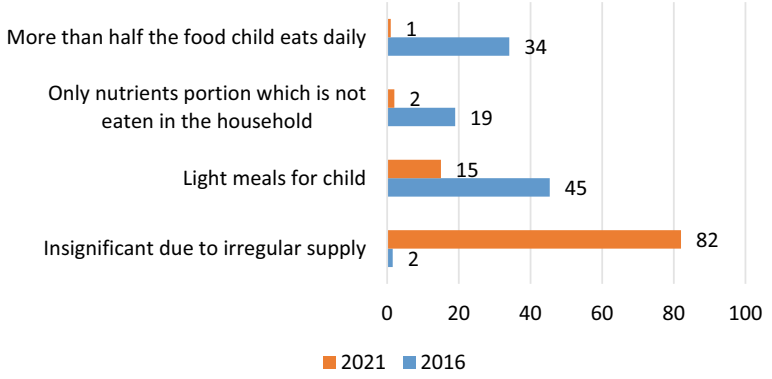


Fig. 17 Mid-day meal supports during the COVID-19 outbreak (in %). *Source* IHD-Bihar longitudinal survey, 2016, 2021

6 Conclusions and Policy Pointers

6.1 By Way of Conclusion

The analyses in the paper show that there has been significant improvement in the various dimensions of food security in rural Bihar, over time, more so during the 18 years period between 1998 and 2016. They are reflected in an increase in per capita consumption expenditure. Over time there has been an increase in the share of all the food items at the cost of cereals which indicates improvement in food quality. This is accompanied by the increase in per capita per day calorie, protein, and fat consumption. Notwithstanding these improvements, the consumption pattern is mostly dominated by staples, which put them at a clearly nutritional disadvantage. Nearly 40% of the households are deprived in terms of required calorie consumption, 35% are deprived of required protein consumption, and almost half of the households are deprived in terms of required fat consumption. Households predominantly depend on cereals and vegetables to meet their energy and nutrient requirements, with relatively low consumption of other food items such as pulses, fruits, edible oils, milk, and other protein-rich food items. Not surprisingly, over one-third of the households have low dietary diversity, i.e. they manage to consume only 4 food groups out of 12 food groups. Thus, in spite of improvement over time, a large proportion of households in rural Bihar do not have a balanced diet in terms of nutritional requirements. This is also reflected in the high incidence of undernutrition among children and anaemia among women as revealed by NFHS-5.

The analysis also shows that the improvements in some food indicators have been more among poorer socio-economic groups as compared to relatively richer groups. But again, the improvements among the poorer groups have been led by the consumption of staple food items. The poorer groups lag behind considerably in the consumption of protein-rich food items. The dietary diversity is also considerably lower among the poorer groups. Thus, food security in rural Bihar has clearly a class dimension.

Migration has clearly played an important role in improving the food security of the rural population. Migrant households as a whole have experienced a relatively larger increase in consumption expenditure, particularly food expenditure, than non-migrant households. Over three-fifths of the rural households in Bihar are migrants which invariably receive remittances. This contributes significantly to improving their access to food and other non-food items. This is also evident from the fact that during COVID-19 food security situation deteriorated largely because of disruption in migration and consequent remittances.

Public Distribution System (PDS) has proved to be an important pillar in improving food security. The households with higher reliance on PDS supplies have better diet diversity as well as food frequency. During the COVID-19 pandemic, PDS played an important role in monitoring households' food security. Along with PDS, Mid-Day Meal scheme and ICDS have contributed to better access of children to food and nutrition security.

6.2 Some Policy Pointers

The findings of the study have some obvious policy implications. Some of the important policy points are

- The diversification of food baskets towards nutritious food will play a very important role in enhancing food security. As revealed by the analysis in this paper, in spite of improvement in food security, the consumption pattern of a majority of the rural households is dominated by staple food items. And there is clearly a need of expanding the food basket.
- Cropping pattern in Bihar is overwhelmingly dominated by cereals. There should be a policy focus to shift this cropping pattern, even by a small margin, to other food items (oil seeds, vegetables, etc.). Millets occupy a very small area in cultivation in Bihar which can easily be increased both in Kharif and Rabi seasons, particularly the latter.
- The practice of creating a small kitchen garden can greatly help in maintaining the basic dietary diversity of the households. A major constraint is that almost three-fifths of the rural households in Bihar are landless and generally they do not have even a small parcel of land for kitchen gardens. The government may devise a policy to purchase land from the market to distribute small parcels of land to the poor households at a subsidized rate for kitchen gardens wherever possible. The practice of community kitchen gardens can also be encouraged.
- There is significant scope in further strengthening PDS. Many of the households even though eligible do not have access to PDS. This exclusion error must be eliminated. Further, the pulses, millets, edible oils, etc. should gradually comprise part of the PDS which will significantly increase the access of poor households to these items. The Mid-Day Meal Scheme and ICDS have also contributed to food security, but there is scope for much improvement in their functioning.
- Along with the above measures, the water and sanitation situation must be improved to make a frontal attack on malnutrition. Anganwadi and Aasha workers along with Primary Health Centres can play a very important role in providing these services. Anganwadi centres are in a generally bad condition, and they have not been given the attention they deserve in enhancing nutrition and food security in Bihar.

References

Ballard, T. J., Kepple, A. W., & Cafiero, C. (2013). *The food insecurity experience scale: development of a global standard for monitoring hunger worldwide*. Technical Paper. Rome, FAO. http://www.fao.org/economic/ess/ess-fs/voices/en/.

Barrett, C. B. (2010). Measuring food insecurity. *Science, 327*, 825–828.

D'Souza, A., & Jolliffe, D. (2010). *Rising food prices and coping strategies: Household-level evidence from Afghanistan.* Policy research working paper WPS no. 5466. World Bank. © World Bank.

Drèze, J., & Khera, R. (2013). Rural poverty and the Public Distribution System. *Economic & Political Weekly, 48*(45–46), 55–60.

Drèze, J., & Khera, R. (2015). Food security in Bihar on the move. *Economic & Political Weekly, L*(34), 44–52.

Drèze, J., & Khera, R. (2017). Recent social security initiatives in India. *World Development, 98*(C), 557–572.

FAO, WFP and IFAD. (2013). *The state of food insecurity in the world, the multiple dimensions of food security.* FAO.

Government of India. (2020–21). *SDG india index & dashboard 2020–21. Partnerships in the decade of action.* NITI Aayog, Government of India and United Nations.

Gundersen, C. G., & Garasky, S. B. (2012). Financial management skills are associated with food insecurity in a sample of households with children in the United States. *Journal of Nutrition, 142*(10), 1865–1870.

ICMR-NIN. (2020). *Short report of nutrient requirements for Indians.* Ministry of Health and Family Planning, Government of India.

ICMR. (2010). *Nutrient requirements and recommended dietary allowances for Indians.* A report of the expert group of the Indian Council of Medical Research National Institute of Nutrition Indian Council of Medical Research.

Institute for Human Development. (2004). *Dynamics of poverty, employment and human development in Bihar*. Report of project sponsored by NABARD, Institute for Human Development, New Delhi.

Jones, A. D., Shrinivas, A., & Bezner-Kerr, R. (2014). Farm production diversity is associated with greater household dietary diversity in Malawi: Findings from nationally representative data. *Food Policy, 46*(2014), 1–12.

Kaushal, N., & Muchomba, F. (2013). *How consumer price subsidies affect nutrition* (No. w19404). National Bureau of Economic Research.

Kochar, A. (2005). Can targeted food programs improve nutrition? An empirical analysis of India's Public Distribution System. *Economic Development and Cultural Change, 54*(1), 203–235.

Mishra, S. K., Dutta, S., & Madan, A. (2021). *Food security during pandemic times: Insights and perspectives from Rural Bihar*. Final report IND-20158, https://www.theigc.org/sites/default/files/2021/11/Kumar-et-al-Final-report-2021.pdf.

MOSPI and WFP. (2019). *Food and nutrition security analysis, India.* WFP and MOSPI, Government of India.

Nayar, G., & Nayar, R. (2016). India's 'poverty of numbers' revisiting measurement issues. *Economic and Political Weekly, 51*(35), 61–71.

NITI Aayog. (2021). *National multidimensional poverty index: Baseline report*. NITI Aayog.

Oyarzun, P. J., Borja, R. M., Sherwood, S., & Parra, V. (2013). Making sense of agro-biodiversity, diet, and intensification of smallholder family farming in the highland Andes of Ecuador. *Ecology of Food and Nutrition, 52*(6), 515–541.

Rahman, A. (2015). *Universal food security program and nutritional intake: Evidence from the hunger prone KBK districts in Odisha.* Working Paper WP-2015–015. Indira Gandhi Institute of Development Research.

Rodgers, G., Datta, A., Rodgers, J., Mishra, S., & Sharma, A. N. (2013). *The challenge of inclusive development in Rural Bihar*. Institute for Human Development and Manak Publications Private Limited.

RBI. (2021). *Handbook of statistics on the indian economy, 2020–21*. Reserve Bank of India. https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/0HBF2021322AC51D15B74324858EEA2C7989B5E2.PDF.

Sarkar, S. (2014). Households' dietary diversity: A study of rural households in West Bengal, India. *European Academic Research, II*(6), 8307–8325.

Sharma, A. N. (1995). Political economy of poverty in Bihar. *Economic and Political Weekly, 30*(41–42).

Sharma, A. N. (2005). Agrarian relations and socio-economic change in Bihar. *Economic and Political Weekly, 40*(10).

Sinha, D. (2021). Hunger and food security in the times of COVID-19. *Journal of Social and Economic Development, 23*(Suppl 2), S320–S331. https://link.springer.com/content/pdf/10.1007/s40847-020-00124-y.pdf.

Styen, P. N., Nel, H. J., Nantel, G., Kennedy, G., & Labadarios, D. (2006). Food variety and dietary diversity scores in children: Are they good indicators of dietary adequacy? *Public Health Nutrition, 9*(5), 644–650.

Suryanarayana, M. H. (2013). *The pursuit of food security in India: Policies sans concept and commitment*? The International Policy Centre for Inclusive Growth, One Pager No. 207. Poverty Practice, Bureau for Development Policy, UNDP, Brazil. http://www.ipc-undp.org/pub/IPCOnePager207.pdf.

Swaindale, A., & Bilinsky, P. (2006). *Household Dietary Diversity Score (HDDS) for measurement of household food access: Indicator guide, food and nutrition.* Technical Assistance (FANTA), USAID.

Taruvinga, A., Muchenje, V., & Mushunje, A. (2013). Determinants of rural household dietary diversity: The case of Amatole and Nyandeni districts, South Africa. *International Journal of Development and Sustainability, 2*(4), 2233–2247.

WFP (World Food Programme). (2008). *Food consumption analysis: Calculation and use of the Food Consumption Score.* International Food Policy Research Institute and Dublin: Concern Worldwide, 2010. http://www.ifpri.org/sites/default/files/publications/ghi10.pdf.

WFP (World Food Programme). (2009). *Comprehensive food security & vulnerability analysis guidelines.* World Food Programme (WFP), Food Security Analysis Service.

Cross-Sectoral Impacts on Nutrition

Milk Consumption Pattern of Young Children: *A Relook at the Indian Evidence*

Brinda Viswanathan and Divya Purohit

1 Introduction

India was one of the highest contributors to the world's stunted children. In 2015, the prevalence of stunting among children under the age of 5 years was 38.4% in India and 23.1% for the world as a whole. The prevalence of stunting in India decreased by merely 3 percentage points to reach 35.5% by the year 2019–21 (IIPS, 2021). However, it is observed that the rural sector is the major contributor to the national decline in the percentage of stunted children as it declined from 41.2% in 2015–16 to 37.3% in 2019–21 whereas the decline in the urban sector over the same period was only 0.9 percentage point (31% in 2015–16 and 30.1% in 2019–21).

Only a few rigorous studies exist that show that milk consumption is positively associated either with lower stunting rates or a lesser likelihood of stunting or higher HAZ scores (de Beer, 2012; Choudhury & Headey, 2018; Headey et al., 2018; Herber et al., 2020). A few studies exist for African countries and even fewer for South Asian countries that analyse the association between milk intake and child's height. This could be because collecting individual-level dietary intake for very small children in a nationwide large-scale survey could be a very challenging task and also prone to reporting errors from the lack of knowledge and understanding among developing country respondents.

The National Sample Survey Organisation (NSSO) collects data on the quantity and expenditure of milk and other dairy products at a household level. The National Family Health Survey (NFHS)—which is a part of the worldwide DHS surveys—collects qualitative information on dietary habits for young children aged between 0 and 23 months and also for the mothers of children aged 0–59 months. Anthropometric information is also available for both mothers and under-five children in the

B. Viswanathan (✉) · D. Purohit
Madras School of Economics, Chennai, India
e-mail: brinda@mse.ac.in

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_6

NFHS data. Thus, this rich source of qualitative information on diets and quantitative information on nutritional outcomes is used for the empirical analysis in this study.

The aim of the study is threefold. First, if there are key covariates that differ between children who consumed milk the previous day and those who did not. Second, if the covariates associated with milk consumed or not are similar or different from the frequency of milk consumed among the children who consumed it. Third, what is the nature of the association between the frequency of milk consumed (including none) and the child's height for age Z-score (HAZ)? We find that all these three aspects are given limited attention in the Indian context.

The findings of the study are intuitive and along expected lines, but the contribution of this study lies in quantitatively establishing it in a manner that is very different from the earlier studies. The Zero-Inflated Poisson model is used to analyse the factors associated with a large number of 'no milk given' reported by the primary caregiver and then the factors associated with the frequency of milk given in the last 24 h. This enables one to understand whether the factors for the two aspects of decision-making are similar or different. Further, by considering the frequency of milk consumed as an endogenous variable in a model that explains the factors associated with HAZ, the association between the higher frequency of milk given and better HAZ scores is significantly evident; once again, a feature not well-established in the Indian context.

Section 2 briefly discusses the relationship between milk consumption and HAZ in very young children and Sect. 3 summarizes the findings of the Indian studies on this aspect. Section 4 discusses the data and the variables of this study followed by Sect. 5 which gives an empirical analysis of the milk consumption pattern and then a brief analysis of its association with HAZ. The last section briefly highlights the policy options to increase the intake of dairy milk.

2 Milk Consumption and Linear Growth Among Young Children

The age group of 6–23 months is ideal for the analysis of milk consumption (given)[1] as a child's dietary requirements increase with age, and complimenting with nutritionally adequate diets alongside optimal breastfeeding is recommended by WHO and UNICEF (IYCF, 2021). The Infant and Young Child Feeding training module for mothers as part of the National Health Mission[2] mentions that breastfeeding though relevant provides only half the nutrition in the 6–12-month age and only one-third of the requirement in the 1–2-year age. One of the complementary foods that is recommended for this age group is dairy milk, which is a natural energy drink and

[1] We will be using the term consumption/consumed or given or intake interchangeably. The question to the primary caregiver is whether the child was given a particular food item in the last 24 h prior to the survey.

[2] Read Here: https://www.nhm.gov.in/MAA/One_Day_Sensitization_Module/One_Day_Sensitization_Module_English_lowres.pdf.

provides balanced nutrition of macronutrients (proteins and fats), vitamin (B12), and micronutrients (calcium) and can be fortified with Vitamins A and D to improve the adequacy of widespread deprivations in those micronutrients (Dror & Allen, 2011).

Milk is an Animal Source Food (or ASF) and is accepted both as part of vegetarian and non-vegetarian diets in India though it has less acceptance among the tribal population. ASFs are found to be better than plant-based proteins to treat moderate malnutrition. An important feature of ASFs is their anti-nutrient property. Anti-nutrients are compounds that reduce the body's ability to absorb essential nutrients. Anti-nutrients are naturally found in animals and many plant-based foods and include phytates, lectics, saponins lysinoalanine, polyphenols, and tannis. Michaelsen et al. (2009) find that high phytate in foods has a strong negative effect on the bioavailabiliy of important minerals like iron and zinc. Phytates along with tannis (polyphenolic compound) have a negative effect on growth, and so low Phytate content should be given priority in the diets of children with moderate malnutrition. Since ASFs have little or no anti-nutrients, they recommend a diet with high content of ASFs for moderately malnourished children.

The focus on 6–23 months old children is also relevant as the first 1000 days of the child's birth is very important in terms of care and nutrition, and any prolonged setback results in growth faltering. This faltering is essentially associated with linear growth or height and captures chronic undernutrition. One of the reasons for not attaining age-appropriate height is the inadequacy of infant and young child feeding practices. Unlike weight as a measure of nutritional status, catching up on heights is usually very slow at a later stage of growth. In a predominantly stunted and anaemic adult population with increasing overweight and obesity among many developing countries including India, the focus on linear growth of children is very important.

As per WHO convention, a child's growth and general nutritional status can be assessed using height-for-age *Z*-scores (HAZ), weight-for-age *Z*-scores (WAZ), weight-for-height *Z*-scores (WHZ), and body-mass-index-for-age *Z*-scores (BMIZ). The Z-score system expresses the anthropometric value as a number of standard deviations or Z-scores below or above the reference mean or median value. A child with HAZ score between −1 and −2 is marginally stunted, between −2 and −3 is moderately stunted, and below −3 is severely stunted. Stunting can hurt a child's physical and cognitive development and in the long run, it can lead to less productivity, lower Intelligence Quotient (IQ), health issues, or even premature death.

3 Milk Consumption and Nutritional Status of Indian Children: Evidence So Far

Vanderhout and Corsi (2021), based on NFHS-4 data for 6–59 months, showed that the coefficient for dairy milk consumption was positive and statistically significant for both HAZ and weight for age (WAZ) after controlling for child, mother, household, and regional characteristics. Interestingly, only 41% of the sample was included in

the HAZ model. Parasar et al. (2021) also used the same data set and noted that across districts of Odisha, when the proportion of children reporting milk consumed exceeds 30%, then with an increase in the proportion of such children the underweight rate declines. Further, using the unit-level data for Odisha, WAZ was found to be positively associated with milk consumption and that economic status, as well as urban residence, played an important role. This study, however, did not analyse the association of milk consumption with HAZ for this less developed state of India. The study further focused on a primary survey to understand the variations across districts and in particular the tribal/non-tribal difference in milk consumption. An important contribution of this survey was to understand other commercial substitutes to dairy milk, like *Amulspray*, *Cerelac*, *Horlicks, Lactogen,* and *Biscuits*. This analysis is very insightful as it not only provides a perception of what kind of commercial products are considered as substitutes of milk by the consumers for their young children but also how it varies across rural–urban, tribal/non-tribal, and age groups of young children.

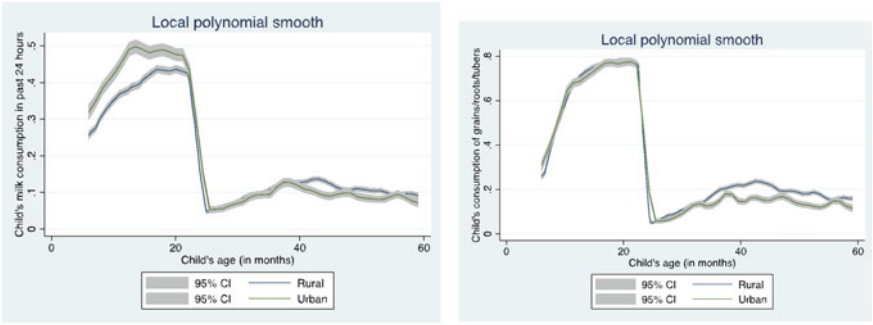
None of these studies pays attention to the fact that DHS surveys restrict the dietary questions to only the recent births in the last three years, and this primarily covers 6–23-month-olds. Headey and Palloni (2020) while taking cognisance of this consider the 24-h recall (on a child's dietary intake) as not a good representation of dietary patterns and instead focus on the mother's dietary habits. However, their analysis focuses mainly on vegetarianism and its association with stunting separately among 6–23-month-old children as well as among 24–59 months.

Agrawal et al. (2019) analyse the dietary pattern of children 6–23 months based on the same data and two results stand out: as a mother's education increases or economic status improves, the proportion of children with no milk consumption declines sharply.

4 Data and Description of Variables

The main database used in this study to analyse the pattern of milk given among very young children is the National Family Health Survey-4 (IIPS, 2017) with the survey conducted between January 2015 and December 2016 in two phases. The data on milk consumption is recorded in the survey as milk given in the last 24 h by the primary caregiver for the child and the frequency is recorded as 0, or 1, 2 going up to seven or more times. The survey design of NFHS is such that milk consumption frequency data are collected for the children born in the last 2 years, which would mean that they are recorded only for 0–23-month-old children. In Fig. 1a, the proportion of children that had milk at least once in the previous day cuts off at about 23 months, and similarly for the proportion of children reporting intake of staple food like grains, tubers, etc. at least once as shown in Fig. 1b.

Thus, the analysis of milk consumption patterns of children and their growth is restricted to 6–23-month-old children. We exclude 0–6-month-old children mainly because the WHO recommendation is for exclusive breastfeeding, and any other



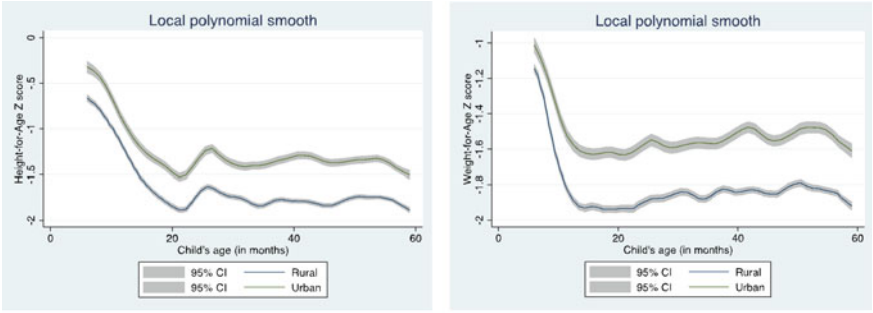
(a) Milk **(b) Grains/Roots/Tubers**

Fig. 1 Type of diet consumed in the past 24 h across age (in months): proportion of children. *Source* Author's own calculation based on NFHS data

food given is simply a violation of the norm, and analysis of such a feature is beyond the scope of this study.

As mentioned earlier, a child's nutritional status is assessed by Height for Age and Weight for Age and measured as Z-scores. Figure 2a shows that height faltering is rather severe in rural than in urban areas with the HAZ scores starting at almost similar values at about 6 months but declining more rapidly and settling down to a lower value around the age of 24 months. Comparing HAZ (Fig. 2a) with WAZ (Fig. 2b), we observe that faltering is more severe for height than on weight. Then there is a persistent rural–urban gap in the 6–23-month age group, which motivates us to focus on heights than on weight. Further, a large part of the existing literature assesses linear growth with milk intake.

In Table 1, summary statistics are presented for the covariates that are used in the econometric models for analysing the variations in the milk intake pattern (binary response of Yes/No and the frequency) and the association between milk intake



(a) HAZ **(b) WAZ**

Fig. 2 Z-scores for height-for-age and weight-for-age across age (in months): rural–urban comparison. *Source* Author's own calculation based on NFHS data

pattern and HAZ after controlling for other covariates. Alongside milk a total of 21 food items that the child could be given in the previous 24 h and reported as binary responses whether given or not. An important variable linked to nutritional intake is breastfeeding which is reported as a binary variable, whether *currently* breastfed or not and is not a 24-h recall like other food items.

The average HAZ score is below zero for both rural and urban 6–23-month-old children in India in 2015–16 indicating that many children in rural areas are far below the normal range of values while the standard deviation is nearly the same for both regions. About 68% (55%) of children in rural (urban) areas have not consumed milk in the past 24 h and among those who have reported consumption, the modal value is two times in a day. The rural–urban gap in the proportion of children is lesser for frequencies *once* and *thrice* compared to other frequencies of milk consumed. The categories for other food items mentioned in Table 1 based on Agrawal et al. (2019) show that rural rates are lower than urban, but the gap is largest for any other solid/semi-solid or liquid food and the least for grains/roots/tubers. This rural–urban difference in lower rates of other diets appears 'compensated' by (currently) breastfeeding of 87% in rural and 79% in urban areas.

In rural areas, the number of female children is marginally lower than the male while the average age is similar at 14–15 months. Due to larger family size, more children in rural areas are with higher birth order than in urban areas, and a *qualitative* assessment of birth size is not very different between rural and urban areas. All these covariates of child characteristics are known to be associated with HAZ from earlier studies and will be used as control variables in the relevant econometric models discussed later.

The average age of a mother is about 26 years and secondary educated mothers have the largest share in both rural and urban areas, but more urban women are better educated than rural. The mother's height captures her long-term cumulative nutritional status since her birth. This would be influenced by both genetic and environmental factors including the socio-economic and health conditions in their early childhood. Mother's heights are categorized into 4 quartiles which show that a higher proportion of rural women are in lower quartiles with a reverse pattern for urban women.[3] This captures an effect of deprivation (than genetic) from having grown up in less privileged circumstances for rural women compared to urban women. The short-term nutritional status of mothers is based on BMI which also shows that more women in rural are underweight, while malnourishment among urban women is from being not only underweight but also overweight and obese. These characteristics of mothers are controlled in the HAZ regression model to account for intergenerational transmission of nutritional status. Mother's education is included in milk consumption and HAZ models to account for mother's awareness and empowerment which play a key role in the care and feeding practices of her children.

[3] Height quartiles are estimated for all women using sampling weights and then the distribution across the four quartiles is calculated in the respective sector of residence so that this will indicate rural–urban differences.

Table 1 Mean and standard deviation of variables for 6–23-month-old children: rural and urban areas (2015–16)

Variable	Rural		Urban		Description
	Mean	Standard deviation	Mean	Standard deviation	
Height for age (HAZ)	−1.38	1.66	−1.07	1.69	
Milk given—none	0.62	0.49	0.55	0.50	Milk given in the last 24 h: yes/no
Once	0.06	0.24	0.07	0.25	
Twice	0.15	0.35	0.17	0.38	
Thrice	0.10	0.30	0.11	0.31	
Four or more times	0.08	0.27	0.10	0.30	
Other solid/semi-solid food and baby food: yes	0.26	0.44	0.32	0.47	Given in the last 24 h: yes/no
Other liquids: yes	0.28	0.45	0.36	0.48	
Grains, roots, and tubers	0.65	0.48	0.67	0.47	
Pulses, etc.: yes	0.13	0.33	0.15	0.35	
Fruits and vegetables: yes	0.43	0.50	0.49	0.50	
Eggs: yes	0.13	0.34	0.18	0.39	
Fish: yes	0.04	0.20	0.06	0.24	
Chicken and meat: yes	0.07	0.26	0.10	0.30	
Currently breastfeeding: yes	0.87	0.34	0.79	0.41	Yes/no
Gender: female	0.48	0.50	0.49	0.50	Male/female
Child's age	14.35	5.18	14.64	5.22	Continuous/months
Age-squared	232.66	150.71	241.58	153.40	Continuous/ $(\text{months})^2$
6–11 months: yes	0.34	0.47	0.32	0.47	Yes/no
12–17 months: yes	0.33	0.47	0.32	0.47	
18–23 months: yes	0.33	0.47	0.35	0.48	
Birth order: first	0.37	0.48	0.43	0.49	
Second	0.32	0.47	0.35	0.48	
Third or more	0.31	0.46	0.22	0.41	
Birth size: very small	0.03	0.17	0.02	0.15	
Small	0.67	0.47	0.68	0.47	
Average	0.11	0.31	0.09	0.28	
Large	0.13	0.34	0.14	0.35	
Very large	0.06	0.23	0.07	0.26	
Mother's age	25.42	4.71	25.99	4.43	Years
Mother's schooling: none	0.32	0.46	0.15	0.36	No schooling

(continued)

Table 1 (continued)

Variable	Rural		Urban		Description
	Mean	Standard deviation	Mean	Standard deviation	
Up to primary	0.15	0.35	0.11	0.32	Grades 1–4
Up to secondary	0.46	0.50	0.52	0.50	Grades 5–10
Beyond secondary	0.08	0.27	0.22	0.41	Grades 12 and above
Mother's height: first	0.27	0.45	0.22	0.42	Quartile 1
Second	0.26	0.44	0.25	0.44	Quartile 2
Third	0.24	0.43	0.25	0.43	Quartile 3
Fourth	0.23	0.42	0.28	0.45	Quartile 4
Mother: underweight	0.32	0.47	0.20	0.40	BMI < 18.5
Normal weight	0.59	0.49	0.58	0.49	18.5 > = BMI < = 24.9
Overweight	0.07	0.26	0.16	0.37	25.0 > = BMI < = 29.9
Obese	0.02	0.12	0.05	0.22	BMI > = 30.0
Household head: female	0.13	0.33	0.11	0.32	Male/female
Household head: age	45.04	15.51	44.88	14.87	Years
Household size < 5	0.23	0.42	0.29	0.45	Yes/no
Cooking fuel: clean	0.17	0.38	0.69	0.46	
Water within the premises: yes	0.56	0.50	0.74	0.44	
Type of toilet facility: flush	0.30	0.46	0.75	0.43	
Unsafe disposal of youngest child's stools	0.54	0.50	0.27	0.44	
Owns bovine: yes	0.51	0.50	0.08	0.28	
Religion—hindu: yes	0.82	0.39	0.72	0.45	
Muslim: yes	0.14	0.34	0.23	0.42	
Others: yes	0.05	0.21	0.05	0.22	
Caste—others: yes	0.20	0.40	0.33	0.47	
Scheduled tribe: yes	0.12	0.33	0.05	0.21	
Scheduled caste: yes	0.23	0.42	0.18	0.38	
Other backward caste: yes	0.44	0.50	0.45	0.50	
Wealth quintile—poorest: yes	0.23	0.42	0.26	0.44	

(continued)

Table 1 (continued)

Variable	Rural		Urban		Description
	Mean	Standard deviation	Mean	Standard deviation	
Poor: yes	0.21	0.41	0.23	0.42	
Middle: yes	0.20	0.40	0.20	0.40	
Rich: yes	0.19	0.39	0.17	0.38	
Richest: yes	0.17	0.38	0.14	0.35	
District average of per consumer unit protein intake from liquid milk in 2011–12 (gm)	7.72	6.36	9.03	6.02	Only for households with at least one child in 0–2 years from the NSSO on household level data on milk consumption

Note Sample size for rural children is 49538 and for urban children is 14662
Source Author's estimations

About 13% (11%) of household heads are women, with an average age of household heads as 45, and 23% (29%) are from households with a size of less than 5 in rural (urban) areas. The access to basic amenities for a healthy and hygienic living environment is far poor in rural than in urban; whether it is clean cooking fuel that would reduce indoor air pollution or better-quality water or poor sanitation with high open defecation or non-disposal of child's stools properly. Cattle at home is a strong predictor of milk consumption among rural children and more so in the absence of milk markets (Hoddinott et al., 2015). In this database, the only information available is on household ownership of bovines, which is 51% (8%) in rural (urban) areas. This binary variable captures if bovine ownership makes a difference to a child's milk consumption after controlling for other factors including the economic status of the household. It is however important to acknowledge that bovine alone may not be the only animal source for the consumption of milk from self-production and that some bovines may not be providing any milk and may be used for other purposes.

Expectedly, Hindus are predominant but more so in rural than in urban followed by Muslims (lower share in rural and urban) and equal representation for other religions. The caste distribution is skewed towards the less privileged ones like the scheduled tribe (ST) and scheduled caste (SC) in the rural areas compared to the urban areas with a higher share of other castes while OBCs are equally represented. The economic status of the household is assessed based on the wealth index score (first principal component based on a multidimensional asset possession dichotomous variable) separately for rural and urban areas and used in this analysis as opposed to the commonwealth index based on all India scores. These scores are then classified into five quintiles each with 20% households in them, and the lowest (topmost) quintile is the relatively poorest (richest). For this sample of 6–23-month-old children, 23% (26%) were from the relatively poorest rural (urban) household and 19% (17%) from the topmost rural (urban) wealth quintile.

Lastly, we consider the district-level average per consumer unit protein from liquid milk intake by households having at least one child aged 0–2 years in the year 2011–12. This information is estimated from the NSSO consumption data after accounting for the age–sex composition of the household (NSSO, 2015). This consumption information thereby proxies for the district-level availability of liquid milk from the previous year. The NSSO data is a few years preceding the NFHS survey and thus avoids any potential endogeneity, and we do not expect any major changes in milk consumption across rural and urban districts of India within this small gap of four years.

5 Examining the Covariates Associated with Milk Consumption

5.1 Breastfeeding, Other Food Items, and Milk: Rural/Urban Comparison

5.1.1 Comparison Across Age Groups

The children, who were currently breastfeeding, were rather high for 6–23-month-olds but declined more slowly with age in rural when compared to urban (Fig. 3a, b). 6–11-month-old children had the largest rate while the decline in breastfeeding rate was modest in the 18–23-month group with about 78% of rural children and 68% of urban children. It is to be noted that compared to food items assessed by a 24-h reference period preceding the survey, the breastfeeding question was on whether the child is currently breastfeeding or not and hence is of different time duration. It is unclear whether breast milk is a substitute or a complement as the frequency was not reported. As a result, it would be difficult to conclude whether it was beneficial to the child or not. However, we could examine this empirically that if its coefficient was either statistically insignificant or significant with a negative value in the model for milk consumption or in the HAZ model, then it could be inferred that breastfeeding was on average a complementary feeding. We now turn to other food items.

The highest share of reported food items in the last 24 h was grains, roots, tubers, etc. followed by liquid milk alone or for all dairy products for the 6–11-month group while the next highest share was for vegetables and fruits in the 11–23 age group; all of these items show an increase in reported rates with an increase in age. So clearly, age plays an important role in the reporting of 24-h recall of milk consumption, yet the percentage of children doing so in rural and urban areas is rather low compared to the consumption of grains, etc. Ease in feeding breast milk as long as mothers are lactating could play an important role in the decision (on average) not to give dairy milk. Thus, the zero milk consumption reported by many children in the last 24 h would be a random event of missing out on a given day only for some children while

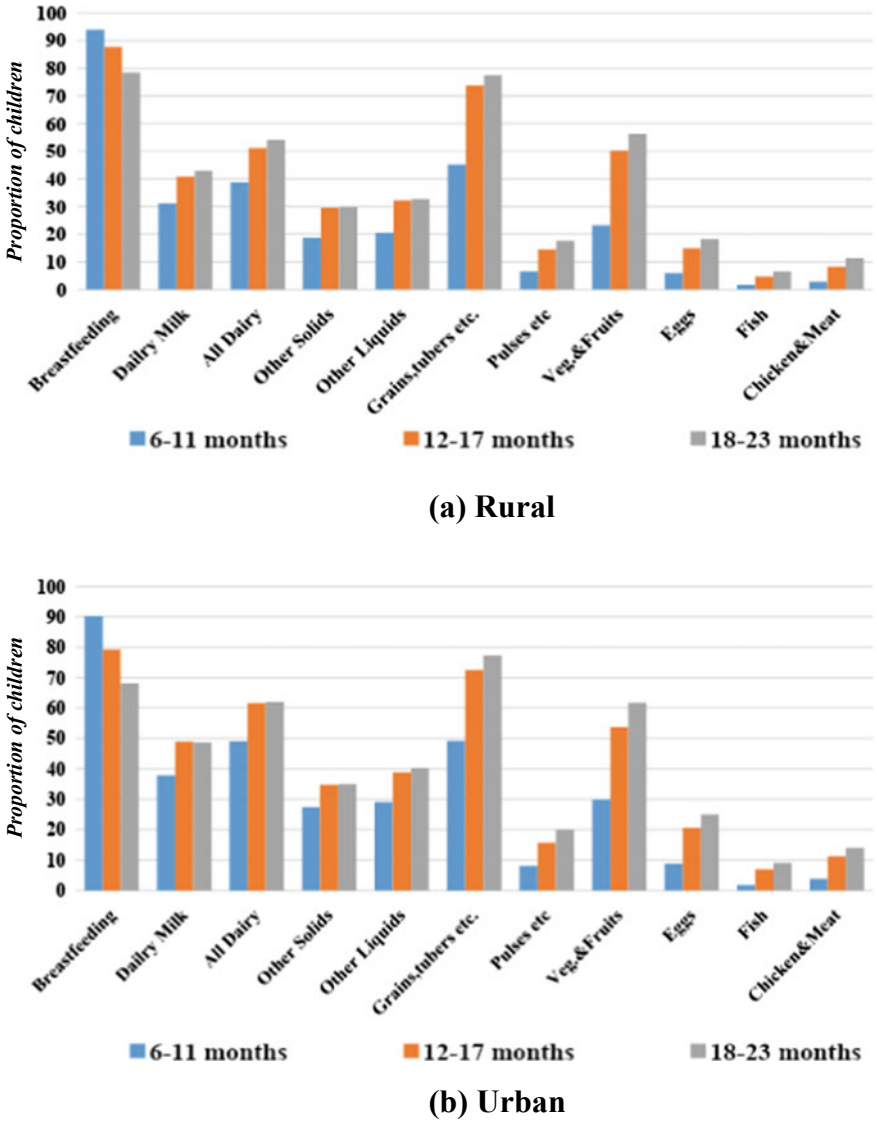


Fig. 3 Rural/urban comparison of breastfeeding, other food items, and milk consumption in 2015–16 across 6-month age groups. *Source* Author's own calculation based on NFHS data

for many it could be a systematic feature either due to lack of availability, or limited affordability or awareness.

5.1.2 Comparison Across Mother's Education

When the proportion of children reporting milk consumption in the last 24 h is classified across the mother's education level, then a higher consumption rate was reported for better-educated mothers (Fig. 4a, b). There is a significant jump in the proportion of children reporting milk (and dairy products) consumption among mothers who have higher secondary and above education. The rate of milk consumption increases from 33% (for no education) to 52% in rural areas while for the urban areas it increases from 38 to 55% increases. Further, compared to rural children, a higher proportion of urban children irrespective of their mother's education level consume milk or dairy products at least once during the reference period but more importantly, the rural–urban gap closes in for the highest education level.

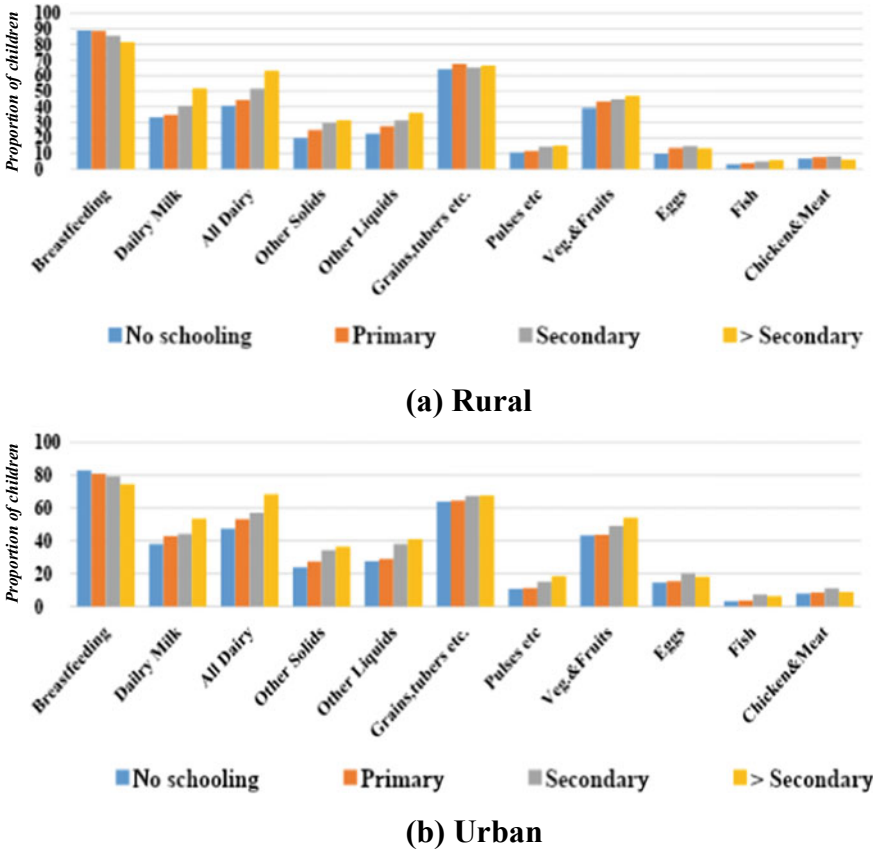


Fig. 4 Rural/urban comparison of breastfeeding, other food items, and milk consumption in 2015–16 across mother's education level. *Source* Author's own calculation based on NFHS data

5.1.3 Comparison Across Household's Economic Status

NFHS combines the possession of several household consumer durables into a wealth index score based on the first principal component. This score is then categorized into five groups with 20% of the households in each 'wealth' category by ranking the scores in the increasing order. The bottom 20% scores are relatively the poorest households in terms of these household assets, followed by poor, middle, rich, and richest (top 20%). These relative rankings of the economic status of the households are available separately for rural and urban areas as well as for all of India. Since we observe that the pattern of milk consumption varies significantly between rural and urban areas, we consider the relative economic status separately for rural and urban areas. Figure 5a, b shows that breastfeeding declines as the wealth index score increases and compared to any other food item, milk and dairy products show a significant positive gradient with economic status.

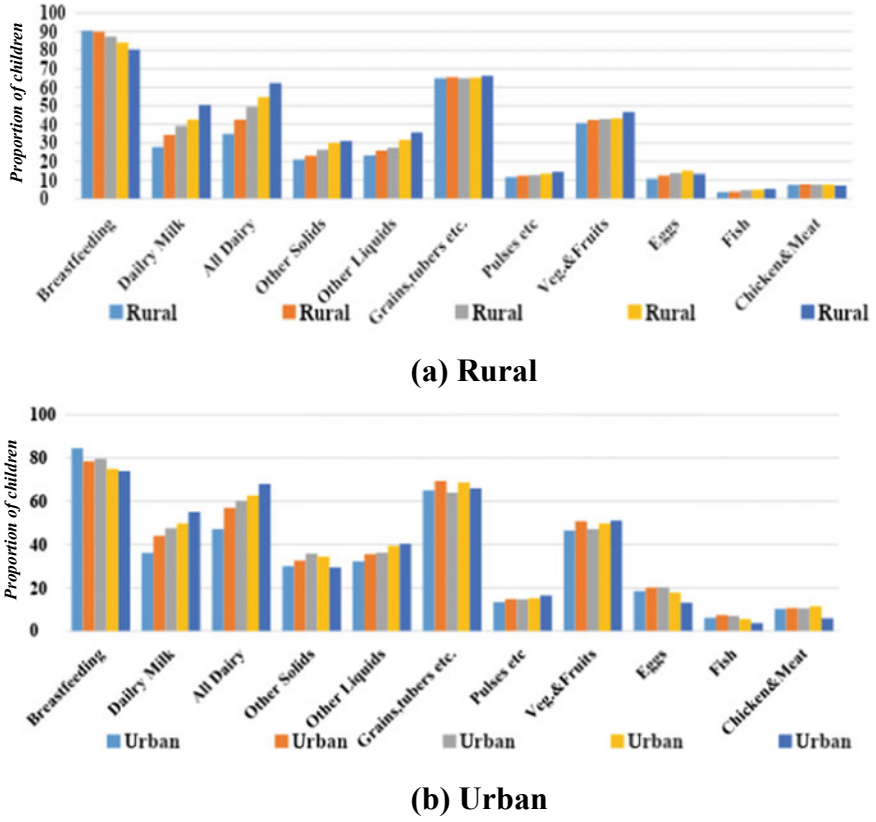


Fig. 5 Rural/urban comparison of breastfeeding, other food items, and milk consumption in 2015–16 across wealth quintiles. *Source* Author's own calculation based on NFHS data

The proportion of children reporting consumption of grains etc. does not vary across the sub-categories of either mother's education or household economic status. Vegetables and fruits increases across all levels of education while this increase is observed only for the topmost wealth quintile among the wealth status categories. Though the patterns of consumption within the sub-categories of either mother's education or household's economic status remain the same, the proportion of children reporting a diverse consumption of food items is higher in urban than in rural areas. This could be attributed to either higher availability or affordability or both. More importantly, irrespective of whether the household is in rural or urban areas mother's education level of higher secondary and above is associated with age-appropriate diets even in a 24-h recall period. For instance, diets like dairy (inclusive of liquid milk), other solid and liquid food, pulses, etc. and vegetables and fruits alongside calorie-rich food like grains and tubers are observed for a higher proportion of children with better-educated mothers. Nutrition awareness as assessed by the mother's education status is highly likely to influence the dietary diversity of young children.

5.2 How Big is the Rich–Poor Gap and How Does One Bridge This Gap?

In this section, we estimate a logit regression model for the binary variable of milk consumed or not. The intention is to understand the role of other covariates in reducing the rich–poor gap in milk consumption and hence provide insights on pathways for policy intervention including behavioural change. The results from the logit model are easy to interpret as odds ratios, which is the ratio of the probability of milk consumption to the probability of no milk consumption.[4] If the estimated odd ratio is more (less) than one for a particular covariate, then it means that the covariate is favourable (unfavourable) to the probability of milk consumption as opposed to the probability of no milk consumption. Table 2 reports the estimates of the odds ratio in a logit model for milk consumption, for three models with different covariates for rural and urban areas.

As shown in Table 2, the estimates of Model-1 for Rural Sector indicate that the odds of the richer children reporting milk consumption in the last 24 h is 2–3 times more than a child from the poorest households. The odds of milk consumption change marginally when other diets and age is controlled for. However when we include mother's education level and milk availability (captured either by bovine at home or the district level average per consumer unit protein from liquid milk), the rich-poor gap in milk consumption declines; thereby highlighting the relevance of mother's awareness and improved access to milk.

[4] Let $Y_i = 1$ if the child consumed milk and 0 otherwise and p_i = Probability $(Y_i = 1) = \Phi(\mathbf{X_i\beta})$ where Φ is the cdf of logistic distribution and X are the covariates in the model. In this case, it is called odds ratio.

Table 2 Estimates of odds ratio (logit regression model) for probability of milk consumption: rural/urban children (6–23 months)

Child's milk consumption	Model 1-rural		Model 1-urban		Model 2-rural		Model 2-urban		Model 3-rural		Model 3-urban	
	Odds ratio	Z-stats	Odds ratio	Z-stats	Odds ratio	Z-stats	Odds ratio	Z-stats	Odds ratio	Z-stats	Odds ratio	Z-stats
Intercept	0.38***	−36.74	0.56***	−10.87	0.47***	−14.93	0.78**	−2.32	0.28***	−22.78	0.52***	−4.9
Wealth index												
Poorer	1.36***	8.37	1.39***	4.07	1.37***	8.24	1.30***	3.22	1.3***	6.82	1.26***	2.66
Middle	1.68***	13.65	1.6***	5.92	1.67***	13.13	1.58***	5.48	1.5***	9.75	1.5***	4.56
Richer	1.93***	17.08	1.74***	6.59	1.88***	15.94	1.61***	5.4	1.59***	10.61	1.46***	3.89
Richest	2.65***	25.17	2.17***	8.61	2.52***	23.17	2.06***	7.76	1.81***	12.38	1.67***	4.68
Currently breastfeeding					0.43***	−23.26	0.37***	−13.17	0.44***	−22.23	0.38***	−12.78
Child consumed grains/roots/tuber					1.81***	20.89			1.88***	21.61	1.8***	9.05
Child's age group (reference: 6–11 months)												
12–17 months					1.25***	6.93	1.27***	3.31	1.26***	7.1	1.28***	3.34
18–23 months					1.23***	6.43	1.08	1.03	1.25***	6.81	1.1	1.29
Owns bovine									1.32***	10.66	1.23**	2.48
Mother's education (reference: no schooling)												
Primary									0.98	−0.46	1.16**	1.28
Secondary									1.12***	3.6	1.09	1.00
Higher									1.48***	6.99	1.34***	2.63
District average of per consumer unit protein intake from liquid milk in 2011–12 (gm)									1.05***	22.96	1.03***	6.99

Source Author's own calculation based on NFHS data

5.3 Frequency of Milk Consumption

5.3.1 Broad Patterns

For milk consumption, the data is also available for the number of times milk is given in the last 24 h with the response recorded as 0, 1, 2, 3, 4, 5, 6, and 7 plus. If we exclude zero milk consumption, then the largest rate is for 'Twice' and is the median value (Table 3). The next largest rate is three times followed by once, and then the frequency of four times and above can be combined for the sake of counting all such children.

Regrouping this milk frequency to 0, 1, 2, 3, and 4 plus, it is observed that the zero milk given declines substantially among those with bovine, and the shift seems to be happening more towards three times and to a lesser extent to twice while in urban areas the change is similar but is very minimal (Table 4). Owning and managing dairy animals and livestock is largely a rural activity, so the change in zero times milk given in urban areas will not be affected if the data on milk consumed is tabulated across ownership of cattle. In the absence of markets and limited affordability, ownership of bovines (as in the NFHS questionnaire) is an important determinant of the frequency of milk given to the child.

The largest change from zero to a higher frequency of milk consumption is when the child is currently not breastfeeding (Table 4). From about 60–65% of children reported as not given milk in the last 24 h, it declines to about 35–41% between 'yes' and 'no' of currently breastfeeding. However, the number of children reporting not breastfeeding currently is a very small percentage, but this once again gives a sense

Table 3 Frequency of milk given in the last 24 h: distribution of children (%)

	None	One	Two	Three	Four	Five	Six	Seven or more	Total
Rural	61.9	6.2	14.5	9.9	4.3	1.8	0.9	0.6	100
Urban	54.7	7.0	17.3	11.1	5.0	2.3	1.4	1.2	100

Source Author's own calculation based on NFHS data

Table 4 Frequency of milk consumed and (a) ownership of bovine or (b) currently breastfeeding

Frequency of milk consumed	(a) Owns Bovine				(b) Currently breastfeeding			
	No		Yes		No		Yes	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Zero	65.4	54.9	58.5	52.6	40.7	34.4	65.1	60.1
Once	6.1	7.0	6.2	7.0	7.6	6.7	5.9	7.0
Twice	13.3	17.2	15.7	18.6	17.7	20.4	14.0	16.5
Thrice	8.5	11.1	11.2	11.8	15.9	16.5	9.0	9.7
Four or more times	6.7	9.9	8.5	10.0	18.1	22.0	6.0	6.7

Source Author's own calculation based on NFHS data

of both availability of other sources of milk and its affordability. This is compounded by limited awareness, and it could be an intensive task to manage the child's daily dietary requirement for many mothers given their daily chores including caregiving for other members of the household.

5.3.2 Zero-Inflated Poisson Model: Frequency of Milk Consumption Among Rural Children

As rural areas show large stunting rates and lower milk consumption, this section analysis the covariates associated with variations in the frequency of milk consumed after accounting for a large number of zero values in the last 24-h reference period. As we observed, in the context of zero versus more than zero frequency of milk consumption in Sect. 5.1.3 that apart from economic status, other aspects play an important role in improving milk given (and hence intake) by these very young children. Most studies in the Indian context have not used this information on milk given in the last 24 h partly because it is not very reliable (Headey & Palloni, 2020), and there are few instances of positive values. However, we do find that this need not be the case and explore further to analyse the data.

We explain the variation in milk pattern using the covariates to first estimate the part with excessive zeros and then a count of events for the frequency of milk consumption using the Zero-Inflated Poisson (ZIP) model. This model on the one hand allows some values to be zero as a natural possibility of Poisson random variable along with the number of times the non-zero event happens while an unusually high number of zero values are also analysed within the same framework but considering that as a part of a different data generating process.

The estimated model has two components: The first part analyses the covariates associated with the 'inflated zeros' or the logit model with the probability that milk consumed (Y) is zero as opposed to the probability that Y has a positive value but the positive values are all assigned one.[5] Unlike a selection model, the logit model

[5] Following Lambert and Cameron and Trivedi (2005), the initial part of the model is to estimate a logit model of the probability of zeros, that is, no milk consumption (note that now this is the complement of the logit model estimated before in Sect. 5.2) followed by a Poisson model for the count of milk frequency from 1 to 4 plus.

$$\mathrm{Y_j} = 0 \text{ with probability } \mathrm{F}_j.$$

$$\mathrm{Y_j} \sim \text{ Poisson}\left(\lambda_\mathrm{j}\right) \text{ with probability } 1 - \mathrm{F_j},$$

where F(.) is the inverse of the logit function. All cross-section entities are assumed to be independent with the j-th response of milk frequency being determined as

$$\Pr\left(\mathrm{Y_j} = \mathrm{n}|\mathrm{x_j},\ \mathrm{z_j}\right) = \mathrm{F_j}\left(1 - \mathrm{F_j}\right)\exp\left(-\lambda_\mathrm{j}\right).$$

$$\Pr\left(\mathrm{Y_j} = \mathrm{n}|\mathrm{x_j},\ \mathrm{z_j}\right) = \left(1 - \mathrm{F_j}\right)\exp\left(-\lambda_\mathrm{j}\right)\left(\lambda_\mathrm{j}^\mathrm{n}/\mathrm{n}!\right) \quad \text{for n} = 1, 2, \ldots$$

here predicts the probability of Y = 0 and not Y = 1. The second part of the model analyses the covariates associated with the frequency of milk consumed using a Poisson regression model. This ZIP model specification is more relevant here to distinguish between no milk consumed on a random day either due to illness, etc. from a systematic pattern of not giving milk as a dietary preference by the household or the primary caregiver. The results of the ZIP model are reported in Table 5 with logit estimates for no milk consumed in Panel (a) and Panel (b) of Table 5 with the Poisson estimates for frequency of milk consumed in the 24 h prior to the survey.

The aim here is to understand given the past literature (and scientific understanding) which of the covariates are relevant for the logit model of zero probability of milk consumption and the ones relevant for the Poisson model for frequency of milk consumption. AIC/BIC are used to compare the model fit across these two specifications, and the one with the least AIC/BIC values was chosen. The main finding is that the model with the larger set of variables in the zero-inflated part of the logit model reduces the AIC/BIC more than the one with fewer variables. Correspondingly, we observe that a few variables that were insignificant in the Poisson model are highly significant in the zero-inflated part.

The interpretation of the coefficients in terms of their exact magnitudes is avoided as causal inference is difficult to establish with such data. Instead, the statistical significance, sign and relative magnitudes of the estimated coefficients are used for the interpretation of the results. In the last 24 h, the probability of no milk given was higher among female children than for male children and a 6–11-month-old (reference group) child was more likely to not consume dairy milk compared to the children in the next two age groups. The gendered aspect of milk consumption could go either way in terms of benefitting or not benefitting a male child compared to a female child. If for an older male child mother's milk was weaned away at an appropriate age and substituted by dairy milk, then it would be nutritionally beneficial while the reverse would be true for a child in the 6–11 month age group.

Currently being breastfed was positively associated with the likelihood of no milk given while food supplements that were given in the past day like grains and tubers, other solid food, and chicken and meat in the last 24 h were all negatively associated with it with the relative magnitudes of the coefficients declining in that order. Controlling for other food items, when egg was given, it was associated with the zero likelihood of milk given, and was perhaps considered as nutritionally equivalent to milk; egg, like milk, can be easily fed to children in that age group. Similarly, other liquid food including dairy products (primarily yogurt) has a statistically significant and positive sign, implying that this is also a substitute for milk.

The zip command in STATA 15.0 maximizes the log-likelihood lnL, defined by

$$\ln L = \Sigma_{j\in S}\left[w_j \ln\{F_j + (1 - F_j)\exp(-\lambda_j)\}\right] + \Sigma_{j\notin S}\left[w_j\{\ln(1 - F_j) - \lambda_j + \xi_j y_j - \ln(y_j!)\}\right]$$

where wj are the weights; S is the set of observations for which the observed outcome $y_j = 0$; and $\lfloor_j = \mathbf{X_j}$® is the mean of the Poisson random variable with **X** as the set of covariates in the Poisson model while **Z** is the set of covariates for the Logit model.

Table 5 Coeffieicient estimates for Zero-Inflated Poisson (ZIP) model for frequency of milk consumption

	Coefficient	Z-statistics
(a) Logit Estimates for No Milk Consumed		
Female child (reference: male)	0.13***	4.48
Child's age group (ref. 6–11 months)		
12–17 months	−0.22***	−5.87
18–23 months	−0.24***	−6.35
Currently breastfeeding	0.87***	19.3
Child consumed grains/roots/tuber	−0.59***	−16.55
Child consumed solid/semi-solid food or baby food	−0.57***	−14.62
Child consumed other liquids	0.23***	6.68
Child consumed pulses	−0.09*	−1.85
Child consumed vegetables/fruits	−0.14***	−3.81
Child consumed eggs	0.15*	2.43
Child consumed fish	−0.01	−0.15
Child consumed chicken/meat	−0.17**	−2.32
Mother's education (ref. secondary or lesser)		
Above secondary	−0.31***	−5.28
Owns bovine	−0.30***	−10.13
Wealth index		
Poorer	−0.32***	−7.44
Middle	−0.51***	−11.15
Richer	−0.59***	−12.64
Richest	−0.76***	−14.82
District average of per consumer unit protein intake from liquid milk in 2011–12 (gm)	−0.05***	−18.89
Intercept	1.08***	16.32
(b) Poisson Estimates for Frequency of child's milk intake		
Female child (reference: male)	−0.01	−0.79
Child's age group (reference: 6–11 months)		
12–17 months	−0.02	−1.43
18–23 months	−0.07***	−5.6
Currently breastfeeding	−0.17***	−14.68
Mother's education (ref. no education)		
Primary	0.02	1.06
Secondary	0.05***	4.04

(continued)

Table 5 (continued)

	Coefficient	Z-statistics
Higher	0.08***	3.95
Religion (ref. hindu)		
Muslim	−0.06***	−3.38
Others	−0.01	−0.19
Caste (ref. general)		
ST	−0.09***	−3.14
SC	−0.06***	−3.28
OBC	−0.02	−1.54
Wealth index	0.01	0.59
Poorer		
Middle	0.02	0.93
Richer	0.04**	2.32
Richest	0.04*	1.87
Intercept	0.99***	12.07

Note (1) The coefficients are estimates from the logit model for Pr(Y = 0), where Y is the binary variable assigned zero or one respectively for no milk consumed in the past 24 h or if consumed at least once

(2) ***, **, and * represent that the estimated coefficients are statistically significant respectively at 1%, 5%, and 10% levels of significance

Source Author's own calculation based on NFHS data

Mothers with above (below) secondary level schooling were more (less) likely to (not) give milk and so were those who owned a bovine at home. This result for bovine ownership is interesting even though it is not known if it was providing milk or not and if so, how much milk was being used for self-consumption. The (less) economically well-off were more likely to give (no) milk and so were those children who were residing in the rural area of a district which had higher per consumer unit protein intake from milk consumption in 2011–12 based on NSSO data. This district average is based on only those households which had at least one child in the 0–2-year age group and, as mentioned earlier, is used as a proxy for the availability of milk at a geographically aggregated district level.

Once the probability of zero milk consumption is accounted for, the Poisson regression estimates in Table 5b show that the frequency of milk consumption is not different for girls and boys. The frequency of milk intake increases more in the older age group of 17–23 months. It must however be mentioned that the Poisson regression model could result in a monotonic association between the number of times milk was consumed, and its covariates while it may not be able to capture the non-linearity. For instance, two- or three-times milk given and supplemented with other diets would be more beneficial. So, the choice of the model could impose an a priori structure that may not be distinguished from the observed behaviour of whether factors associated with milk given twice or thrice were different from when

milk was given once or more than thrice. For instance, a multinomial logit model with selection may be better if the different milk frequency was considered as a separate nominal category rather than ordinal ones after allowing for the selection of zero/non-zero milk given. Though this would allow the observed outcome to be appropriately modelled, this would mean that for the selection model all zeros are treated similarly while the reality would be that some zeros are expected while many could be inflated. Further, in this context, a higher frequency of milk could also be beneficial from a nutritional perspective given the young age of the child who cannot consume much in one feeding time. So small quantities of milk interspersed between other food items to feed periodically in the last 24 h could be the preferred option provided time is available for the mother or other caregivers in the family. On both these accounts, the choice of the Poisson regression model seems appropriate.

Currently, breastfeeding reduces the frequency of milk given even after playing a significant role in being associated with the likelihood of no milk given. In contrast to this, dummy variables for consumption of different food items were all statistically insignificant and hence excluded from this model. The frequency of milk consumption increases with a mother's secondary and post-secondary education compared to below secondary education. Children in Muslim, scheduled tribe, or scheduled caste households in rural areas were given milk less frequently. After accounting for the observed zero-inflated data on milk consumption in the past 24 h, higher milk frequency is positive and statistically significant at 5% (10%) only for the relatively richer (richest) compared to the children in all other rural households. This is different from the zero-inflated part of the results where the higher economic status had a very clear secular decline in the relative magnitudes with the probability of no milk given.

Thus, the above empirical strategy of the Zero-Inflated Poisson regression model has enabled us to make use of the frequency of milk given to 6–23 months old based on a 24-h recall prior to the survey date. It has also enabled us to control for other demographic characteristics and dietary intake behaviour of such children while also understanding the role of accessibility to milk through either markets or home production. This analysis fills the gap in the absence of a quantitative assessment based on a nationwide representative survey for India while such studies exist for neighbouring Bangladesh and some of the African nations. Our findings corroborate that the presence of bovine at home and currently breastfeeding as important factors for milk consumed by very young children. Economic status and mother's education are other factors for improving the number of times milk is given while the results for a girl child can at best be interpreted ambiguously. The following section further analyses such ambiguities as well as to understand the relevance of milk intake on linear growth.

5.4 Milk Consumption and HAZ for Rural Children

In most recent studies that analysed the role of milk consumption in a child's HAZ (or linear growth), the milk consumption variable was considered as an exogenous

variable. Given the findings in the previous section, we consider the five categories (frequencies) of milk consumption as endogenous variables. The endogeneity arises from the fact that a very large number of households surveyed over two years could not be reporting zero milk consumption for the 6–23-month-old children in the past 24 h unless there is a decision involved in doing so. Herber et al. (2020) find a huge variation in their sample of 73 countries covering two decades that the proportion of children who consumed milk in the last 24 h ranges from 20 to 95% across different countries. Thus, economic, social, and cultural factors which influence food habits, seem to determine the decision to give milk regularly to children in this age group and this gets reflected even when milk consumption was recorded with a short recall period of 24 hours.

We estimate a linear regression model for HAZ (the dependent variable) of 6–23-month-olds with the frequency of milk consumed in the previous day as an endogenous variable and the results reported in Table 6.[6] We estimate the model with a slightly different specification where endogenous milk consumption is specified as an ordered probit model with no milk given as the reference category, and once, twice, thrice, and more than thrice are the four other categories.

Table 6 reports only a part of the results of the regression model mainly to focus on the difference in the result when the frequency of milk consumption is exogenous vis a vis when it is endogenous. When the frequency of milk consumed is exogenous, then it is statistically significant and has a positive association only when it was consumed once and all other higher frequencies are no different from no milk consumed and hence have no association with HAZ. When the frequency of milk consumed is endogenous, not only are each of the milk frequency variables statistically significant but the higher the frequency (compared to the reference category of no milk consumption), the larger is its coefficient magnitude after controlling for the usual covariates based on child, mother, household, and regional characteristics.

The results of other variables that impinge upon the child's milk consumption (estimates in columns 4 and 5) are similar to the ZIP model in the statistical significance and sign for the endogenous model. The estimates for the other variables in this table are not directly comparable since in the exogenous model these variables are associated with HAZ while in the endogenous model these variables are associated with the frequency of milk consumption and are also based on the ordered probit model. Equally important to note is that the household's ownership of bovine and the district average of protein intake of milk as a proxy for district-level variations in milk availability are both insignificant in the exogenous model indicating that they are not directly associated with child HAZ. This also justifies the use of these two variables as instruments in the zero-inflated specification of the ZIP model.

Grains and tubers, and other solid/semi-solid food are the two consumption variables significant and positively associated with the HAZ model (Table 6). However, in the milk consumption equation of the endogenous model, several complementary

[6] HAZ is regressed as a linear function of the set of covariates including milk frequency which is endogenous. The endogenous milk frequency is estimated as an ordered probit model with the relevant covariates. These estimations are carried out using the *eregress* command of STATA 15.

Table 6 Coefficient estimates for HAZ with frequency of milk consumption as exogenous and endogenous

HAZ: dependent variable	Exogenous milk variable		Endogenous milk variable	
	Coefficient	Z-statistic	Coefficient	Z-statistic
Frequency of milk intake in past 24 h (ref: not even once)				
Once	0.09**	2.24	0.32***	4.89
Twice	0.01	0.21	0.31***	3.98
Thrice	−0.02	−0.84	0.39***	3.7
Four or more times	−0.004	−0.12	0.57***	3.97
Currently breastfeeding (ref. no)	−0.1***	−3.37	−0.55***	−27.51
Gender (ref: male)			−0.07***	−5.15
Child's age group (ref. 6–11 months)				
12–17 months			0.07***	3.75
18–23 months			0.04**	2.2
Child consumed the following food item in past 24 h (reference: no)				
Grains/roots/tuber: yes	0.05**	2.22	0.26***	14.2
Solid/semi-solid food, etc.: yes	0.04*	1.79	0.19***	10.98
Other liquids: yes	0.01	0.35	0.17***	10.07
Pulses and legumes, etc.: yes	0.01	0.3	0.03	1.13
Vegetables/fruits: yes	0.004	0.17	0.04**	2.13
Eggs: yes	−0.002	−0.06	−0.11***	−3.76
Fish: yes	0.03	0.57	−0.03	−0.8
Chicken/meat: yes	0.07	1.61	−0.003	−0.11
Owns bovine: yes (reference: no)	0.02	1.24	0.16***	11.33
District average of per consumer unit protein intake from liquid milk in 2011–12 (gm)	0.002	0.9	0.03***	28.86

Note Coefficient estimates for other covariates are reported in Tables 7 and 8 of the Appendix
Source Author's own calculation based on NFHS data

foods are positively associated with higher milk frequency indicating that additional diets are given to some children along with milk, as may be appropriate for that child on a given day. The relative magnitudes of the different food coefficients decline in that order indicating the level effect that is as follows: the higher the share of children reporting a particular food item, the larger is its association with higher milk frequency. As in the ZIP model, if a higher proportion of mothers report that egg was given in the previous day, then it is associated with a lower frequency of milk given. This perhaps reiterates the vegetarian versus non-vegetarian preferences of households where both are animal-sourced food and may have a similar implication while both have the advantage of easy to feed these very young children. One additional advantage of milk is that it can be given in small quantities and multiple times in a given day. This is perhaps the reason that higher milk frequency is associated with

higher HAZ. However, there are two cautions here. Estimation of milk frequency as an ordinal variable imposes the structure through the ordered probit model that a higher frequency of consumption is associated with higher HAZ. A multinomial probit model could consider the different milk frequency as a nominal variable so that there are separate estimates for each frequency of milk intake. This would enable us to understand if a higher frequency is a reflection of less spaced out feedings for children of this age group and perhaps more appropriate for them. On the other hand, if higher milk frequency is a reflection of more (and perhaps diluted) milk being used as a substitute for other food items, then it will be a nutritionally inadequate diet and hence have no impact or even worse impact on a child's growth.

Thus, even though we are not interpreting the magnitudes of the milk frequency variable as a causal effect on HAZ, and accounting for it by not using an appropriate empirical framework has a completely different implication.

6 Conclusion

There are several studies in recent years that have shown the importance of crop diversity on the nutritional intake of farmers in several countries including India (Ruel Marie et al., 2018; Viswanathan & David, 2021 and Nithya et al., 2021). However, extending this to the allied sectors of agriculture in particular livestock, poultry, fishing, etc. is very limited. 98% of the livestock is in rural areas as per the latest livestock census of India. Here lies the opportunity in harnessing the potential by providing better resources and care to manage it and for improving the availability and accessibility of milk to rural children. Chaturvedi (2022) in a newspaper article mentions that managing livestock through better technology will not only improve income but also employment while this article misses out on an important aspect of the consumption of milk from self-production. This could address the needs of some groups of people who have land and also own some livestock but for rural labour either in agriculture or non-agriculture, subsidies could be provided to both the consumer and producer so that demand and supply are ensured in the local economy given that milk is also a highly perishable food item. Alongside this, milk cooperatives and agri-food businesses producing milk powder could also be considered. As was observed in the study in Odisha, milk powder was readily available in remote and small villages of rural areas but had varied uses rather than providing the same for young children (Parasar et al., 2021). Awareness programmes to give dairy milk to children from the 6th month onwards could play a significant role. The manual on infant and young child feeding practices by the National Health Mission hardly emphasizes the role of dairy milk and focuses more on other complementary foods and their feeding practices.

India has a significant vegetarian population but even the diverse culture encourages the consumption of ASFs, especially dairy products. Milk is a major source of dietary energy, protein, fats, lactose, and a variety of vitamins and minerals. In

comparison with many Plant-Based Foods (PBF), milk has less anti-nutrient composition and is easily digestible by people of various ages. Different types of dairy products with different nutritive values can be prepared from milk to increase the variety and avoid boredom in feeding the children.

In India, production and transportation are also not major hurdles to the availability or accessibility of milk especially because of its local availability. Over the years from 1993–94 to 2011–12, the NSSO data shows that there has been a consistent increase in milk's share in calorie and protein consumption in both rural and urban India (Purohit, 2020). However, there has not been a systematic spatial or temporal analysis of milk consumption among very young children based on several earlier surveys of the same database. More recent data for NFHS-5 covering the years 2019–20 is now available and can be used in future studies to enrich the analysis. More importantly, Purohit (2020) finds that states that have higher child undernourishment rates are also the states that do not report the district-level milk supply data thereby indicating the poor capacity of such institutions in enabling better and higher quality supply of milk within smaller administrative divisions.

Availability of the right kind of information on milk supply and consumption is a challenge, yet India's well-equipped machinery to provide publicly available statistics has made it possible to analyse milk consumption patterns this far. Some researchers feel that the 24-h recall may not reflect the exact consumption pattern but a one-week recall in other countries by the DHS has shown that it is even worse. The statistical analysis from this study is worthwhile as it provides a sense of variation based on a single cross-section of children reporting milk consumption and its association with other covariates. Large sample surveys like NFHS are also very useful in carrying out a regional analysis, and combining two years of such data for 2015–16 and 2019–20 could give further scope to analyse the districts with high rates of child undernutrition. Understanding seasonal patterns of consumption is also very relevant in the context of young children as severe deprivations during the rainy season or harsh winters or hot summers can set in growth faltering that may be difficult to address at a later stage. The NFHS surveys are not evenly spread across the quarters like the NSSO surveys and are limited from that aspect.

This study used 2011–12 NSSO data on per-consumer unit proteins from milk intake for households with children in the 0–2-year age group as a proxy for the availability of milk at the district level. Some more analysis can be done from such consumption data, but it is rather dated now. It has been a decade of no survey on household consumption data by the NSSO which has created a huge void to further examine milk intake patterns among households with young children and understand the inequities that exist in the country on such aspects which in turn impinge on the health of children.

A hitherto less used econometric specification was considered in this study to analyse the factors associated with milk consumption and perhaps among the very few studies to analyse the frequency of milk consumed by very young children in India. Though there are methodological limitations in establishing a causal relationship between milk consumption and a child's growth using observational data,

nevertheless, the findings of this study show a strong positive association between milk consumption and a child's linear growth.

Table 7 Coefficient estimates for HAZ with frequency of milk consumption as exogenous and endogenous

HAZ: dependent variable	Exogenous milk variable		Endogenous milk variable	
	Coefficient	Z-statistic	Coefficient	Z-statistic
Intercept	−0.26	−1.28	−0.37*	−1.88
Child's age (in months)	−0.18***	−15.69	−0.18***	−15.85
Child's age—squared	0.003***	8.17	0.003***	8.34
Female child (ref: male)	0.16***	8.64	0.17***	9.17
Birth order (ref: 3rd or more)				
First child	0.15***	5.21	0.15***	5.14
Second child	0.04*	1.68	0.04*	1.69
Birth size (ref: average size)				
Very small	−0.34***	−6.53	−0.34***	−6.56
Small	−0.19***	−6.62	−0.19***	−6.57
Large	0.06**	2.2	0.06**	2.24
Very large	0.09**	1.99	0.09**	1.99
Immediate (within an hour)	0.01	0.77	0.02	0.85

Source Author's own calculation based on NFHS data

Table 8 Coefficient estimates for HAZ with frequency of milk consumption as exogenous and endogenous

HAZ: dependent variable	Exogenous milk variable		Endogenous milk variable	
	Coefficient	Z-statistic	Coefficient	Z-statistic
Open defecation	0.03	1.41	0.03	1.44
Mother's age (in years)	0.01***	4.02	0.01***	4.03
Mother's level of education (reference: none)				
Primary	0.1***	3.58	0.1***	3.56
Secondary	0.18***	7.47	0.18***	7.53
Higher	0.4***	9.46	0.4***	9.47
Mother's height (reference: second quartile)				
First quartile	−0.3***	−12.45	−0.3***	−12.43
Third quartile	0.19***	7.6	0.2***	7.62
Fourth quartile	0.42***	15.6	0.42***	15.6

(continued)

Table 8 (continued)

HAZ: dependent variable	Exogenous milk variable		Endogenous milk variable	
	Coefficient	Z-statistic	Coefficient	Z-statistic
Mother's BMI (reference: normal 18.5–24.9)				
Less than 18.5 (underweight)	−0.19***	−9.59	−0.19***	−9.57
25.0–29.9 (overweight)	0.08**	2.26	0.09**	2.28
More than 30.0 (obese)	0.25***	2.96	0.25***	2.95
Female household head	−0.01	−0.27	−0.01	−0.27
Age of household head	0.001	1.46	0.001	1.54
Household size: (reference: 5 or more members)				
Small (less than 5 members)	0.07**	2.52	0.07***	2.59
Wealth index				
Poorer	0.04	1.36	0.04	1.31
Middle	0.11***	3.67	0.11***	3.6
Richer	0.2***	5.68	0.19***	5.55
Richest	0.32***	6.99	0.31***	6.84
Religion (ref: hindu)				
Muslim	−0.13***	−4.39	−0.12***	−4.25
Others	−0.03	−0.49	−0.03	−0.47
Caste (ref: others)				
ST	−0.14***	−3.58	−0.13***	−3.43
SC	−0.15***	−4.89	−0.15***	−4.88
OBC	−0.09***	−3.18	−0.08***	−3.15
Type of cooking fuel (ref: dirty)				
Clean	0.08**	2.41	0.08**	2.46
Water is located within the premises/plot (ref: no, elsewhere)				
Yes	0.04**	2.08	0.04**	2.08
Flush toilet facility (ref: no)				
Yes	0.02	0.87	0.02	0.87

Source Author's own calculation based on NFHS data

Appendix

Tables 7 and 8 provide estimates for covariates in addition to those reported in Table 6.

References

Agrawal, S., Kim, R., Gausman, J., Sharma, S., Sankar, R., Joe, W., & Subramanian, S. V. (2019). Socio-economic patterning of food consumption and dietary diversity among Indian children: Evidence from NFHS-4. *European Journal of Clinical Nutrition, 73*(10), 1361–1372. https://doi.org/10.1038/s41430-019-0406-0.

Chaturvedi, A. (2022, January 31), *Just what the doctor ordered for the livestock farmer—The Hindu.* https://www.thehindu.com/opinion/op-ed/just-what-the-doctor-ordered-for-the-livestock-farmer/article38284016.ece.

Choudhury, S., & Headey, D. D. (2018). Household dairy production and child growth: Evidence from Bangladesh. *Economics and Human Biology, 30*, 150–161. https://doi.org/10.1016/j.ehb.2018.07.001.

de Beer, H. (2012). Dairy products and physical stature: A systematic review and meta-analysis of controlled trials. *Economics and Human Biology, 10*(3), 299–309. https://doi.org/10.1016/j.ehb.2011.08.003.

Dror, D. K., & Allen, L. H. (2011). The importance of milk and other animal source foods for children in low-income countries. *Food and Nutrition Bulletin, 32*(3), 227–243. https://doi.org/10.1177/156482651103200307.

Headey, D., Hirvonen, K., & Hoddinott, J. (2018). Animal sourced foods and child stunting. *American Journal of Agricultural Economics, 100*(5), 1302–1319. https://doi.org/10.1093/ajae/aay053.

Headey, D., & Palloni, G. (2020). Stunting and wasting among Indian preschoolers have moderate but significant associations with the vegetarian status of their mothers. *The Journal of Nutrition, 150*(6), 1579–1589. https://doi.org/10.1093/jn/nxaa042.

Herber, C., Bogler, L., & Subramanian, S. V., et al. (2020). *Association between milk consumption and child growth for children aged 6–59 months. Scientific Report, 10*, 6730. https://doi.org/10.1038/s41598-020-63647-8.

Hoddinott, J., Headey, D., & Dereje, M. (2015). Cows, missing milk markets, and nutrition in rural Ethiopia. *The Journal of Development Studies, 51*(8), 958–975. https://doi.org/10.1080/00220388.2015.1018903.

International Institute for Population Sciences (IIPS) and ICF. (2017). *National Family Health Survey (NFHS-4), 2015–16: India.* IIPS. Retrieved June 10, 2021, from https://dhsprogram.com.

International Institute for Population Sciences (IIPS) and ICF. (2021). *National Family Health Survey (NFHS-5), 2019–20.* IIPS. https://dhsprogram.com.

Michaelsen, K. F., Hoppe, C., Roos, N., Kaestel, P., Stougaard, M., Lauritzen, L., Mølgaard, C., Girma, T., & Friis, H. (2009). Choice of foods and ingredients for moderately malnourished children 6 months to 5 years of age. *Food and Nutrition Bulletin, 30*(3_suppl3), S343–S404. https://doi.org/10.1177/15648265090303S303.

National Sample Survey Office. (2015). *Nutritional Intake in India, 2011–12.* NSSO Report No. 560. Retrieved June 10, 2021, from https://www.mospi.gov.in/reports-publications.

Nithya, D., Raju, S., Bhavani, R., Panda, A., Wagh, R., & Viswanathan, B. (2021). Nutrient intake of rural households that participated in a farming system for nutrition study in India. *Food and Nutrition Sciences, 12*, 277–289. https://doi.org/10.4236/fns.2021.123022.

Parasar Rohit, R., Bhavani, V., & Raju, S. (2021), Access to milk and milk products and child underweight. In S. S. Vepa & B. Viswanathan (Eds.), *Undernutrition, Agriculture and Public Provisioning: Impact on Women and Children in India* (pp. 201–229). Routledge.

Purohit, D. (2020). *Milk consumption pattern and child's height-for-age Z-score in India.* Dissertation, Madras School of Economics.

Ruel Marie, T., Quisumbing, A. R., & Balagamwala, M. (2018). Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security, 17*, 128–153. https://doi.org/10.1016/j.gfs.2018.01.002.

Vanderhout, S. M., & Corsi, D. J. (2021). Milk consumption and childhood anthropometric failure in India: Analysis of a national survey. *Maternal & Child Nutrition, 17*(2), e13090. https://doi.org/10.1111/mcn.13090.

Viswanathan, B., & David, G. (2021). Women's BMI among farm and non-farm households in rural India. In S. S. Vepa & B. Viswanathan (Eds.), *Undernutrition, Agriculture and Public Provisioning: Impact on Women and Children in India* (pp. 82–114). Routledge.

World Health Organisation. (2021). *Indicators for assessing infant and young child feeding practices: Definitions and measurement methods*. Retrieved November 15, 2021, from https://www.who.int/publications/i/item/9789240018389.

Exploring the Prevalence of Undernutrition and Consumers' Knowledge, Preferences, and Willingness to Pay for Biofortified Food

Alka Singh, Venkatesh Palanisamy, Renjini Valiyaveettil Raman, Praveen Koovalamkadu Velayudhan, and Ashok Kumar Singh

1 Introduction

Malnutrition among children has been a significant public health concern in recent decades (Singh et al., 2019). Stunting, underweight, and wasting are the most common forms of manifestation of malnutrition in children. Although countries worldwide are reducing the prevalence of malnutrition (Kumar et al., 2021), 149.2 million children below five years are still affected by stunting, and 45.4 million by wasting in the year 2020 (Isanaka et al., 2021). Malnutrition has multiple development and economic consequences as well (Horton, 1999). Poor child health pushes the countries into a vicious circle of poor nutritional status, high burden of diseases, and high poverty (Lakshminarayanan & Jayalakshmy, 2015). There are concerted efforts at the world level to address the issue of malnutrition. One of the critical targets of the Sustainable Development Goals of the United Nations is to reduce the number of underweight children by half from the 1990 level by 2015 and to end hunger and malnutrition by 2030 (Khan & Mohanty, 2018). Despite these measures, the problem of malnutrition is severe, especially in developing countries of the South Asia region (Sunny et al., 2015), since it is inextricably linked with poverty. India alone accounts for about 61 million stunted, 47 million underweight, and 25 million wasted children (Singh et al., 2019). Hence the performance of India is crucial in determining the progress made at the world level in terms of reducing malnutrition incidences (de Onis & Branca, 2016).

Malnutrition may involve both undernutrition and overnutrition (Patel et al., 2020). The prevalence of obesity, previously observed only in the developed world, has become a concern in developing countries like India (Jomi et al., 2018). The combined occurrence of obesity and undernutrition is called the double burden of malnutrition.

A. Singh (✉) · V. Palanisamy · R. V. Raman · P. K. Velayudhan · A. K. Singh
ICAR-Indian Agricultural Research Institute, New Delhi, India
e-mail: asingh.eco@gmail.com

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_7

Adding to the woes, India has recently experienced micronutrient deficiency along with undernutrition and obesity, resulting in the triple burden of malnutrition (Jain & Agnihotri, 2020). This issue of the triple burden of malnutrition is relatively new and is not sufficiently discussed in the academic literature (Kumar et al., 2021). Against this backdrop, we discuss and map the prevalence of the triple burden of malnutrition in India, considering the cases of both children and adults.

India attempts to address the malnutrition problem through several dimensions. Though measures like income and food supplements by the central and state governments and programmes like Integrated Child Development Service (ICDS) exist, long-term strategies are required to tackle the issue sustainably. As the majority of the Indian population is dependent on agriculture for livelihood, the sector can contribute immensely to the nutritional security of the Indian household by cultivating and consuming nutrition-rich food crops. Biofortification is a promising strategy in this line. Biofortification improves the nutritional content of food crops through breeding or genetic engineering (Nestel et al., 2006; White & Broadley, 2005). Biofortification helps to enhance access to nutritious food. Because staple foods are eaten in large quantities every day by the malnourished poor, the delivery of biofortified foods can rely on existing consumer behaviour (Bouis, 1999). Biofortification is cost-effective (Meenakshi et al., 2010), more sustainable than nutrient supplementation (Bouis, 1999), and a viable complementary strategy to food fortification (Akalu et al., 2010; Bouis, 1999; Horton, 2006).

Many biofortified crop varieties have been released in the country, but their adoption at the farm level has remained minimal. Further, the lack of adequate marketing mechanisms and seed systems, coupled with poor knowledge and preferences at the consumer level, has restricted this technology from spanning its wings. Considering the vast potential that this technology holds in tackling the issue of malnutrition in the country, we briefly discuss and summarize the world's major biofortification programmes. Further, we conduct a systematic review and meta-analysis to bring together the available evidence to prove the utility of biofortified crops in improving the health outcomes of children and women. We also present the results of an ex ante assessment of the health benefits of biofortification through the case of rice biofortification with zinc. The success of any intervention is measured by its penetration into end-users. For broader adoption of biofortified crops, the consumers' acceptance is essential. Hence, understanding the consumers' awareness level, knowledge, and perception of biofortified products becomes crucial. We report the results of a cross-sectional survey conducted to assess consumers' awareness of biofortification and its benefits towards the end of the chapter.

2 Data and Analytical Approaches

The study utilized both primary as well as secondary data. The data on various indicators of malnutrition were collected from the National Family Health Survey (NFHS-4 and 5) factsheets. We analyse the malnutrition status at national, state,

and district levels. At the national level, we compare the country's progress on key indicators of malnutrition across different rounds of NFHS. At the state level, we calculate malnutrition indices to compare the performances between NFHS-4 and 5. Three indices, i.e. Normalized Child Malnutrition Index (NCMI), Normalized Adult Malnutrition Index (NAMI), and Combined Normalized Malnutrition Index (CNMI), were constructed to study the malnutrition status across states. The details of indicators used in the construction of the indices are presented in Table 1. NCMI was built by combining five indicators: underweight, stunted, wasted, overweight, and anaemic. NAMI was constructed using the data on thin, overweight, and anaemic women and men to measure malnutrition in adults. Finally, the CNMI was constructed by combining all the indicators referring to children and adults.

The first step in the construction of the malnutrition indices is normalization. Normalization enables the mean values of all the selected indicators to be 'equal' or 'normalized', making the indicators scale-free (Gulati et al., 2012), which helps in meaningful comparisons between states. Each of the above indicators was normalized with the help of the following formula:

$$Normalized\ indicator = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Table 1 Description of indicators used in the construction of malnutrition indices

Indicators	Description
Malnutrition among children (under 5 years)	
1. Stunting	Percentage of children whose height for age is below minus two standard deviations—based on WHO Child Growth Standards
2. Underweight	Percentage of children whose weight for age is below minus two standard deviations—based on WHO Child Growth Standards
3. Wasting	Percentage of children whose weight for height is below minus two standard deviations—based on WHO Child Growth Standards
4. Overweight	Percentage of children whose weight for height is above +2 standard deviations—based on WHO Child Growth Standards
5. Anaemic	Percentage of children who are anaemic
Malnutrition in adults (15–49 years)	
1. Thin men and women	Percentage of women whose body mass index (BMI) is below normal (<18.5 kg/m^2)
2. Overweight men and women	Percentage of women whose body mass index (BMI) is above normal (<25 kg/m^2)
3. Anaemic men and women	Percentage of women who are anaemic (based on haemoglobin in grams per decilitre)

Source National Family Health Survey (NFHS) factsheet

The normalized indicators were further used to construct the indices. Equal weight is given to each indicator while constructing the indices assuming that each indicator entering the indices is equally important. The indices are then constructed by calculating the arithmetic average of normalized indicators. We then plot the district-level data on malnutrition indicators to generate maps to provide insights into malnutrition hotspots.

Many researchers have studied the association between malnutrition indicators and socio-economic, health, and demographic factors (Sunny et al., 2015). Studies provide diverse views on what determines child and adult malnutrition. While some suggest improved sanitation and socio-economic profile as the most critical factors (Spears & Lamba, 2013), others argue that maternal education and nutritional status are the key determinants (Corsi et al., 2016). To identify the factors determining malnutrition incidence in India, we take up a district-level multivariate regression analysis. We estimated separate Ordinary Least Square regression models for different child and adult malnutrition indicators using the explanatory variables available with the NFHS-5 data for 680 districts of India.

A systematic review and meta-analysis were conducted to analyse the impact of biofortification on health and nutritional outcome, considering its relevance in tackling the issue of global malnutrition. A systematic review attempts to gather all available empirical research using clearly defined, systematic methods to obtain answers to a specific question. Meta-analysis is a statistical method to integrate the results of independent studies that address the same research question (Hedges & Olkin, 1985; Schmidt & Hunter, 2016). A meta-analysis combines the results of many studies into a statistically valid overall effect size that is useful for evidence-based policymaking. For each analysis, a statistic, called effect size, is calculated to quantify the effect of a treatment or intervention in a way that is interpretable and comparable across studies. A summary effect size is then calculated to quantify the overall impact of a treatment or intervention across studies. The effect size can be measured by mean difference, standardized mean difference, risk ratio/response ratio, or correlation coefficient. This study used the mean difference as most of the research articles on the effects of biofortification on nutritional outcomes reported the effect size in terms of continuous variables. Studies directly reported the impact of the consumption of biofortified crops on the nutrient level as compared to the control crop.

For meta-analysis in this study, we have focused on randomized control trials of Iron-, Zinc-, and Vitamin A-biofortified crops on the nutritional status of women and children as they are the most affected populations of micronutrient deficiency. Iron deficiency is the most common micronutrient deficiency worldwide, with the most significant burden in women of reproductive age and young children (WHO, 2015). Iron is essential for brain development, myelination, growth, and cognitive function (Lönnerdal, 2017). Zinc is vital for the growth and health of young children (Krebs, 2013). A deficiency of dietary Zn is now recognized as a significant cause of early childhood morbidity and mortality. Also, Vitamin A deficiency is a leading cause of morbidity and mortality, especially in young children and pregnant and lactating women (Black et al., 2008).

Two approaches were followed to study the ex ante potential health benefits of biofortification in the case of rice biofortification with zinc: first, we estimated the monetary gain due to incremental consumption of zinc with the current level of rice consumption; second is the number of disability-adjusted life years (DALY) saved through zinc biofortification. By adopting Rao et al. (2006), we calculated the zinc intake through rice consumption from popular and biofortified varieties to estimate the monetary gain through incremental zinc consumption. The formula is given below

$$Monetary\ gain\ of\ zinc\ biofortified\ rice\ per\ day^{-1} = \begin{pmatrix} Rice\ consumption\ day^{-1} \times Incremental\ Zinc\ availability\ in\ rice\ kg^{-1} \\ \times\ Unit\ cost\ of\ Zinc\ Rs/kg \end{pmatrix}$$

The required data was compiled from various sources. The state-wise rural and urban households' average rice consumption was compiled from the 68th round of the Household Consumer Expenditure survey of NSSO (2012). The zinc availability in popular varieties and biofortified varieties were taken from ICAR. The unit cost of zinc from rice consumption was derived by dividing the average retail price of the rice by the average zinc availability in popular varieties.

The DALY method is widely used to analyse the potential health benefits of biofortification (Nirmala et al., 2016; Rao et al., 2006; Stein et al., 2008). The DALY provides a single index with which to measure the morbidity and mortality related to a particular disease and thus the burden. DALYs lost are, therefore, related to the sum of the 'years of life lost' (YLL) due to cause-specific mortality and the sum of the 'years lived with disability' (YLD):

$$DALYs\ lost = YLL + YLD$$

where the sum of the DALYs lost for each disability gives the total burden of disease. Taking account of different levels of severity and the varying extent of disease among groups within a population:

$$\text{DALYs lost} = \sum\nolimits_j T_j M_j \frac{\left(1 - e^{-rL_j}\right)}{r} + \sum\nolimits_i \sum\nolimits_j T_j I_{ij} D_{ij} \frac{\left(1 - e^{-rd_{ij}}\right)}{r}$$

where

Tj = Total number of people in the target group j

Mj = Mortality rates associated with target group j deficiency

Lj = Average life expectancy left for target group j

Iij = Incidence rate of disease i in target group j

Dij = Disability weight for disease i in target group j

dij = Duration of disease i in target group j (for permanent diseases dij equals the average remaining life expectancy Lj)

r = Discount rate for future life years.

To quantify the impact of biofortified zinc rice, we estimated the number of DALYs lost with the current level of consumption of existing popular varieties, and the number of DALYs lost with the hypothetical scenario of biofortified food consumption. The difference between these two would give the number of DALYs saved through biofortification. The information on the population in the target group is compiled from the Indian census data and other related information like mortality rate, average life expectancy, disease incidence rate, disability weights, and duration of the disease were taken from WHO. The monetary value was arrived at by multiplying DALYs with the per capita income level. We classified all the states into four regions based on other food grain consumption based on their share in total cereal consumption. For example, the rice region indicates the share of average per capita consumption of rice is more than 80 per cent of the total cereal consumption. The information on zinc deficiency and its effect on the target population was compiled from WHO websites.

Finally, we collected the data through a cross-sectional survey to analyse the consumers' awareness and perception of biofortification. The survey was conducted both through personal interviews and online survey methods. By using a pre-tested structured schedule, the personal interview was conducted both with rural (123) and urban (134) consumers located in and around the National Capital Region (NCR) of Delhi. For the online survey, a Google form was prepared with the same set of questions and circulated among 400 respondents comprising the students and staff of the Indian Council of Agricultural Research (ICAR) institutes and State Agricultural Universities (SAUs). We received 85 responses from the online survey, thus enabling us to collect data from 342 respondents; 219 (64%) are from urban areas, and 123 (36%) are from rural areas. Descriptive and graphical analyses were used to analyse the data.

3 Prevalence of Malnutrition in India—National, State, and District Level Status

The trends in malnutrition among children and adults compiled from different rounds of National Family Health Surveys are presented in Figs. 1 and 2. In children under five, the prevalence of stunting, wasting, and being underweight has continuously declined in the past 30 years. However, it should also be noted that the rate of decline in these malnutrition indicators has slowed down between NFHS-4 and 5, which is not impressive. During 2019–21, 35.5 per cent of children in India are stunted, 19.3 per cent are wasted, and 32.1 per cent are underweight. Though we are moving in the right direction in reducing incidences of these malnutrition indicators, the actual number of affected children is still very high in India.

On the other hand, obesity and anaemia among children have increased during 2019–21 compared to 2015–16. In the case of adults, the prevalence of thin men and women has decreased, whereas the incidence of obese and anaemic adults has

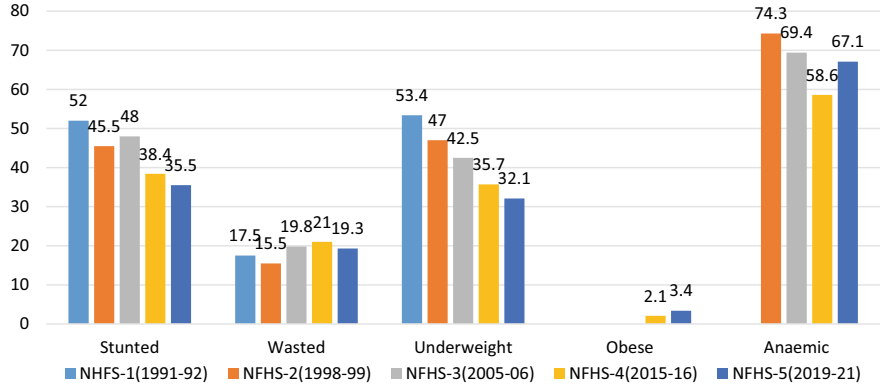


Fig. 1 Trends in malnutrition among children (per cent of children affected). *Source* National Family Health Survey (Various rounds)

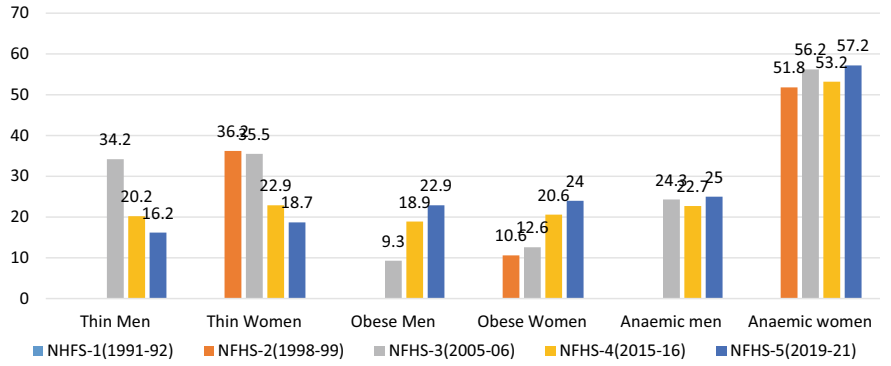
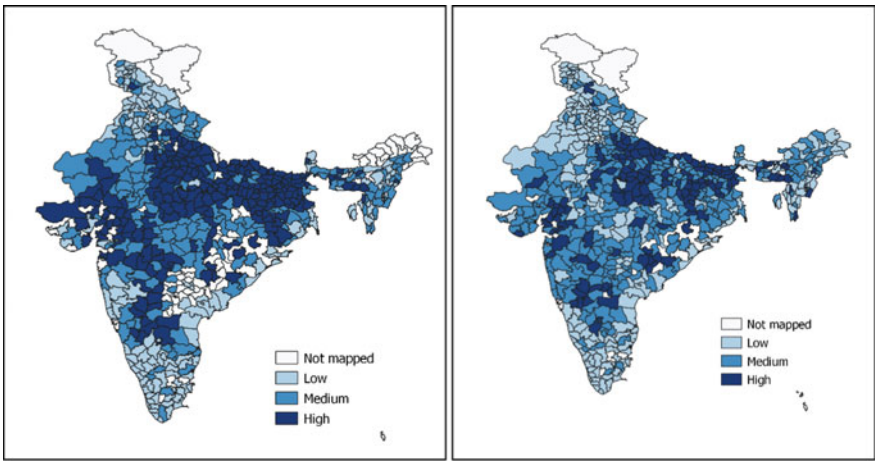


Fig. 2 Trends in malnutrition among adults (per cent of adults affected). *Source* National Family Health Survey (Various rounds)

increased in recent years. From the graph, the prevalence of the triple burden of malnutrition in India is evident. The prevalence of stunting, wasting, and underweight in children and thin adults indicates undernutrition; on the one hand, obesity indicates the concurrent occurrence of overnutrition. Along with this, increasing anaemia in both children and adults suggests the prevalence of micronutrient deficiency. Summing, the obesity rate is high, yet the country is undernourished.

The maps of per cent stunted, per cent wasted, and per cent underweight children for the years 2015–16 and 2019–21 show a similar pattern (Figs. 3, 4, and 5). The country's northern and southern regions are less malnourished than the eastern and western regions. However, some states have made considerable improvements between these two time periods. For example, in stunting in children below five years, Bihar, Haryana, Jharkhand, Madhya Pradesh, Uttar Pradesh, Uttarakhand, and Rajasthan have made progress by achieving a reduction of more than 10 per



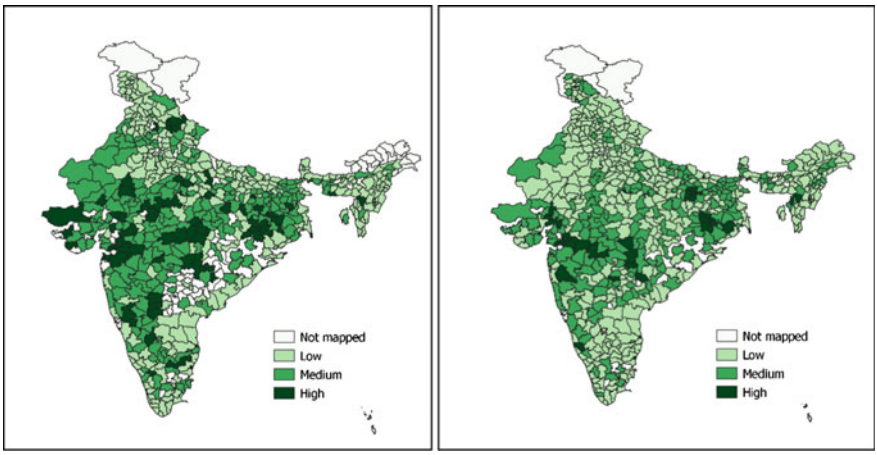
(a) Stunting in 2015 (b) Stunting in 2019

Fig. 3 District-level prevalence of stunting in 2015–16 and 2019–21. *Notes* Low—0–30%, Medium—30–40%, High—>40%. *Source* National Family Health Survey 4 and 5

cent. The prevalence of stunting ranges from 22.3 per cent in Sikkim and 23.4 per cent in Kerala to 42.9 per cent in Bihar and 46.5 per cent in Meghalaya. At the same time, the average wasting prevalence across states varied from 9.8 per cent in Mizoram to 25.6 per cent in Maharashtra. The prevalence of underweight children was found to be highest in Jharkhand (48.38%), followed by Bihar (41%), Gujarat (39.7%), and Jharkhand (39.4%). In wasting, Uttarakhand and Punjab have achieved more than 30 per cent reduction, and in the underweight category, Madhya Pradesh, Rajasthan, and Punjab have made a significant reduction in the incidence.

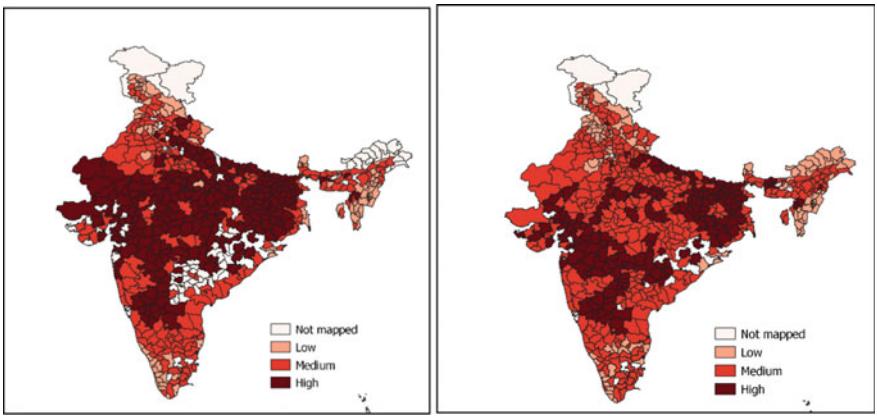
The change in malnutrition incidence between 2015–16 and 2019–21 also shows some worrying patterns. Obesity and anaemia have emerged as significant threats to the health scenario of the nation (Figs. 6 and 7). Worryingly, the incidence of obesity and anaemia has shown a drastic increase in most parts of the country, both in children and adults. While the incidence of obesity in women is concentrated more in the southern and north-western parts of the country, anaemia in women occurs more in the eastern and north-western parts of the country. Obesity in children is severe in the country's north-eastern states and Jammu and Kashmir. The highest per cent of anaemic children was observed in Gujarat, Haryana, Jammu and Kashmir, Punjab, Madhya Pradesh, and Rajasthan. The high occurrence of anaemic women and children even in the major cereal-producing states of the country points to the prevalence of micronutrient deficiency.

Further, though we can observe a reduction in the prevalence of thin men and women in most parts of the country, the overall situation of women in India in terms of malnutrition is even worse than men. The prevalence of thin men varies from 4.6 per cent in Jammu and Kashmir to 21.5 in Bihar. In the case of women,



(a) Wasting in 2015 (b) Wasting in 2019

Fig. 4 District-level prevalence of wasting in 2015–16 and 2019–21. *Notes* Low—0–20%, Medium—20–30%, High—>30%. *Source* National Family Health Survey 4 and 5

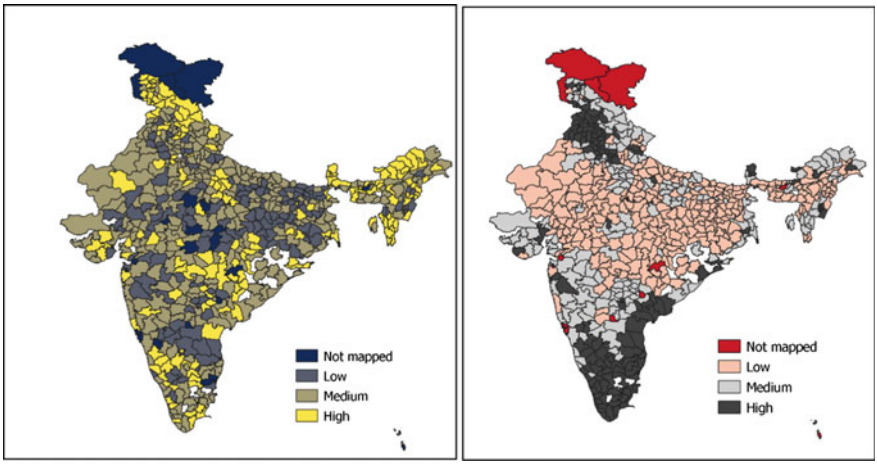


(a) Underweight in 2015 (b) Underweight in 2019

Fig. 5 District-level prevalence of underweight in 2015–16 and 2019–21. *Notes* Low—0–20%, Medium—20–35%, High—>35%. *Source* National Family Health Survey 4 and 5

prevalence ranges from 5.2 per cent in Jammu and Kashmir to 26.2 in Jharkhand. The district-level prevalence of thin women in 2019–20 is mapped in Fig. 8.

Different malnutrition indices were constructed to compare and summarize the child, adult, and overall malnutrition status across the states (Table 2). A higher index value suggests a higher prevalence of malnutrition. Gujarat and Bihar had the highest CNMI values for the year, suggesting these states to be the worst performers. The north-eastern states and Kerala were the best performing states with the least CNMI



(a) Obese children in 2019 (b) Obese women in 2019

Fig. 6 District-level prevalence of obesity in children and women in 2019–21. *Notes* Obese children—Low—0–2%, Medium—2–5%, High—>5%; Obese women—Low—0–20%, Medium—20–30%, High—>30%. *Source* National Family Health Survey 4 and 5

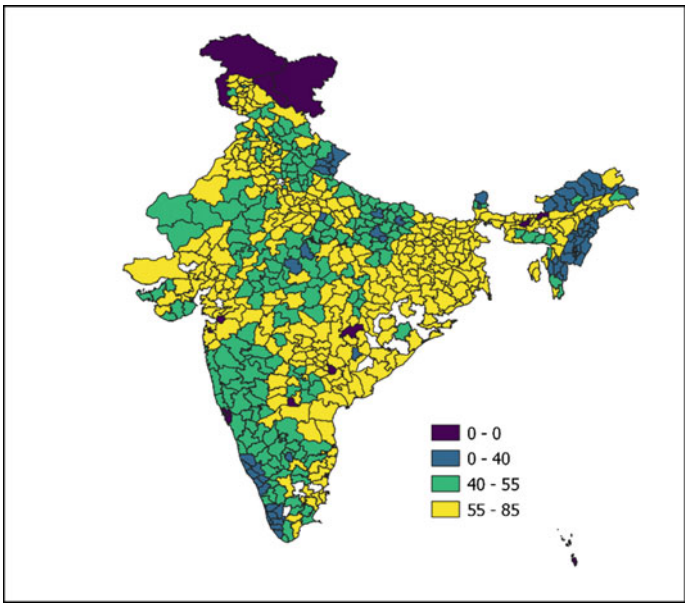


Fig. 7 District-level prevalence of anaemia in women in 2019–21. *Notes* Low—0–40%, Medium—40–55%, High—>55%. *Source* National Family Health Survey 5

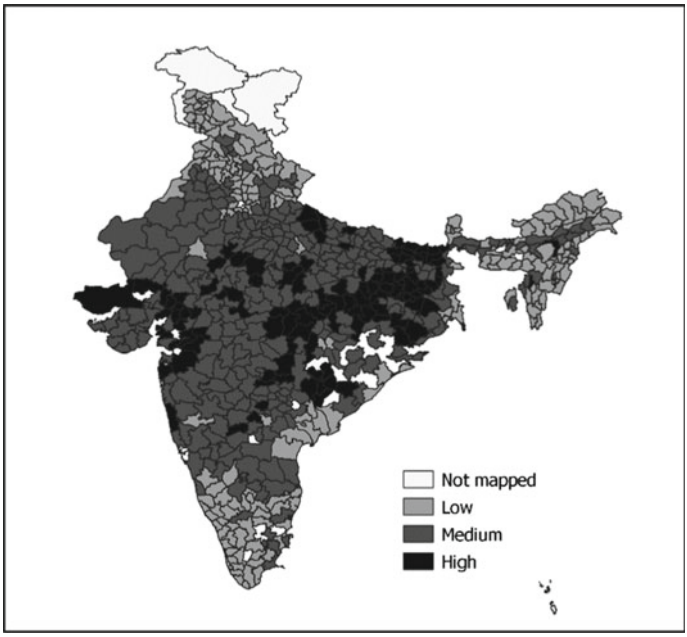


Fig. 8 District-level prevalence of thin women in 2019–21. *Notes* Low—0–15%, Medium—15–25%, High—>25%. *Source* National Family Health Survey 5

values. However, compared to 2015, most states are moving in the right direction of reducing malnutrition.

The spatial pattern of malnutrition indicators is already depicted in respective maps. Table 3 presents the mean, standard deviation, coefficient of variation, the minimum and maximum value of the selected district-level variables based on 680 districts in India. The coefficient of variation values suggested a wide variation in the anthropometric indicators of malnutrition across India. Among the maternal and birth-related variables, the per cent of mothers capable of taking iron and folic acid tablets during pregnancy is meagre in India. Among the other variables, while a higher coverage of electricity and improved drinking water source was observed, progress needs to be achieved in women's education, insurance adoption, sanitation, etc.

Table 4 presents the results of multivariate regression analysis estimating the determinants of child malnutrition indicators. Electricity access, sanitation facility, use of iodized salt, women's education, and institutional birth had a negative and statistically significant relationship with stunting. In contrast, the women with BMI below normal showed a positive relationship with stunting. In the case of wasting, the socio-economic variables and the variables on mothers' health and child nutrition immediately after birth significantly affected the prevalence. While wasting was lower in children who were exclusively breastfed, it was higher in the case of mothers with less than normal BMI. A similar relationship was observed in the case of the

Table 2 The trend in malnutrition indices across the states

	Normalized child malnutrition index 2019–21	Normalized child malnutrition index 2015–16	Normalized adult malnutrition index 2019–21	Normalized adult malnutrition index 2015–16	Combined normalized malnutrition index 2019–21	Combined normalized malnutrition index 2015–16
Andhra Pradesh	0.41	0.47	0.52	0.75	0.49	0.61
Arunachal Pradesh	0.39	0.47	0.26	0.32	0.29	0.38
Assam	0.62	0.43	0.39	0.49	0.49	0.48
Bihar	0.69	0.69	0.49	0.65	0.62	0.68
Chhattisgarh	0.54	0.57	0.41	0.47	0.49	0.54
Goa	0.31	0.41	0.46	0.46	0.40	0.43
Gujarat	0.77	0.66	0.54	0.65	0.67	0.67
Haryana	0.31	0.61	0.64	0.50	0.50	0.53
Himachal Pradesh	0.43	0.35	0.44	0.57	0.44	0.48
Jammu and Kashmir	0.57	0.42	0.40	0.48	0.43	0.44
Jharkhand	0.65	0.79	0.43	0.63	0.55	0.71
Karnataka	0.53	0.50	0.49	0.50	0.52	0.50
Kerala	0.18	0.27	0.47	0.40	0.34	0.33
Madhya Pradesh	0.54	0.72	0.43	0.57	0.52	0.67
Maharashtra	0.67	0.58	0.47	0.56	0.57	0.57
Manipur	0.07	0.19	0.30	0.25	0.19	0.23
Meghalaya	0.41	0.55	0.20	0.41	0.29	0.46
Mizoram	0.29	0.18	0.26	0.25	0.25	0.21
Nagaland	0.39	0.27	0.19	0.19	0.27	0.23
Odisha	0.46	0.51	0.48	0.58	0.48	0.56
Punjab	0.27	0.38	0.53	0.60	0.42	0.49
Rajasthan	0.46	0.62	0.32	0.46	0.40	0.55
Sikkim	0.33	0.52	0.37	0.37	0.33	0.40
Tamil Nadu	0.30	0.49	0.52	0.59	0.42	0.53
Telangana	0.56	0.43	0.52	0.63	0.55	0.56
Tripura	0.56	0.38	0.46	0.48	0.50	0.44
Uttar Pradesh	0.54	0.64	0.41	0.55	0.50	0.62
Uttarakhand	0.29	0.54	0.43	0.42	0.39	0.48
West Bengal	0.57	0.51	0.44	0.62	0.51	0.57

Source Authors' estimates based on National Family Health Survey 4 and 5

Table 3 Descriptive statistics of selected district-level indicators (2019–21)

Variables	Mean	SD	CV	Min	Max
District profile					
Population living in households with electricity (%)	96.91	4.40	0.05	68.40	100.00
Population living in households with an improved drinking-water source (%)	93.59	8.78	0.09	41.20	100.00
Population living in households that use an improved sanitation facility (%)	71.60	14.22	0.20	29.20	99.90
Households using clean fuel for cooking (%)	52.78	23.43	0.44	8.60	99.50
Households using iodized salt (%)	95.08	5.53	0.06	47.90	100.00
Households with any usual member covered under a health insurance/financing scheme (%)	40.65	23.12	0.57	4.20	97.80
Women who are literate (%)	72.47	12.89	0.18	10.40	99.70
Women with 10 or more years of schooling (%)	39.66	13.98	0.35	13.60	85.80
Child malnutrition indicators					
Children under 5 years who are stunted (height-for-age) (%)	33.67	8.51	0.25	13.20	60.60
Children under 5 years who are wasted (weight-for-height) (%)	18.70	6.50	0.35	4.50	48.00
Children under 5 years who are severely wasted (weight-for-height) (%)	7.68	4.06	0.52	0.50	32.50
Children under 5 years who are underweight (weight-for-age) (%)	29.72	9.78	0.33	5.20	62.40
Children under 5 years who are overweight (weight-for-height) (%)	4.20	3.14	0.74	0.00	21.10
Children aged 6–59 months who are anaemic (<11.0 g/dl) (%)	65.86	12.37	0.19	4.80	93.20
Women malnutrition indicators					
Women whose Body Mass Index (BMI) is below normal (BMI < 18.5 kg/m2) (%)	18.18	7.39	0.41	1.20	43.60
Women who are overweight or obese (BMI ≥ 25.0 kg/m2) (%)	22.53	10.41	0.46	3.80	66.90
Women who have high risk waist-to-hip ratio (≥0.85) (%)	57.05	13.77	0.24	18.00	96.60
All women aged 15–49 years who are anaemic (%)	56.08	11.87	0.21	7.40	84.80
Maternal and birth-related indicators					
Mothers who consumed iron-folic acid for 100 days or more when they were pregnant (%)	45.49	20.73	0.46	1.60	95.00

(continued)

Table 3 (continued)

Variables	Mean	SD	CV	Min	Max
Mothers who consumed iron-folic acid for 180 days or more when they were pregnant (%)	26.45	17.39	0.66	0.80	84.60
Institutional births (%)	88.46	12.03	0.14	21.40	100.00
Children aged 12–23 months fully vaccinated based on information from either vaccination card or mother's recall (%)	76.26	15.77	0.21	0.00	100.00
Children under age 6 months exclusively breastfed (%)	41.97	33.35	0.79	0.00	94.00
Children aged 6–8 months receiving solid or semi-solid food and breastmilk (%)	3.91	13.16	3.36	0.00	85.20

Source Authors' estimates based on National Family Health Survey 5

Table 4 Determinants of malnutrition in children

Parameters	Stunting	Wasting	Underweight	Obesity	Anaemia
Population living in households with electricity (%)	−0.253***	0.034	−0.07	−0.021	−0.076
	−0.06	−0.052	−0.058	−0.027	−0.089
Population living in households with an improved drinking-water source (%)	0.094	−0.068***	0.011	0.018	−0.147***
	−0.03	−0.026	−0.029	−0.013	−0.044
Population living in households that use an improved sanitation facility (%)	−0.044*	−0.039*	−0.078***	0.003	0.047
	−0.024	−0.021	−0.023	−0.011	−0.036
Households using clean fuel for cooking (%)	0.051	−0.124***	−0.115***	−0.026***	−0.151***
	−0.016	−0.014	−0.015	−0.007	−0.024
Households using iodized salt (%)	−0.247***	0.037	−0.115***	−0.045**	0.009
	−0.043	−0.037	−0.041	−0.019	−0.064
Households with any usual member covered under a health insurance/financing scheme (%)	−0.051***	−0.051***	−0.062***	−0.006	−0.064***
	−0.012	−0.01	−0.011	−0.005	−0.017
Women who are literate (%)	−0.015	0.002	−0.01	0	−0.112**
	−0.031	−0.027	−0.03	−0.014	−0.046
Women with 10 or more years of schooling (%)	−0.064**	0.013	−0.039	−0.009	−0.144***
	−0.031	−0.027	−0.03	−0.014	−0.046
Mothers who consumed iron-folic acid for 100 days or more when they were pregnant (%)	0.007	−0.033	−0.046	−0.031**	−0.127***
	−0.03	−0.026	−0.029	−0.014	−0.045
Institutional births (%)	−0.141***	0.064	−0.015	0.002	0.194***
	−0.027	−0.023	−0.026	−0.012	−0.04

(continued)

Table 4 (continued)

Parameters	Stunting	Wasting	Underweight	Obesity	Anaemia
Children aged 12–23 months fully vaccinated based on information from either vaccination card or mother's recall (%)	0.017	0.022	0.035**	−0.005	0.038
	−0.016	−0.013	−0.015	−0.007	−0.023
Children under age 6 months exclusively breastfed (%)	0.004	−0.027***	−0.017**	0.001	0.049***
	−0.008	−0.007	−0.008	−0.004	−0.012
Children aged 6–8 months receiving solid or semi-solid food and breastmilk (%)	0.037**	0.033**	0.053***	−0.015*	−0.029
	−0.018	−0.016	−0.018	−0.008	−0.027
Women whose Body Mass Index (BMI) is below normal (BMI < 18.5 kg/m2) (%)	0.257***	0.192***	0.635***	−0.246***	0.008
	−0.059	−0.051	−0.057	−0.027	−0.088
Women who are overweight or obese (BMI ≥ 25.0 kg/m2) (%)	−0.271***	−0.455***	−0.423***	−0.102***	−0.266***
	−0.042	−0.036	−0.04	−0.019	−0.062
Women who have high risk waist-to-hip ratio (≥0.85) (%)	−0.027	0.019	0.008	0.032***	−0.033
	−0.021	−0.018	−0.021	−0.01	−0.032
All women aged 15–49 years who are anaemic (%)	0.012	0.076***	0.076***	0.028***	0.535***
	−0.024	−0.02	−0.023	−0.011	−0.035
Constant	91.480***	11.023*	42.653***	3.27	22.573**
	−7.229	−6.286	−6.995	−3.28	−10.802
Observations	679	679	679	679	679
R-squared	0.561	0.432	0.687	0.325	0.537

Note ***, **, and * indicate significance at 1, 5, and 10 percent levels respectively
Source Authors' estimates based on National Family Health Survey 5

underweight as well. While obesity increased with better socio-economic characteristics and mothers' nutrition, an opposite relationship was observed in the case of child anaemia. In the case of determinants of malnutrition in women (Table 5), better socio-economic characteristics significantly reduced the incidence of thin women and anaemic women and increased the incidence of obese women. It is thus clear from the table that mothers' nutrition is a crucial determinant of child nutrition. Women's education also helps reduce the incidence of malnutrition indicators.

4 The Global Programme of Biofortification

Harvest Plus leads the global biofortification effort, working with the CGIAR network of international agricultural research centres, and a wide variety of partners, including governments, researchers, NGOs, and the private sector. Harvest Plus focuses on 12

Table 5 Determinants of malnutrition in women

Parameters	Thin women	Obese women	Anaemic women
Population living in households with electricity (%)	0.04	0.196***	−0.171*
	−0.053	−0.065	−0.104
Population living in households with an improved drinking-water source (%)	−0.105***	0.102	−0.197***
	−0.026	−0.032	−0.051
Population living in households that use an improved sanitation facility 2 (%)	−0.220***	0.046*	−0.320***
	−0.02	−0.025	−0.039
Households using clean fuel for cooking (%)	−0.041***	0.170***	0.013
	−0.012	−0.015	−0.024
Households using iodized salt (%)	0.024	−0.133***	−0.026
	−0.039	−0.048	−0.077
Households with any usual member covered under a health insurance/financing scheme (%)	0.038***	−0.042***	0.053***
	−0.009	−0.011	−0.018
Women who are literate (%)	−0.100***	0.057*	0.110**
	−0.027	−0.033	−0.052
Women with 10 or more years of schooling (%)	−0.059**	0.224***	−0.235***
	−0.025	−0.031	−0.05
Constant	28.125***	−16.957**	44.986***
	−6.083	−7.519	−11.965
Observations	680	680	679
R-squared	0.484	0.602	0.226

Note ***, **, and * indicate significance at 1, 5, and 10 percent levels respectively
Source Authors' estimates based on National Family Health Survey 5

staple food crops consumed by most of the world's poor living in Africa, Asia, and Latin America (Table 6). The biofortification programme of Harvest Plus focuses on three micronutrients, Zinc, Iron, and Vitamin A, which the World Health Organization identifies as most lacking in diets globally. Africa is the largest beneficiary of biofortification, having 40 varieties released and 85 varieties under trial. 28 varieties are released, 17 varieties are being tested in Asia while 29 varieties are released, and 20 varieties are under trial in Latin America and the Caribbean region. The number of staple crops released and trialled in the programme is according to the consumption habits of different regions. The target crops are orange sweet potato (OSP), beans, cassava, and maize in Africa. Unlike Africa, more than 90 per cent of rice is grown and consumed in Asia, followed by wheat which is reflected in the release of varieties. Most Latin American and Caribbean (LAC) countries do not consume large amounts of a single staple crop, and hence, for them, different approaches are needed.

In India, ICAR is the front runner in the research of biofortified crops. ICAR, through All India Coordinated Research Projects (AlCRP), developed and released

Table 6 Biofortified varieties released by harvest plus, 2020

Crop	Nutrient	Africa	Asia	LA/Caribbean
Rice	Zn	1 (T)	3 (R), 3 (T)	3 (R), 3 (T)
Wheat	Zn	5 (T)	4 (R), 4 (T)	3 (R)
Maize	Vitamin A	10 (R), 15 (T)	4 (T)	1 (R), 4 (T)
	Zn	1 (T)		6 (R), 3 (T)
Cowpea	Fe, Zn	1 (T)	1 (R)	1 (R)
Pearl millet	Fe	1 (R), 18 (T)	1 (R)	
Banana	Vitamin A	2 (R), 7 (T)		
Cassava	Vitamin A	5 (R), 18 (T)		1 (R), 5 (T)
Irish Potato	Fe, Zn	5 (T)	4 (T)	2 (T)
Lentil	Fe, Zn	2 (T)	4 (R), 2 (T)	
Sorghum	Fe, Zn	1 (T)	1 (R)	
Orange Sweet Potato	Vitamin A	16 (R), 7 (T)	6 (R)	6 (R), 2 (T)
Bean	Fe	6 (R), 4 (T)		8 (R), 1 (T)

Source Harvest Plus Biofortified Crops Around the World_0.pdf, 2020 R: Released; T: Trial

Table 7 Details of varieties developed by ICAR as of 2020

Crop	Number of varieties	Nutrient
Rice	7	Zn, protein
Wheat	22	Fe, Zn, Protein
Maize	11	Lysine, Tryptophan, Provitamin-A
Pearl millet	8	Fe, Zn
Finger millet	3	Fe, Zn, Ca
Small millet	1	Fe, Zn
Lentil	2	Fe, Zn
Groundnut	2	Oleic acid
Linseed	1	Linoleic acid
Mustard	3	Erucic acid, Glucosinolates
Soyabean	3	Trypsin inhibitor, Lipoxygenase, and Oleic acid
Cauliflower	1	Provitamin-A
Potato	2	Anthocyanin
Sweet potato	2	Provitamin-A and Anthocyanin
Greater yam	2	Anthocyanin, Protein, Zn, Fe, Ca
Pomegranate	1	Iron, Zinc, Vitamin C

Source Kumar et al., (2020)

around 71 biofortified varieties of 16 crops (Table 7). The ICAR biofortification programme concentrates on micronutrients like Iron, Zinc in most cereals, and Vitamin A and Anthocyanin in vegetables. Wheat is the major crop with the highest number of biofortified varieties, followed by maize, pearl millet, and rice. Different ICAR institutes and State Agricultural Universities are actively participating in biofortification programmes. Around 30 per cent of the biofortified varieties released in India are from the Indian Agricultural Research Institute, New Delhi.

5 Systematic Review and Meta-Analysis of the Impact of Biofortified Food Crops on Health and Nutritional Outcomes of Women and Children

We conducted a structured literature search on April 2021 in databases like Web of Science, Google Scholar, AgEcon Search, and CeRA-J gate for the period 2000–2021. Additional sources were identified from bibliographies of published studies and manual searches of related articles in references. The search strategy and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram are presented in Table 8 and Fig. 9.

After removing duplicates, a total of 1404 studies were identified from the search. After the full-text screening, 28 studies were selected for systematic review, out of which 12 studies were found desirable for meta-analysis. Extracted information from the studies included year of study, duration of intervention, kind of biofortified foods, sample size, iron status, serum retinol status, plasma zinc level, anthropometric,

Table 8 Search strategy

Search	Query	Results
#1	TS (biofortif* OR nutritionally enhance* OR nutritional enhance*)	15,902
#2	AB = (biofortif* OR nutritionally enhance* OR nutritional enhance*)	12,108
#3	TI = (biofortif* OR nutritionally enhance* OR nutritional enhance*)	1,620
#4	AK = (biofortif* OR nutritionally enhance* OR nutritional enhance*)	1,425
#5	#4 OR #3 OR #2 OR #1	15,902
#6	TS = (randomized controlled trial OR controlled clinical trial OR randomized OR trial)	1,623,740
#7	TS = (impact OR effect* OR assessment OR intervention*)	13,175,009
#8	#7 AND #6 AND #5	1,411

Source Authors' search strategy for selection of studies for meta-analysis

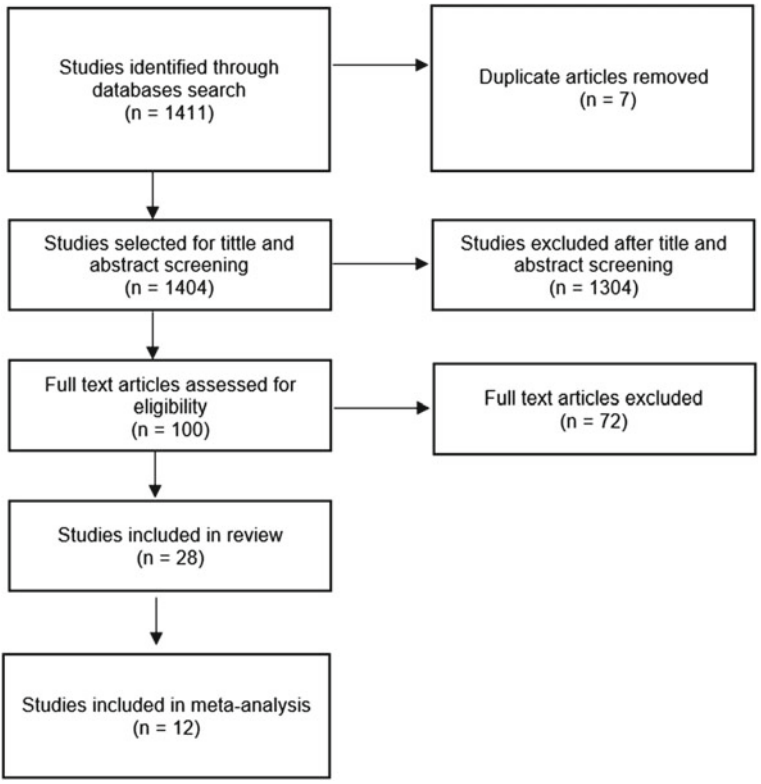


Fig. 9 Prisma flow diagram. *Source* Authors' selection of studies for meta-analysis

cognitive function, physical performance, and any other outcomes reported by the study authors.

5.1 Findings from the Systematic Review

A total of 28 studies were selected for the systematic review that assessed the intervention on children and women. Among the selected studies that dealt with children, eight studies focused on vitamin A, four studies on iron, and one on zinc. In the case of women, 8 of the selected studies were on iron, three were on vitamin A, and two were on zinc. Two studies assessed women's and children's zinc and vitamin A status combinedly. 17 of the selected studies were from Africa and 4 studies were based in India. Maize, pearl millet, and orange sweet potato are the primary intervention crops.

Consumption of iron-biofortified pearl millet and beans has helped increase the iron status of children (Finkelstein et al., 2015, 2019). In adolescents, iron-biofortified

pearl millet consumption has further improved attention and memory tasks (Scott et al., 2018). Kodkany et al. (2013) attempted to determine the absorption of iron and zinc from pearl millet biofortified in children in Karnataka, India. The absorption of iron from biofortified pearl millet was adequate to meet the estimated physiological requirements for iron, while it was less than the physiological requirements for zinc. Chomba et al. (2015) examined the physiological requirements of zinc in young children in Zambia and the differential zinc absorption from biofortified and controlled meals. The quantity of zinc absorbed was significantly higher for the consumers of biofortified maize than in the control group.

The benefits of biofortified food were further demonstrated by Gannon et al. (2014), Sheftel et al. (2017), and Palmer et al. (2016a) in maize. While the orange maize improved total body stores of vitamin A and visual function, the pro-vitamin A-biofortified maize consumption had increased pupillary responsiveness. Talsma et al. (2016) found that yellow cassava supplementation increased serum retinol concentration and serum b-carotene concentration in Kenyan children. The inclusion of QPM in children's diets positively affected their growth (Akalu et al., 2010). In their study in Ethiopia, Donato et al. (2020) found that the distribution of new, biofortified crop varieties with a consumption targeting campaign can change storage, cooking, and consumption behaviours but did not translate into increased growth. Similarly, Van Jaarsveld et al. (2005) found that consumption of orange-fleshed sweet potato (OSP) improved vitamin A status in school children in South Africa. However, some studies report no significant effect of vitamin A biofortification (Afolami et al., 2021).

The benefits of biofortified food consumption in women were demonstrated by La Frano et al. (2013) through biofortified cassava and Li et al. (2010) through biofortified maize. Though Palmer et al. (2016b) reported the inability of daily biofortified maize consumption to increase mean milk retinol concentration in lactating Zambian women, it has helped reduce the risk of low milk retinol across intervention groups. Further, the consumption of biofortified wheat flour had increased plasma zinc levels in adults (Khan et al., 2017; Rosado et al., 2009). Iron-biofortified rice and beans consumption helped improve the cognitive performance in women, in addition to the improvements in iron status (Haas et al., 2005, 2016; Luna et al., 2020; Murray-Kolb et al., 2017). Studies also reported the limiting effect of Higher Phytic acid (HPA) concentrations on the benefits of biofortified beans (BB) (Petry et al., 2012, 2013).

Further, Petry et al. (2016) reported that the total amount of iron absorbed from low phytic acid (LPA) beans and BBs did not significantly differ but was higher than from control beans. The higher iron absorption from BB meals was also reported by Petry et al. (2014) in their study of Rwandese women. De Brauw et al. (2019) found that vitamin A intake was higher in children and women in the targeted farmer households growing orange sweet potatoes (OSP) in northern Mozambique. While there was no significant effect of zinc-biofortified wheat flour consumption on zinc status in women and children in India, it has significantly reduced the days with pneumonia and vomiting among children and days with fever among women (Sazawal et al., 2018).

5.2 *Findings from the Meta-Analysis*

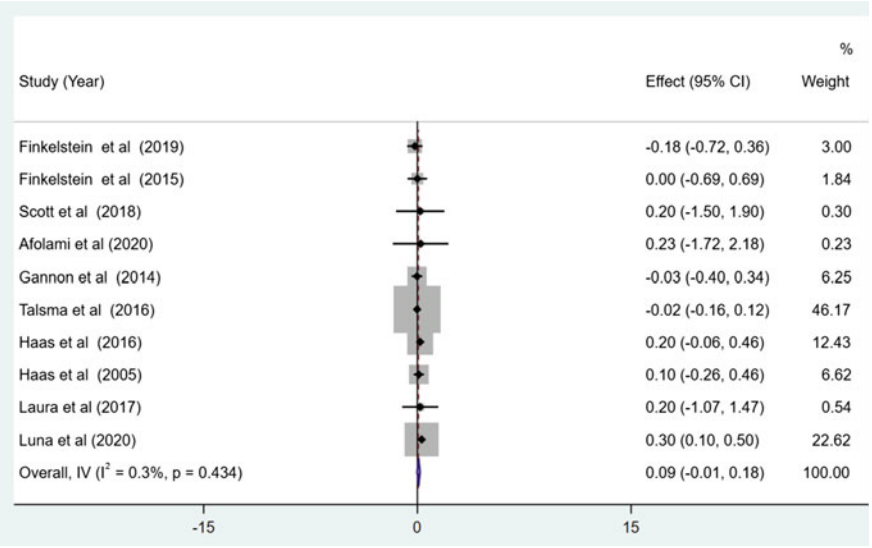
Based on the evidence generated by these randomized trials, we conducted meta-analyses to examine the efficacy of iron-, zinc-, and vitamin A-biofortification interventions on nutritional outcomes. The studies that reported medians (and ranges) and geometric means (reported standard deviations, standard errors, or confidence intervals) were converted to arithmetic means and standard deviations using the Hozo et al. (2005) and Higgins et al. (2008) method. Statistical analyses were conducted in STATA software, and the subgroup analysis was carried out wherever data was available. The effect sizes could vary by the type of biofortified crop and intervention group. We estimate the effect size using the random-effects model to account for this heterogeneity. The random-effects model assumes the presence of a true variation between the studies selected for meta-analysis (Higgins et al., 2021).

Ten Randomized Control Trials studies were included in analysing the impact of the consumption of iron-biofortified crops. The forest plot shows the size of the effect of iron-fortified crops' consumption on changes in women's and children's iron status (Fig. 10). Consumption of iron-biofortified crops will increase the iron content by an average of 0.09 g/dl. Out of 10 studies analysed, seven reported positive outcomes, and three reported negative outcomes of consumption of biofortified crops' Fe level. The heterogeneity between studies was confirmed by the low Tau-squared and the large I-squared statistic. The I-squared statistics indicated that only 0.3 per cent of the variation might be attributed to heterogeneity between studies rather than sampling variation within studies.

Subgroup analysis shows that studies on children did not have a positive effect size, while for women, the change in Fe level is 0.24 g/dl. The highest impact was found in Luna et al. (2020), where the effect is recorded at 0.24 g/dl Fe level (Fig. 11). Publication bias was assessed visually using the funnel plot (Fig. 12) and Egger's statistical test (Table 9). In the absence of bias and heterogeneity, funnel plots should be funnel-shaped and symmetrically centred around the summary effect estimate of the analysis.

In our analysis, effect sizes are symmetrically distributed around the summary effect size (Fig. 15). This symmetry shows that there was no tendency to publish only statistically significant positive effects. The effect size of studies with low precision, plotted at the bottom of the graph, is likely to deviate more from the pooled effect size than the effect size of studies with higher precision, plotted at the top of the graph, creating a funnel-shaped distribution. Egger's test formalizes the approach by regressing the effect size on its standard error. In the absence of publication bias, the correlation between effect size and its standard error should be zero, confirmed by the test.

We have conducted a separate meta-analysis for studies including vitamin A- and zinc-biofortified crops. The analysis indicated that the consumption of iron-biofortified crops increased the serum retinol and plasma zinc level by an average of 0.66 μg/dl (Fig. 13). Four studies reported positive outcomes on serum retinol and plasma zinc level. The heterogeneity between studies was confirmed by the low



I^2=0.3%, P=.434; tau^2=0.001

Fig. 10 The overall effect of biofortified crops on changes in Fe level in children and women. *Source* Authors' estimates based on meta-analysis

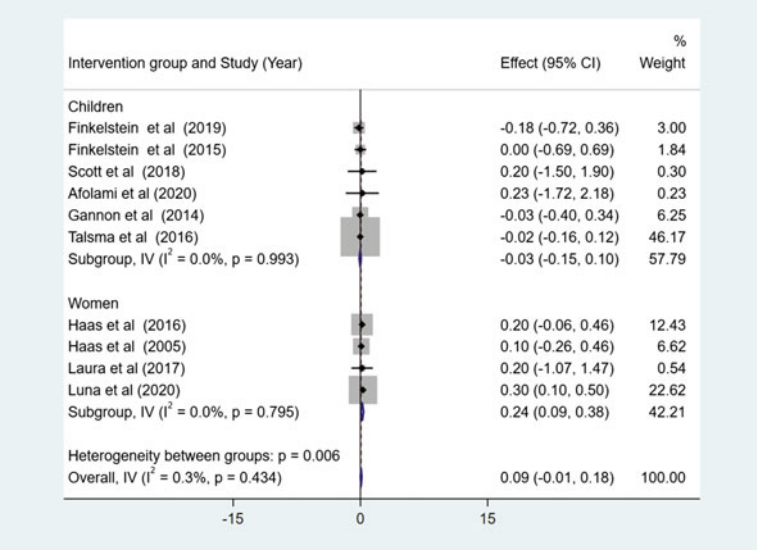


Fig. 11 Subgroup effect of biofortified crops on changes in Fe level in children and women. *Source* Authors' estimates based on meta-analysis

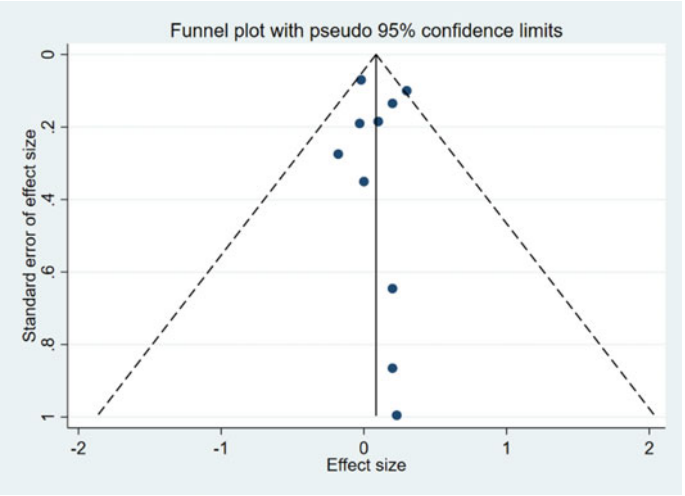


Fig. 12 Funnel plot for studies on the effect of biofortified crops on changes in Fe level. *Source* Authors' estimates based on meta-analysis

Table 9 Egger's test for studies on the effect of biofortified crops on changes in Fe level

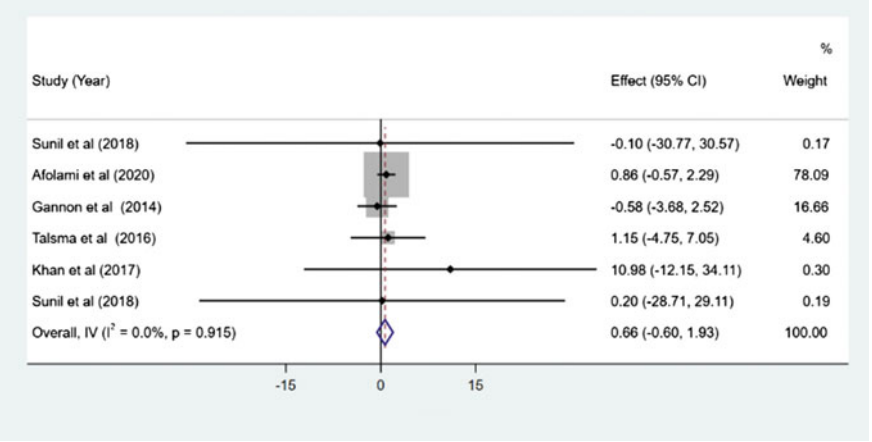
Std_Eff	Coef	Std. Err	t	P > t	[95% Conf Interval]	
Slope	−1.47	0.00	−634.30	0.00	−1.47	−1.46
Bias	0.35	0.19	1.82	0.14	−0.18	0.87

Source Authors' estimates based on meta-analysis

Tau-squared and the large I-squared statistic. The I-squared statistics indicated no variation but not significant, which might be attributed to heterogeneity between studies rather than sampling variation within studies. Subgroup analysis showed a positive effect on both children and women, with larger effect sizes for the latter (Fig. 14). Publication bias was not found as indicated by the funnel plot (Fig. 15) and Egger's statistical test (Table 10).

6 Ex Ante Health Benefits of Biofortification—A Case of Biofortification Rice with Zinc and Iron

The results of our assessment of monetary gain through incremental zinc consumption are given in Table 11. As per the analysis, the average monthly per capita consumption of rural households was about 55.39 kg rice, 4.39 kg wheat, 0.17 kg pearl millet, and 0.1 kg lentil. The average zinc intake was about 76 mg/month, which is less than the ICMR recommended dietary allowance (RDA) for adults, 330 for



I^2=0.0%, P=.915; tau^2=0.000

Fig. 13 Overall effect of consumption of Vitamin A- and Zinc-biofortified crops in women and children. *Source* Authors' estimates based on meta-analysis

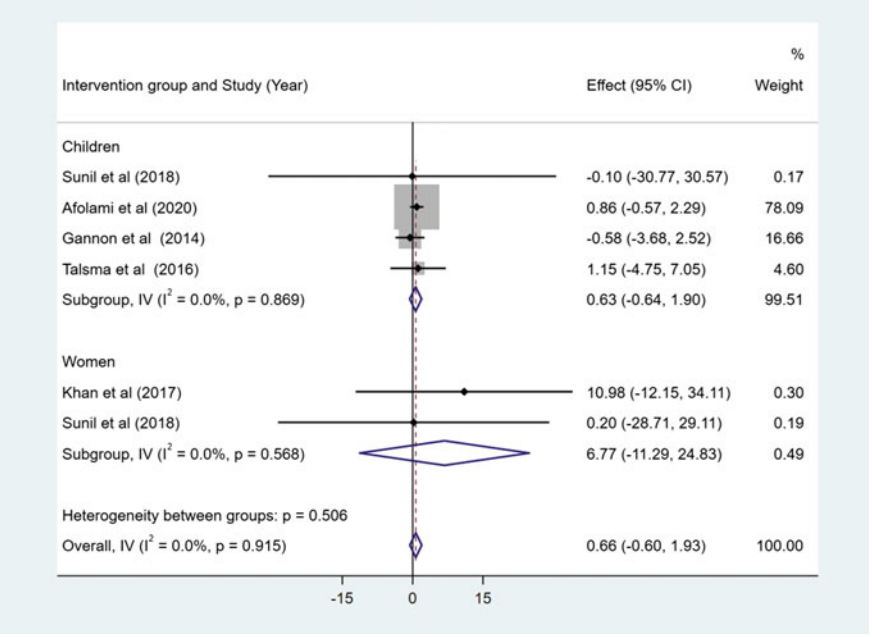


Fig. 14 Effect of biofortified crops on changes in Vitamin A and Zn level in children and women: by intervention group. *Source* Authors' estimates based on meta-analysis

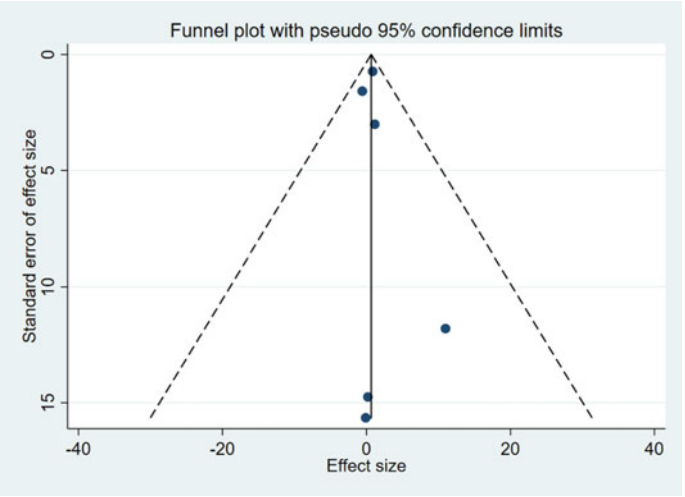


Fig. 15 Funnel plot for studies on the effect of biofortified crops on changes in Vitamin A and Zn levels. *Source* Authors' estimates based on meta-analysis

Table 10 Egger's test for studies on the effect of biofortified crops on changes in Vitamin A and Zn levels

Std_Eff	Coef	Std. Err	t	P > t	[95% Conf. Interval]
Slope	−0.0818085	0.2402426	−0.34	0.766	−1.115489 0.951872
Bias	0.2142673	0.4031233	0.53	0.648	−1.520232 1.948767

Source Authors' estimates based on meta-analysis

women and 360 (NIN, 2020) for men and lactating and pregnant women. Similarly, RDA for iron is about 570 g/month, however, the average iron intake from major food sources is very low 145 m/month. However, a detailed analysis of nutrient intake from various foods by different groups (children, pregnant women, and other vulnerable populations) is required to precisely estimate the RDA deficit. The consumption of currently available highest potential zinc-biofortified rice could nearly double the nutrient intake without changing the quantity of the current level of rice consumption. With the current level of rice consumption, on average, about Rs 50–200 per month per person can be saved since the biofortified varieties will not make up 100 per cent of rice consumption. It will follow the usual adoption pattern of any new variety; hence we did a simulation analysis. With the assumption that 5 per cent of the total adult population in the country consumes biofortified rice, the expenditure on zinc supplements could be saved to the extent of Rs 203 crores per month. Correspondingly, the expenditure on iron supplements could be saved to the extent of Rs 81 crores/month by consuming biofortified foods. In comparison to the potential monetary benefits of biofortification, the cost related to research and development of biofortification is meagre. A study on the cost of varietal development in India

reported about Rs 3–6 crores for maize, mustard, and vegetable crops (Geetha, 2019). It indicates that developing biofortified staple food crops and promoting consumption is the cheapest way to mitigate micronutrient deficiency problems.

The results of our assessment of DALYs saved through zinc biofortification indicate that, on average, about 15.8 million DALYs are lost due to zinc deficiency, and with the use of biofortified zinc, about 5.25 million DALYs lost could be saved. The per capita DALYs lost indicate that the target population loses about 36 days on average, and the biofortification can save about 12 days of their lives. The monetary value of per capita DALYs lost indicates that about Rs2933/year/person could be saved through biofortification (Table 12).

Table 11 The estimated monetary gain of biofortified foods

S. No.	Particular	Zinc biofortification	Iron biofortification			
		Rice	Wheat	Pearl Millet	Lentil	Total
1.	Average per capita consumption (Kg/month)	5.39	4.39	0.17	0.1	4.66
2.	Zinc or Iron intake with popular variety (mg/month)	75.47	131.7	8.08	5.5	145.28
3.	Zinc or iron intake with biofortified variety (mg/month)	145.56	175.6	12.41	6.5	194.51
4.	Incremental zinc or iron intake with biofortified variety (mg/month)	70.08	43.9	4.34	1	49.24
5.	Monetary gain due to incremental zinc or iron consumption					
	(a) By derived unit cost of zinc or iron (Rs/month/per capita)	200.44	39.51	2.47	1.18	43.16
	(b) By supplementary tablet intake	49.06	17.56	1.73	0.4	19.69
	© If 5% of adult population consumes biofortified food (based on supplementary tablet price—Rs crore/month)	203.1	72.7	7.18	1.66	81.53

Source Authors' estimates based on NSSO, 2014

Table 12 DALY saved through zinc biofortification

Regions	DALY lost (mn)	Per capita DALYs lost	Per capita DALYs lost (monetary terms) (@per capita NI) (Rs.)
Pessimistic (without biofortified rice)			
Rice	4.84	0.102	8871.83
Wheat	1.49	0.103	8906.009
Rice–wheat	6.07	0.100	8702.219
Rice–Wheat–Millet	3.39	0.102	8866.916
All India	15.80	0.102	8836.743
Optimistic (use of biofortified varieties)			
Rice	3.25	0.069	5954.153
Wheat	1.02	0.071	6120.002
Rice–wheat	4.12	0.068	5913.861
Rice–Wheat–Millet	2.15	0.065	5623.19
All India	10.55	0.068	5902.801
Gain from biofortification			
Rice	1.59	0.0337	2917.677
Wheat	0.46	0.032	2786.007
Rice–wheat	1.94	0.032	2788.358
Rice–Wheat–Millet	1.24	0.037	3243.726
All India	5.25	0.0338	2933.84

Source Authors' estimates based on NSSO, 2014

7 Consumers' Awareness, Knowledge, and Perception of Biofortified Foods

This section details the findings from the consumers' survey on their awareness, knowledge, and perception of biofortified foods. Table 13 provides the critical socio-economic characteristics of the respondents. Among the 342 respondents, the majority were from urban areas (64%). Overall, a more or less equal representation of males and females was observed in the sample; however, the number of male respondents was slightly higher in urban areas and vice versa in rural areas. The education level of the respondents was quite the opposite in rural and urban areas. More than 80 per cent of urban respondents were either bachelor's or master's degree holders, while more than 80 per cent of rural respondents had education only up to secondary school. Agriculture was the primary occupation of the rural respondents (72%). At the same time, about 80 per cent of the urban respondents were regular monthly salary earners either in the private or government sectors. A majority (83%) of the rural respondents' average monthly income was less than INR 20,000/- while urban respondents belonged majorly (41%) in the INR 20–50,000/- category, a sizeable

sample fell in the 50,000 to one lakh category also. The average number of members in the respondents' families was 4 in urban areas and 7 in rural areas.

The food habits were distinct in rural and urban areas. While the vegetarians and non-vegetarians were more or less equally distributed in the urban sample, the majority of the rural respondents were vegetarians (93%). Understanding the target

Table 13 Socio-economic profile and food habits of the respondents

Particular	Urban	Rural	Overall
No. of respondents	219	123	342
Average age (In Years)	37.6	41.1	38.9
Gender			
Male (%)	53.3	49.0	51.7
Female (%)	46.7	51.0	48.3
Education			
Up to 12th std (%)	16.9	82.9	40.6
Graduate (%)	21.5	10.6	17.5
PG and PhD (%)	61.6	6.5	41.8
Occupation			
Agri (%)	0.9	72.4	26.6
Agri + salaried (%)	0.0	13.0	4.7
Salaried (%)	78.5	1.6	50.8
Business (%)	18.3	13.8	16.7
Student (%)	2.3	0.0	1.5
Monthly Income (INR)			
<20,000	1.4	82.9	30.7
>20,000–50,000 (%)	41.6	15.4	32.2
>50,000–1 lakh (%)	27.4	1.6	18.1
>1 lakh–2 lakhs (%)	16.4	0.0	10.5
≥2 lakhs (%)	13.2	0.0	8.5
Family size	4.1	6.5	5.5
Food habits			
Non-Vegetarian (%)	53.4	7.3	36.8
Vegetarian (%)	46.6	92.7	63.2
Most influential person in purchasing food items			
Wife (%)	64.9	22.4	49.6
Husband (%)	16.1	64.2	33.4
Children (%)	5.8	7.5	6.4
Elders (%)	13.2	6.0	10.6

Source Authors' estimates based on primary survey

group for a wider reach of biofortified foods among Indian families is essential. Therefore, we collected information on the most influential family members who decide on the day-to-day food purchase activities. As far as the urban areas were concerned, wives (64%) influenced the purchase of food items. Contrastingly, husbands' choices (64%) were important in rural areas. The role of children was minimum (6%) both in rural and urban areas.

We asked the consumers a binary question, i.e. whether they heard of or were aware of the biofortified foods. More than 90 per cent of the consumers were aware or heard of biofortification both in rural and urban areas. It is worth mentioning that the rural respondents were mainly from ICAR-IARI biofortified variety intervention villages. These villages were exposed to training, demonstrations, exhibition, and meetings on biofortification, which could influence the awareness level of the rural respondents. Also, urban respondents from online surveys were prejudiced as they are from ICAR and SAUs backgrounds. After the preliminary question, we analysed the respondents' knowledge based on the four statements. Their responses classified them into four groups: not-aware, slightly aware, moderately aware, and completely aware.

The results indicate that only 34 per cent of urban respondents and 41 per cent of rural respondents were completely aware (Table 14). About 13 per cent of the overall respondents were not aware, which is higher than the heard/aware respondents (6.5%). It indicates that about 6 per cent of the respondents do not know about biofortification; however, they believe they are aware. Partially aware respondents mostly misunderstood fortified foods as genetically modified (GM) crops. Understanding the sources of information plays a pivotal role in formulating suitable strategies to create awareness among the target population. There were multiple sources of information, and rural and urban were divided on this front. We found that the Internet or mobile phones were the most important source of information in urban areas (32%) and training programmes in rural areas (25%). Written communications such as journals, magazines, and newspapers were the additional sources of information for the urban respondents. On the other hand, training programmes, exhibitions, and friends and relatives were supplementary information sources for rural respondents. Both radio and TV play a substantial role in rural areas, while TV plays a moderate role in urban areas, but radio's influence is nil.

A perception study reported that, in general, consumers prefer a food product as natural as possible, with minimum ingredients and the least number of manufacturing processes (Harvestplus). Hence, consumers' perception of biofortified products gains the greatest significance in the context of the acceptability and adoption of biofortified foods. The respondents were asked to score five statements about the biofortified foods; the 5-point Likert scale was used, 1 for 'strongly disagree' and 5 for 'strongly agree'. All the rural respondents believed that biofortified foods are rich in nutrients. Among the urban respondents, about 8 per cent either disagreed or could not decide (Table 15). As the rural respondents were more acquainted with biofortified varieties during the demonstrations, they strongly agreed on the nutrition potential of biofortified foods.

Similarly, they also firmly believed that it could help combat the malnutrition problem, especially in vulnerable populations. However, about 10 per cent of the urban and 5 per cent of rural respondents disagreed with this statement or could not

Table 14 Awareness, knowledge, and sources of information

Particular	Urban	Rural	Overall
Aware (%)	91.3	97.5	93.5
Not aware (%)	8.7	2.5	6.5
Knowledge index			
Not aware (%)	13.5	11.5	12.8
Slightly aware (%)	10.0	1.6	7.0
Moderately aware (%)	42.3	45.9	43.6
Completely aware (%)	34.2	41.0	36.7
Most significant sources of information			
Radio	0.3	7.0	2.7
Newspaper	16.8	10.6	14.6
Television	11.0	8.6	10.2
Internet/mobiles	31.7	2.5	21.2
Journals	10.3	1.0	7.0
Magazines	11.6	0.0	7.4
Exhibitions	3.3	15.7	7.8
Training	3.8	25.3	11.5
Friends and relatives	11.2	29.8	17.9

Source Authors' estimates based on primary survey

Table 15 Consumers' perception of biofortified foods

Statements	Sector	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Rich in micronutrients	Urban	57.3	35.4	4.1	1.8	1.4
	Rural	49.2	50.8	0.0	0.0	0.0
	Overall	54.4	40.9	2.6	1.2	0.9
Help to fight nutrient deficiency	Urban	52.5	37.9	4.9	4.0	1.4
	Rural	36.1	59.0	4.9	0.0	0.0
	Overall	46.6	45.5	4.9	2.5	0.9
Tasty	Urban	6.7	38.7	44.7	8.1	1.9
	Rural	32.8	44.3	18.0	3.3	1.6
	Overall	16.1	40.7	35.1	6.4	1.8
Risky for human consumption	Urban	3.8	17.9	22.6	47.1	8.8
	Rural	4.9	3.3	27.9	47.5	16.4
	Overall	4.2	12.6	24.5	47.2	11.6
Risky for the environment	Urban	10.7	23.3	18.4	40.8	6.7
	Rural	4.9	8.2	23.0	37.7	26.2
	Overall	8.6	17.9	20.0	39.7	13.7

Source Authors' estimates based on primary survey

decide. More than 75 per cent of the respondents opined that biofortified foods are tasty and will not change much. However, most urban respondents were either undecided or disagreed with this, and their apprehension was that the product's taste would change. Most importantly, overall, about 17 per cent of the total respondents opined that biofortified foods are risky for human consumption and 27 per cent believed that they will be harmful to the environment. A substantial proportion of respondents were undecided about human health (25%) or environmental risks (20%). Our findings point out that creating proper awareness about biofortified foods is paramount for improving their consumption.

7.1 Dynamics of Food Purchasing Behaviour of the Consumers

Understanding the consumers' purchasing behaviour is essential for formulating strategies for broader adoption. When the new products are positioned in the market, about 5 per cent of the sample consumers from urban areas and 15 per cent of rural consumers would never try those products (Table 16). Overall, only about 9 per cent of the total respondents would try the product immediately, and a majority were irregular adopters. Hence, the new products would face initial hindrances. Further, when it is coupled with negative perceptions such as health and environmental risks, it would be difficult to convince consumers to go for biofortified foods. Over 90 per cent of the total respondents felt that advertisements are necessary for wider adoption.

The biofortified foods purchase intent score was as high as 75 per cent for the total respondents, indicating three-fourths of them would likely buy the biofortified foods. For those who showed an intention to buy biofortified foods, we asked their willingness to pay a premium price. About 15 per cent of urban and 30 per cent of rural consumers showed disinterest in buying biofortified foods if the price is hiked compared to other varieties of the same product. An average 9 per cent price hike was acceptable for those who agreed to pay a premium price for biofortified foods. Interestingly, rural consumers' purchase intent score was less than urban respondents, despite having positive opinions about biofortified foods. Hence, it is essential to understand various factors determining food buying behaviours. Price was a critical factor for 33 per cent of urban consumers and 38 per cent of rural consumers, and for others, the importance level was moderate. About 70 per cent of the total respondents consider taste is a very important trait of the products (Table 17). Hence, the product developer needs to note that there should not be any compromise on the taste and flavour of the products for wider adoption of the products. Urban consumers were more concerned about the nutritional content of the product and additional health information than their counterparts, whereas the proportion of consumers giving more weightage to brand names was relatively more in rural areas than urban areas.

Table 16 Food purchasing behaviour of consumers

Questions	Urban	Rural	Overall
What is your purchasing behaviour regarding newly arrived food products in the market?			
Always	8.7	9.8	9.1
Often	21.5	6.5	16.1
Sometimes	40.2	39.8	40.1
Rarely	25.1	28.5	26.3
Never	4.6	15.4	8.5
Do you think that biofortified products require promotion and advertisements for wider adoption?			
Yes	91.3	85.8	89.3
No	8.7	14.2	10.7
Would you buy a biofortified product if it were available in the market?			
Yes	84.0	58.5	74.9
No	16.0	41.5	25.1
Would you buy if biofortified products have prices a little higher when compared to other varieties of the same product?			
Yes (%)	85.6	70.7	80.2
No (%)	14.4	29.3	19.8
If yes, to what percentage of increase in the price is acceptable to you	9.3	7.4	8.6

Source Authors' estimates based on primary survey

7.2 Acceptability and Willingness to Pay

The biofortified foods purchase intent score was as high as 75 per cent for the total respondents, indicating three-fourths of them would likely buy the biofortified foods. For those who showed an intention to buy biofortified foods, we asked their willingness to pay a premium price (Table 18). About 15 per cent of urban and 30 per cent of rural consumers showed disinterest in buying biofortified foods if the price is hiked compared to other varieties of the same product. An average 9 per cent price hike was acceptable for those who agreed to pay a premium price for biofortified foods. Interestingly, rural consumers' purchase intent score was less than that of urban respondents, despite them having more positive opinions about biofortified foods. There was no significant influence of age, gender, and income in accepting the price hike, and more than 90 per cent of the respondents accepted the prices hike. They perceived that quality foods always come with a higher price. The perception of health and environmental risks were the most important factors. The acceptance level of the premium price or price hike was relatively low among those who perceived the risks. Hence, there is a need to create proper awareness about biofortified foods among consumers for a wider adoption.

Table 17 Determining factors of consumers' food purchasing behaviour

Statements	Sector	Very important	Important	Moderately important	Slightly important	Not important
Taste/Flavor	Urban	75.8	18.3	4.6	0.9	0.5
	Rural	69.9	15.4	10.6	1.6	2.4
	Overall	73.7	17.3	6.7	1.2	1.2
Price	Urban	32.9	22.8	13.7	14.6	16.0
	Rural	38.2	31.7	18.7	3.3	8.1
	Overall	34.8	26.0	15.5	10.5	13.2
Nutritional information	Urban	52.1	36.5	9.1	1.4	0.9
	Rural	22.0	30.9	19.5	7.3	20.3
	Overall	41.2	34.5	12.9	3.5	7.9
Brand name	Urban	33.8	38.4	21.0	3.2	3.7
	Rural	40.7	31.7	13.8	6.5	7.3
	Overall	36.3	36.0	18.4	4.4	5.0
Additional health information	Urban	32.0	42.5	19.6	4.6	1.4
	Rural	16.3	38.2	20.3	11.4	13.8
	Overall	26.3	40.9	19.9	7.0	5.8

Source Authors' estimates based on primary survey

Table 18 Acceptance level of biofortified foods and willingness to pay

Particular	Would you buy if biofortified products are available on the market? Yes (%)	If yes, to what percentage of increase in the price is acceptable to you, WTP average
Sector		
Rural	70.7	7.4
Urban	85.6	9.4
Average	80.2	8.6
Age		
<30	100	7.1
31–40	92.3	8.3
>41	92.3	9.8
Gender		
Male	93.1	9.1

(continued)

Table 18 (continued)

Particular	Would you buy if biofortified products are available on the market? Yes (%)	If yes, to what percentage of increase in the price is acceptable to you, WTP average
Female	92.1	8.2
Income		
20,000–50,000	100.0	9.4
50,000–1 lakh	90.0	7.7
1 lakh–1 lakh	92.9	9.1
≥2 lakhs	93.1	8.6
Perception		
No health risk perceived	98.4	9.4
Health risk perceived	78.3	6.7
No environmental risk perceived	96.5	8.7
Environment risk perceived	85.7	8.6

Source Authors' estimates based on primary survey

8 Conclusion

The incidence of malnutrition indicators in India has been uncovered through this study. We found that, though most states and regions of the country are progressing in tackling the prevalence of traditional malnutrition indicators like stunting, wasting, and underweight in children below five years of age and thin adults, there are other concerns to be addressed soon. Obesity and anaemia have already emerged as a threat to the nation's health status. While obesity occurs due to overnutrition, anaemia is a result of micronutrient deficiency in the diet. Hence the country has to address the triple burden of malnutrition. In this context, biofortification is a promising technique that can enrich staple food products with micronutrients. We synthesize evidence from the literature to pool the effect of biofortification on nutritional outcomes. The meta-analysis suggested that the consumption of biofortified food positively impacted nutritional outcomes in children and women. Consumption of iron-biofortified crops will increase the iron content by an average of 0.09 g/dl. Consumption of iron-biofortified crops will increase the serum retinol and plasma zinc level by an average of 0.66 μg/dl. Publication bias was not found in all the intervention studies. The effect sizes vary by crop, intervention group, and duration. The ex ante health benefit assessment of biofortification provided a promising result of almost doubling zinc intake without increasing rice consumption. Besides, savings of lost DALYs to the extent of 5.25 million is possible by consuming biofortified food by the target population. The results reiterate the importance of biofortification programmes and help to determine the future course of action in intervention studies.

However, the concern is the low level of awareness of consumers towards biofortification. Less than 40 per cent of the respondents surveyed were aware of biofortified food. A sizable number of respondents also believed that biofortified foods are harmful to humans and the environment, suggesting the requirement for creating the proper awareness among consumers. The taste and price of the biofortified products were the most critical attributes perceived by the respondents.

References

Afolami, I., Mwangi, M. N., Samuel, F., et al. (2021). Daily consumption of pro-vitamin A biofortified (yellow) cassava improves serum retinol concentrations in preschool children in Nigeria: A randomized controlled trial. *American Journal of Clinical Nutrition,113*, 221. https://doi.org/10.1093/AJCN/NQAA290

Akalu, G., Taffesse, S., Gunaratna, N. S., & De Groote, H. (2010). The effectiveness of quality protein maize in improving the nutritional status of young children in the Ethiopian highlands. *Food and Nutrition Bulletin,31*, 418–430. https://doi.org/10.1177/156482651003100304

Black, R. E., Allen, L. H., Bhutta, Z. A., et al. (2008). Maternal and child undernutrition: Global and regional exposures and health consequences. *Lancet (london, England),371*, 243–260. https://doi.org/10.1016/S0140-6736(07)61690-0

Bouis, H. E. (1999). Economics of enhanced micronutrient density in food staples. *Field Crops Research,60*, 165–173. https://doi.org/10.1016/S0378-4290(98)00138-5

Chomba, E., Westcott, C. M., Westcott, J. E., et al. (2015). Zinc absorption from biofortified maize meets the requirements of young Rural Zambian children. *Journal of Nutrition,145*, 514. https://doi.org/10.3945/JN.114.204933

Corsi, D. J., Mejía-Guevara, I., & Subramanian, S. V. (2016). Risk factors for chronic undernutrition among children in India: Estimating relative importance, population attributable risk and fractions. *Social Science and Medicine,157*, 165–185. https://doi.org/10.1016/J.SOCSCIMED.2015.11.014

De Brauw, A., Moursi, M., & Munhaua, A. B. (2019). Vitamin A intakes remain higher among intervention participants 3 years after a biofortification intervention in Mozambique. *British Journal of Nutrition,122*, 1175–1181. https://doi.org/10.1017/S0007114519002162

de Onis, M., & Branca, F. (2016). Childhood stunting: A global perspective. *Maternal & Child Nutrition,12*(Suppl 1), 12–26. https://doi.org/10.1111/MCN.12231

Donato, K., McConnell, M., Han, D., et al. (2020). Behavioural insights to support increased consumption of quality protein maize by young children: A cluster randomised trial in Ethiopia. *BMJ Global Health,5*, e002705. https://doi.org/10.1136/BMJGH-2020-002705

Finkelstein, J. L., Mehta, S., Udipi, S. A., et al. (2015). A randomized trial of iron-biofortified pearl millet in school children in India. *Journal of Nutrition,145*, 1576–1581. https://doi.org/10.3945/JN.114.208009

Finkelstein, J. L., Mehta, S., Villalpando, S., et al. (2019). A randomized feeding trial of iron-biofortified beans in school children in Mexico. *Nutrients,11*, 381. https://doi.org/10.3390/NU11020381

Gannon, B., Kaliwile, C., Arscott, S. A., et al. (2014). Biofortified orange maize is as efficacious as a vitamin A supplement in Zambian children even in the presence of high liver reserves of vitamin A: A community-based, randomized placebo-controlled trial. *American Journal of Clinical Nutrition,100*, 1541–1550. https://doi.org/10.3945/AJCN.114.087379

Geetha, M. L. (2019). *Impact assessment of biofortified varieties of IARI*. Unpublished Thesis, Division of Agricultural Economics, ICAR-IARI, New Delhi.

Gulati, A., Ganesh-Kumar, A., Shreedhar, G., & Nandakumar, T. (2012). Agriculture and malnutrition in India. *Food and Nutrition Bulletin,33*, 74–86. https://doi.org/10.1177/156482651203300108

Haas, J. D., Beard, J. L., Murray-Kolb, L. E., et al. (2005). Iron-biofortified rice improves the iron stores of nonanemic Filipino women. *Journal of Nutrition,135*, 2823–2830. https://doi.org/10.1093/JN/135.12.2823

Haas, J. D., Luna, S. V., Lung'aho, M. G., et al. (2016). Consuming iron biofortified beans increases iron status in Rwandan women after 128 days in a randomized controlled feeding trial. *Journal of Nutrition,146*, 1586–1592. https://doi.org/10.3945/JN.115.224741

Harvestplus. (2019). Consumer attitudes and perception of biofortification and biofortified foods. https://www.leatherheadfood.com/files/2020/03/HP-consumer-white-paper-2019-002.pdf

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis*. Elsevier.

Higgins, J., Chandler, J., & Cumpston, M., et al. (2021). *Cochrane Handbook for Systematic Reviews of Interventions*. Cochrane Training.

Higgins, J. P. T., White, I. R., & Anzures-Cabrera, J. (2008). Meta-analysis of skewed data: Combining results reported on log-transformed or raw scales. *Statistics in Medicine,27*, 6072–6092. https://doi.org/10.1002/SIM.3427

Horton, S. (1999). Opportunities for investments in nutrition in low-income Asia. *Asian Development Review,17*, 246–273.

Horton, S. (2006). The economics of food fortification. *Journal of Nutrition,136*, 1068–1071. https://doi.org/10.1093/JN/136.4.1068

Hozo, S. P., Djulbegovic, B., Hozo, I. (2005). Estimating the mean and variance from the median, range, and the size of a sample. *BMC Medical Research Methodology, 5*. https://doi.org/10.1186/1471-2288-5-13.

Isanaka, S., Andersen, C. T., Cousens, S., et al. (2021). Improving estimates of the burden of severe wasting: Analysis of secondary prevalence and incidence data from 352 sites. *BMJ Global Health,6*, e004342. https://doi.org/10.1136/BMJGH-2020-004342

Jain, A., & Agnihotri, S. B. (2020). Assessing inequalities and regional disparities in child nutrition outcomes in India using MANUSH—A more sensitive yardstick. *Int J Equity Health,19*, 138. https://doi.org/10.1186/S12939-020-01249-6

Jomi, J., Sushama, B., & Vijayaraghavan, R. (2018). Dietary pattern and prevalence of overweight & obesity among children aged 6–11 years in southern part of Kerala, India-A pilot study. *International Journal of Nursing Education,10*, 68. https://doi.org/10.5958/0974-9357.2018.00104.6

Khan, J., & Mohanty, S. K. (2018). Spatial heterogeneity and correlates of child malnutrition in districts of India. *BMC Public Health,18*, 1–13. https://doi.org/10.1186/S12889-018-5873-Z/TABLES/5

Khan, M. J., Ullah, U., & Usama, et al. (2017). Effect of agronomically biofortified zinc flour on zinc and selenium status in resource poor settings; a randomised control trial. *The Proceedings of the Nutrition Society, 76*, 183https://doi.org/10.1017/S0029665117003457.

Kodkany, B. S., Bellad, R. M., Mahantshetti, N. S., et al. (2013). Biofortification of pearl millet with iron and zinc in a randomized controlled trial increases absorption of these minerals above physiologic requirements in young children. *Journal of Nutrition,143*, 1489–1493. https://doi.org/10.3945/JN.113.176677

Krebs, N. F. (2013). Update on zinc deficiency and excess in clinical pediatric practice. *Annals of Nutrition & Metabolism,62*(Suppl 1), 19–29. https://doi.org/10.1159/000348261

Kumar, D., Partha, Y., & Choudhury, R., et al. (2020). *Biofortified Varieties: Sustainable Way to Alleviate Malnutrition* (Third ed.). Indian Council of Agricultural Research (ICAR).

Kumar, P., Chauhan, S., Patel, R., et al. (2021). Prevalence and factors associated with triple burden of malnutrition among mother-child pairs in India: A study based on National Family Health Survey 2015–16. *BMC Public Health,21*, 1–12. https://doi.org/10.1186/S12889-021-10411-W/FIGURES/3

La Frano, M. R., Woodhouse, L. R., Burnett, D. J., & Burri, B. J. (2013). Biofortified cassava increases β-carotene and vitamin A concentrations in the TAG-rich plasma layer of American women. *British Journal of Nutrition,110*, 310–320. https://doi.org/10.1017/S0007114512005004

Lakshminarayanan, S., & Jayalakshmy, R. (2015). Diarrheal diseases among children in India: Current scenario and future perspectives. *Journal of Natural Science Biology and Medicine,6*, 24–28. https://doi.org/10.4103/0976-9668.149073

Li, S., Nugroho, A., Rocheford, T., & White, W. S. (2010). Vitamin A equivalence of the ß-carotene in ß-carotene-biofortified maize porridge consumed by women. *American Journal of Clinical Nutrition,92*, 1105–1112. https://doi.org/10.3945/AJCN.2010.29802

Lönnerdal, B. (2017). Development of iron homeostasis in infants and young children. *American Journal of Clinical Nutrition,106*, 1575S-1580S. https://doi.org/10.3945/AJCN.117.155820

Luna, S. V., Pompano, L. M., Lung'aho, M., et al. (2020). Increased iron status during a feeding trial of iron-biofortified beans increases physical work efficiency in Rwandan women. *Journal of Nutrition,150*, 1093–1099. https://doi.org/10.1093/JN/NXAA016

Meenakshi, J. V., Johnson, N. L., Manyong, V. M., et al. (2010). How cost-effective is biofortification in combating micronutrient malnutrition? An ex ante assessment. *World Development,38*, 64–75. https://doi.org/10.1016/J.WORLDDEV.2009.03.014

Murray-Kolb, L. E., Wenger, M. J., Scott, S. P., et al. (2017). Consumption of iron-biofortified beans positively affects cognitive performance in 18- to 27-year-old Rwandan female college students in an 18-week randomized controlled efficacy trial. *Journal of Nutrition,147*, 2109–2117. https://doi.org/10.3945/JN.117.255356

National Institute of Nutrition (NIN). (2020). *Short report of nutrient requirements of Indians.* A Report of the Expert Group. https://www.nin.res.in/RDA_short_Report_2020.html.

Nestel, P., Bouis, H. E., Meenakshi, J. V., & Pfeiffer, W. (2006). Biofortification of staple food crops. *Journal of Nutrition,136*, 1064–1067. https://doi.org/10.1093/JN/136.4.1064

Nirmala, B., Babu, V. R., & Neeraja, C. N., et al. (2016). Linking agriculture and nutrition: an Ex-ante analysis of zinc biofortification of rice in India. *Agricultural Economics Research Review, 29*, 171–177.

NSSO (National Sample survey Office). (2014). Household consumption of various goods and services in India, 2011–12. Ministry of Statistics and Programme Implementation, Government of India. http://164.100.161.63/sites/default/files/publication_reports/Report_no558_rou68_30june14.pdf.

Palmer, A. C., Chileshe, J., Hall, A. G., et al. (2016a). Short-term daily consumption of provitamin a carotenoid-biofortified maize has limited impact on breast milk retinol concentrations in zambian women enrolled in a randomized controlled feeding trial. *Journal of Nutrition,146*, 1783–1792. https://doi.org/10.3945/JN.116.233700

Palmer, A. C., Healy, K., Barffour, M. A., et al. (2016b). Provitamin a carotenoid-biofortified maize consumption increases pupillary responsiveness among zambian children in a randomized controlled trial. *Journal of Nutrition,146*, 2551–2558. https://doi.org/10.3945/JN.116.239202

Patel, R., Srivastava, S., Kumar, P., & Chauhan, S. (2020). Factors associated with double burden of malnutrition among mother-child pairs in India: A study based on National Family Health Survey 2015–16. *Children and Youth Services Review,116*, 105256. https://doi.org/10.1016/J.CHILDYOUTH.2020.105256

Petry, N., Egli, I., Campion, B., et al. (2013). Genetic reduction of phytate in common bean (Phaseolus vulgaris L.) seeds increases iron absorption in young women. *Journal of Nutrition,143*, 1219–1224. https://doi.org/10.3945/JN.113.175067

Petry, N., Egli, I., Gahutu, J. B., et al. (2012). Stable iron isotope studies in Rwandese women indicate that the common bean has limited potential as a vehicle for iron biofortification. *Journal of Nutrition,142*, 492–497. https://doi.org/10.3945/JN.111.149286

Petry, N., Egli, I., Gahutu, J. B., et al. (2014). Phytic acid concentration influences iron bioavailability from biofortified beans in Rwandese women with low iron status. *Journal of Nutrition,144*, 1681–1687. https://doi.org/10.3945/JN.114.192989

Petry, N., Rohner, F., Gahutu, J. B., et al. (2016). In Rwandese women with low iron status, iron absorption from low-phytic acid beans and biofortified beans is comparable, but low-phytic acid beans cause adverse gastrointestinal symptoms. *Journal of Nutrition,146*, 970–975. https://doi.org/10.3945/JN.115.223693

Rao, P. P., Birthal, P. S., Reddy, B. V., et al. (2006). Diagnostics of sorghum and pearl millet grains-based nutrition in India. *International Sorghum and Millets Newsletter,47*, 93–96.

Rosado, J. L., Hambidge, K. M., Miller, L. V., et al. (2009). The quantity of zinc absorbed from wheat in adult women is enhanced by biofortification. *Journal of Nutrition,139*, 1920. https://doi.org/10.3945/JN.109.107755

Sazawal, S., Dhingra, U., Dhingra, P., et al. (2018). Efficacy of high zinc biofortified wheat in improvement of micronutrient status, and prevention of morbidity among preschool children and women—A double masked, randomized, controlled trial. *Nutrition Journal,17*, 86. https://doi.org/10.1186/S12937-018-0391-5

Schmidt, F. L., & Hunter, J. E. (2016). *Methods of Meta-Analysis: Correcting Error and Bias in Research Findings*.https://doi.org/10.4135/9781483398105.

Scott, S. P., Murray-Kolb, L. E., Wenger, M. J., et al. (2018). Cognitive performance in Indian school-going adolescents is positively affected by consumption of iron-biofortified pearl millet: A 6-month randomized controlled efficacy trial. *Journal of Nutrition,148*, 1462–1471. https://doi.org/10.1093/JN/NXY113

Sheftel, J., Gannon, B. M., Davis, C. R., & Tanumihardjo, S. A. (2017). Provitamin A-biofortified maize consumption increases serum xanthophylls and 13C-natural abundance of retinol in Zambian children. *Experimental Biology and Medicine,242*, 1508. https://doi.org/10.1177/1535370217728500

Singh, S., Srivastava, S., & Upadhyay, A. K. (2019). Socio-economic inequality in malnutrition among children in India: An analysis of 640 districts from National Family Health Survey (2015–16). *International Journal for Equity in Health,18*, 1–9. https://doi.org/10.1186/S12939-019-1093-0/FIGURES/1

Spears, D., & Lamba, S. (2013). *Effects of Early-Life Exposure to Sanitation on Childhood Cognitive Skills : Evidence from India's Total Sanitation Campaign*. World Bank.

Stein, A. J., Meenakshi, J. V., Qaim, M., et al. (2008). Potential impacts of iron biofortification in India. *Social Science and Medicine,66*(8), 1797–1808.

Sunny, J., Bheemeshwar, R. A., & Mayank, A. (2015). Child undernutrition in India assessment of prevalence, decline and disparities. *Economic and Political Weekly,53*, 7–8.

Talsma, E. F., Brouwer, I. D., Verhoef, H., et al. (2016). Biofortified yellow cassava and vitamin A status of Kenyan children: A randomized controlled trial. *American Journal of Clinical Nutrition,103*, 258–267. https://doi.org/10.3945/AJCN.114.100164

Van Jaarsveld, P. J., Faber, M., Tanumihardjo, S. A., et al. (2005). Beta-carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *American Journal of Clinical Nutrition,81*, 1080–1087. https://doi.org/10.1093/AJCN/81.5.1080

White, P. J., & Broadley, M. R. (2005). Biofortifying crops with essential mineral elements. *Trends in Plant Science,10*, 586–593. https://doi.org/10.1016/J.TPLANTS.2005.10.001

WHO. (2015). *The global prevalence of anaemia in 2011*. Geneva.

Does Crop Insurance Promote Nutrition and Good Health Among Women and Children in the Agrarian Households of India?

Reshmi Sengupta and Debasis Rooj

1 Introduction

The persisting challenge of undernutrition in India remains a major hindrance in achieving Sustainable Development Goals (SDG) directly related to hunger, food, nutrition security (FNS), and good health. Notwithstanding wide acknowledgment on the scale of the challenges and a large body of the literature on the determinants of nutritional and health outcomes, gaps remain in understanding and explaining the pathways through which these outcomes are shaped in poor and rural communities. Moreover, the role and effectiveness of social safety nets in agriculture to improve the livelihood of the rural population remains to be assessed in specific contexts of vulnerabilities.

The agricultural sector in India is vital in providing food security and employment opportunities to the country's 1.3 billion population. According to the Periodic Labour Force Survey (2017–18), 55% of rural males and 73.2% of rural females are engaged in agricultural activities. In addition, the Reserve Bank of India (RBI) database on the Indian economy shows that agriculture accounts for nearly 13% of the country's Gross Value Added (GVA) for the year 2018–19 (at constant prices). Given the importance of the agricultural sector, the Government of India is continuously taking several initiatives to support the farmers and provide food security through different agricultural policies and programmes, such as farm loan waivers, crop insurance (CI), input subsidy, maximum support price, and public distribution system, among others.

R. Sengupta (✉) · D. Rooj
Associate Professor, Department of Economics, FLAME University, Pune, Maharashtra, India
e-mail: reshmi.sengupta@flame.edu.in

D. Rooj
e-mail: debasis.rooj@flame.edu.in

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_8

One of the major challenges in Indian agriculture is inadequate irrigation support and its heavy dependence on monsoon rains and heterogenous rainfall patterns. Variations in rainfall have increased over time due to climate change. There is enough evidence that climatic shocks lead to crop failure and increase income and food insecurity, leading to sustained poverty, especially among rural farming households (Barnwal & Kotwani, 2013; Birthal et al., 2014). Natural disasters, uncertainties in yields due to poor quality seeds, pests, diseases, and inefficient farming practices also lead to crop failure. The majority of the farming community is poor. They have inadequate access to finance and agricultural resources, making them even more vulnerable to these uncertainties.

Crop insurance (CI) can play a critical role not only in mitigating the major crop production-related challenges a farming household may face during a particular cropping season but may also reduce the cost of risk-bearing and stabilize farmer's income over time (He et al., 2019; Nair, 2010). Weather-related shocks and stresses in agricultural production can affect small-scale and large-scale enterprises in rural areas (Davies et al., 2008). CI is an essential policy response to risk and vulnerability in the agriculture sector. The scheme's main objective is to protect farmers against the crop losses suffered from natural calamities, such as drought, flood, hailstorm, cyclones, pests, diseases, etc. It is available to all farmers—loanee and non-loanee—irrespective of the size of the holding. The basic concept of insurance is to spread the risk of loss over many years and across a broad population base. During years of suffering loss, farmers can collect a large insurance payout, thus protecting them from insolvency or livelihood insecurity (Patt et al., 2010). Insurance can play a more significant role in absorbing risks, especially in developing countries where climatic impacts are critical to agricultural production (Panda, 2013). The insurance guarantee against the loan allows high-risk and low-income farmers to obtain credit to invest in seeds and other inputs for higher-yielding crops (Leary et al., 2007). Insurance can also free up assets to ensure enhanced consumption of merit goods like health and education. After a risk is realized (ex post), insurance payments can help families maintain their economic assets, ensure long-term financial viability, and escape the inter-generational poverty trap. An appropriate amount of timely and hassle-free claim disbursement can alleviate farmers' distress and positively impact income generation, thereby enabling them to achieve avenues for human resource development. CI as a shock absorber can help the agricultural households in maintaining a threshold amount of consumption and thus ensure sustainable standard of living.

However, in India, a large section of the farmers' population lacks proper insurance services. Lack of access to adequate insurance services may lead to an inefficient use of resources or negative coping mechanisms during times of crisis, such as choosing low-risk or low-return crops and inadequate production methods. It may also affect the inter-temporal resource allocation, such as reducing food consumption or the use of healthcare services, or the withdrawal of children from school, which may eventually erode their future-earning capacity, aggravating their vulnerability and perpetuating the vicious cycle of poverty (FAO, 2015).

Therefore, we argue that crop insurance has a vital role in households' demand for health services, potentially protecting the woman and her newborn's health and the entire family's welfare. This idea can be supported by 'Health' being a fundamental commodity, and consumers undertake health production by combining several inputs, including healthcare services (Dowie, 1975). Crop failure reduces agricultural yields, which causes a reduction in real income for the rural farming population in India. This, in turn, can reduce investment in health-improving goods (Burgess et al., 2014). Further, a household without crop insurance will not get the necessary income protection. It may also compel women to work during adverse events of income loss. Eventually, discouraging these women from seeking essential healthcare (antenatal and postnatal care) during their pregnancy and childbirth, thereby adversely affecting their health.

Although there is a vast body of literature that focuses on the demand for CI and its impact on input use in the presence of asymmetric information in the CI market (Möhring et al., 2020; Smith & Goodwin, 1996), some other studies (Ahsan et al., 1982; Chambers & Quiggin, 2002; Hau, 2006; Van Ittersum, 2015) have used crop yield as a measure of food security. However, these studies do not focus their analysis on identifying the effect of CI on the welfare aspects (Cole et al., 2017).

Households in India can differ in their access to market-supplied healthcare services and their ability to produce health due to several socio-economic and demographic differentials. The same is true for crop insurance. A visual depiction of the district-wise distribution of the crop insurance adoption and health-seeking practices by the women of their reproductive age shows that in general, districts with a higher proportion of crop insurance are also the districts where women are seeking more healthcare, such as receiving antenatal care in their first trimester opting for institutional delivery and postnatal checkup (Figs. 1, 2, 3 and 4).

Therefore, in this study, we analyse the effect of crop insurance on women's health-seeking behaviour in their reproductive age (15–49 years) and children's nutritional outcomes. In particular, we examine whether crop insurance improves health-seeking practices such as antenatal care, intuitional delivery, and postnatal care. We argue that crop insurance protects the farmers during times of distress. Higher adoption of crop insurance also indicates a higher level of knowledge and creates a coping mechanism during financial distress. Furthermore, through a primary survey and analysis, we could also provide positive evidence of the government's income support programme on households', women's, and children's health-seeking behaviour and nutritional support. Thus we contribute to the literature by looking at the extended role of crop insurance and the government's income support programme in the welfare of rural households.

We contribute to the literature in several ways. First, we are the first to examine the role of crop insurance on health-seeking practices and nutritional outcomes of the vulnerable populations, pregnant women and children, in India. We use several measures of health-seeking practices, including prenatal and postnatal healthcare variables. We also use nutritional measures for children. We find that crop insurance has substantial implications for women's healthcare-seeking practices in their reproductive age. Therefore, this paper makes an essential contribution by using

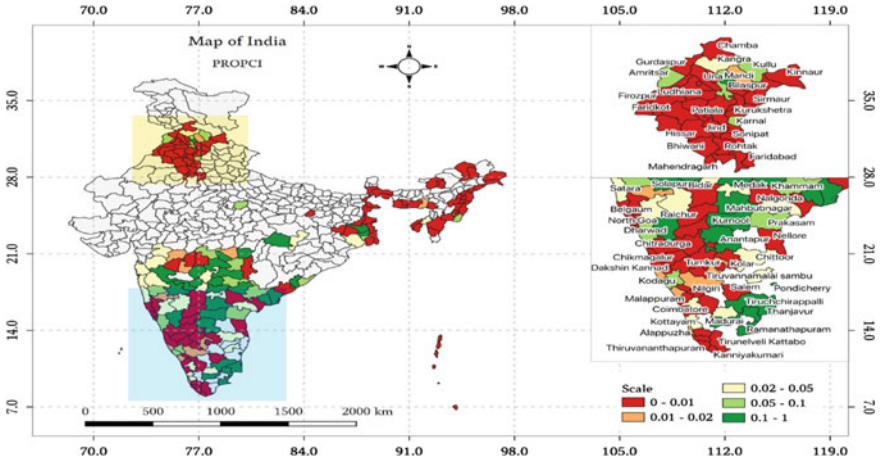


Fig. 1 District-wise distribution of crop insurance. *Source* Authors' own calculations; *Notes* The data on crop insurance is available from the NSSO 70th round (January–December 2013) survey on 'Situation Assessment Survey of Agricultural Households, January–December 2013'

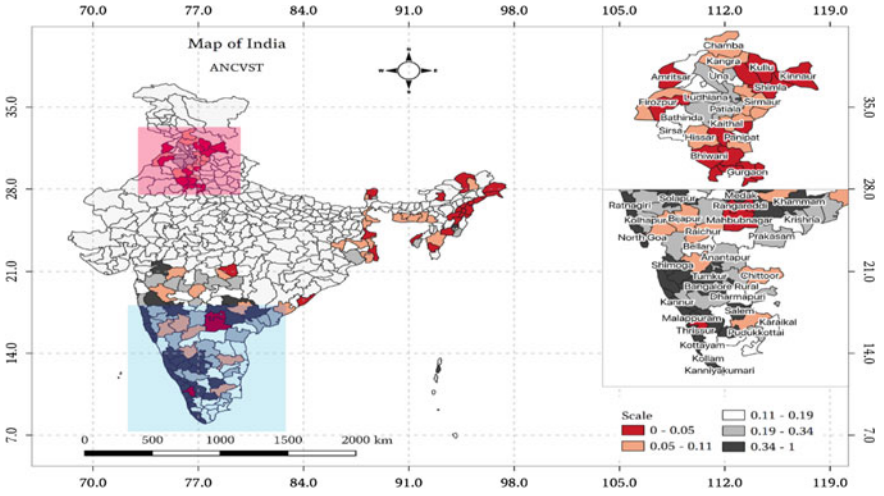


Fig. 2 District-wise distribution of ANC visits. *Source* Authors' own calculations; *Notes* The data on ANC visits is available from the DLHS-4 data set and are for the women in their reproductive age (15–49 years) who were pregnant and/or gave birth during the survey period

district-level data on crop insurance adoption paired with individual-level data on health outcomes to assess the role of crop insurance on the health-seeking behaviour of women in their reproductive age.

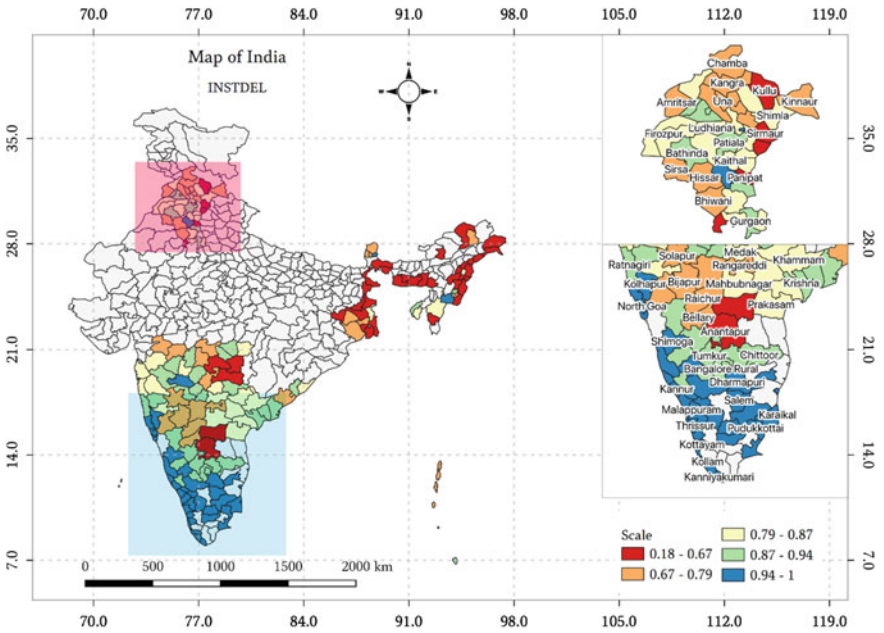


Fig. 3 District-wise distribution of institutional delivery. *Source* Authors' own calculations; *Notes* The data on ANC visits is available from the DLHS-4 data set and are for the women in their reproductive age (15–49 years) who were pregnant and/or gave birth during the survey period

In addition, we also conduct a primary survey to examine how the government's income support programme can impact the health-seeking practices of households, women, and children, and their food security.

2 Data

We use both secondary and primary data analysis to ascertain the effect of crop insurance adoption on women's health-seeking behaviour during pregnancy and household and child nutritional statuses.

2.1 Secondary Data

To conduct the secondary data analysis, we combine data from NSSO (70th round) and District Level Household and Facility Survey (DLHS-4) to empirically analyse

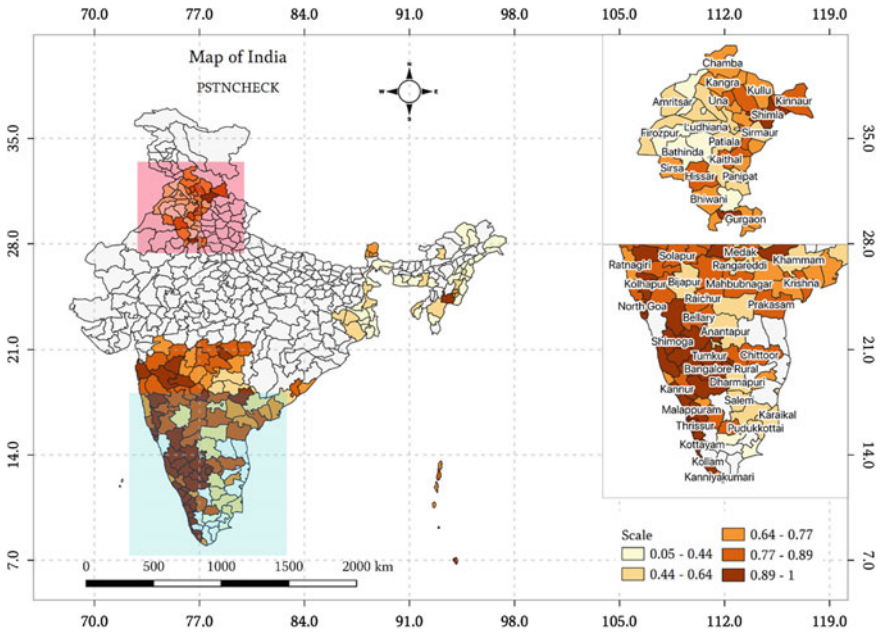


Fig. 4 District-wise distribution of postnatal checkup. *Source* Authors' own calculations; *Notes* The data on ANC visits is available from the DLHS-4 data set and are for the women in their reproductive age (15–49 years) who were pregnant and/or gave birth during the survey period

the effect of crop insurance on women's healthcare-seeking practices and child nutrition. The NSSO 70th round (January–December 2013) survey on 'Situation Assessment Survey of Agricultural Households, January–December 2013' has detailed information on households' financial assets. On the other hand, DLHS-4 was conducted during 2012–13.[1] However, since we are using two separate datasets from two different surveys, we cannot match information at the individual level. The only common identifier between the datasets is the match at the district level. We use crop insurance information from the NSSO data aggregated at the district level, and women healthcare use information and child nutritional status from DLHS-4 at the individual level. Finally, we merge the two datasets using district identifiers to obtain comprehensive data containing individuals matched across different districts giving us a complex multilevel structure.

[1] Both these databases have similar rural and urban samples with NSSO having 56% of samples from rural areas and 44% from urban areas. On the other hand, for DLHS there are 58 and 42, respectively.

2.1.1 Variables

Using DLHS-4 and NSSO 70th round of data, we define our variables for the secondary data analysis. The outcome variables of interest are women's health-seeking indicators, defined only for women in their reproductive age (15–49 years) who were pregnant and/or gave birth during the survey period. Child nutritional status is defined for children under 2 years old.

The outcome variables on women's health-seeking behaviours are defined based on whether pregnant women's sought prenatal care, institutional delivery, and postnatal care. We use various indicators of antenatal care, such as whether a woman sought antenatal care (ANC), whether ANC was received during the first or second trimester (ANCFTRIM, ANCSTRIM), whether the woman received at least 4 or 8 ANC (AT4ANC, AT8ANC) if a woman had received iron and folic acid supplements (IFA), whether taken tetanus toxoid injection and at least three injections (TT, AT3TTINJ), if the woman went for any treatment due to health problem during pregnancy (TRTHP), if the woman sought delivery in an institutional setting and a private healthcare facility (INSTDEL, PVTINST), and finally, whether the woman sought postnatal care in a private healthcare set-up (PNATALPVT). To measure the nutritional status of children weight-for-age z-score is used. A child is defined as being severely or moderately underweight (UNDERWT) if the weight-for-age z-score is below minus 2 (−2.0) standard deviations (SD) below the mean on the WHO Child Growth Standards, and as being severely underweight (SEVUNDERWT) if the weight-for-age z-score is below minus 3 (−3.0) standard deviations (SD) below the mean on the WHO Child Growth Standards. A detailed description of these outcome variables is presented in Table 1.

Crop insurance is the independent variable of interest in women's health-seeking behaviour analysis and child nutritional analysis. To define the primary independent variable, we consider whether rural households had crop insurance either because of crop insurance linked with an agricultural loan or crop insurance bought voluntarily. Therefore, we define CINS = 1 if a household has crop insurance and 0 if no crop insurance. Given the nature of our data, we converted crop insurance information into district-level constructs for our empirical analysis. We define PDCI as the proportion of households in a district having crop insurance during 2012–13.

Following the literature (Woldemicael & Tenkorang, 2010; Bhuiya et al., 2018), we include several women, household, and district-level indicators in analysing women's healthcare use. For instance, we include women's age in years (MAGE), women's level of education (below primary, primary, middle years of schooling, secondary, higher secondary, college education, and above. Illiterate being the reference group), women's employment status (EMP), birth order (1, 2, and 3 or more). Further, we include whether the women received financial assistance through Janani Suraksha Yojana (JSY). A variable (DIAGCHRONIC) captured whether any household member sought a diagnosis for a chronic illness. This variable will help us understand the health-seeking practices of the household. Next, we include the religion of the household head (Hindu and Muslim) and caste (scheduled tribes, scheduled caste, and other backward classes). We capture the economic status of the household

Table 1 Variable definitions and descriptive statistics (secondary data) outcome variables

Outcome variables	Definitions	Mean	SD
Women (15–49 years of age)			
ANC	=1 if a woman received any antenatal care, else 0	0.838	0.368
ANCFITRIM	=1 if a woman received ANC during the first trimester, else 0	0.593	0.491
ANCSTRIM	=1 if a woman received ANC during the second trimester, else 0	0.125	0.331
AT4ANC	=1 if a woman received at least 4 ANC visits, else 0	0.504	0.5
AT8ANC	=1 if a woman received at least 8 ANC visits, else 0	0.149	0.356
IFA	=1 if a woman received IFA bottle or tablet, else 0	0.651	0.477
TT	=1 if received TT injection, else 0	0.799	0.4
AT3TTINJ	=1 if received at least 3 TT injections, else 0	0.173	0.378
TRTDP	=1 if any treatment for health problem during last pregnancy, else 0	0.214	0.41
INSTDEL	=1 if institutional delivery, else 0	0.791	0.407
PVTINST	=1 if delivery in private institution, else 0	0.281	0.45
PNATALPVT	=1 if a woman sought post-natal care in a private institution, 0 otherwise	0.22	0.414
No. of observations		35,226	
Children (0–2 years of age)			
UNDERWT	If the weight-for-age z-score is below minus 2 (−2.0) standard deviations (SD) below the mean on the WHO Child Growth Standards	0.181	0.385
SEVUNDERWT	If the weight-for-age z-score is below minus 3 (−3.0) standard deviations (SD) below the mean on the WHO Child Growth Standards	0.054	0.228
No. of observations		12,470	

Source Authors' own definitions and calculations; *Notes* All the outcome variables are obtained from the DLHS-4 data set for women in their reproductive age (15–49 years) who were pregnant and/or gave birth during the survey period and for children in the age group of 0–2 years

through several indicators. We include below-poverty line (BPL) cards as a proxy for below or above-poverty-line households.

Further, we include ownership of pucca house (PUCCA), use of LPG and electricity as a cooking fuel (FUEL), having electricity (ELEC), and ownership of land (OWNSLAND) as other measures of the economic status of the households. Finally, we also include a variable that captures the wealth index, divided into quintiles, computed based on different asset information from the DLHS-4 survey. Households were categorized from the poorest to the wealthiest groups based on the quintiles, where quintile five represents the wealthiest group (HHWEALTHQ). Moreover, we include FAMSZ as an indicator of the size of the household and the husband's level of education (below primary and primary, middle years of schooling, secondary, higher secondary, college education, and above) as additional control variables in our analysis.

We also include several district-level indicators as well. For instance, PROPHFAR indicates the district-wise proportion of villages with distance to health facility being far away. Moreover, we define a variable DISTBANK: the number of bank branches to capture the financial access.[2]

In the child nutritional status analysis, we use child and household-related covariates from the DLHS-4 CAB data, such as child age in months (CAGE), child gender (CFEMALE), highest education of household members (HHHIGHESTEDU), the religion of household head (HINDU, MUSLIM), and size of the household (FAMSZ). We define a few household living condition indicators following WHO standards; as improved drinking water (IMPWATER); improved sanitation (IMPSANI), modern fuels (FUEL), including LPG, electricity, and biogas; whether the household owns a pucca house (PUCCA), whether the household has improved and clean sources of lightning (ELEC), such as electricity and solar; whether owns the house (OWNER), whether holds land (OWNSLAND); and household wealth status in quintiles (HHWEALTHQ). Finally, we add district-level information on the number of bank branches (DISTBANK). Table 2 provides a detailed description of all the variables used in both analyses.

The data for NSSO covered 634 districts from all the states in India. However, DLHS-4 was conducted in 275 districts. After combining these two databases, restricting our sample to the rural population, and deleting missing values on key indicators, our final women data sample consists of 35,226 observations from 198 districts. The child data sample consists of 12,470 observations from 197 districts.

2.2 Primary Data

We also conducted a pilot study in two districts of Bihar, Rohtas (199 households) and Nawada (201 households). The choice of the districts is based on specific criteria. We

[2] This data is obtained from RBI website and we consider the district level branches for the month of December 2012.

Table 2 Variable definitions and descriptive statistics (secondary data) independent variables

Variables	Definition	Mean	Std.
PDCI	District level proportion of crop insurance	0.04	0.08
Women (15–49 years of age)			
AGE	Women's age in years (15–49 years)	26.61	5.07
MPRIMEDUC	=1 if women had below primary and primary education, else 0	0.18	0.38
MMIDEDUC	=1 if women completed middle school education, else 0	0.19	0.39
MSECEDUC	=1 if women completed secondary education, else 0	0.20	0.40
MHSECEDUC	=1 if women completed higher secondary education, else 0	0.12	0.32
MCOLPEDUC	=1 if women completed college education or above, else 0	0.07	0.26
BO	Birth Order (0–12)	2.12	1.24
EMP	=1 if women is currently employed, else 0	0.19	0.39
JSY	=1 if received financial assistance under JSY, else 0	0.21	0.41
DIAGCHRONIC	=1 if any household member sought diagnosis for chronic illnesses, else 0	0.23	0.42
HINDU	=1 if the religion of the household head is Hindu, else 0	0.70	0.46
MUSLIM	=1 if religion of the household head is Muslim, else 0	0.06	0.23
SC	=1 if household head belongs to SC, else 0	0.28	0.45
ST	=1 if household head belongs to ST, else 0	0.21	0.41
OBC	=1 if household head belongs to OBS, else 0	0.34	0.47
BPL	=1 if the household is Below Poverty Line, else 0	0.39	0.49
PUCCA	=1 if the household has a pucca house, else 0	0.35	0.46
FUEL	=1 if the household uses LPG and Electricity as cooking fuel, else 0	0.25	0.43
ELEC	=1 if the household has electricity, else 0	0.99	0.11
OWNSLAND	=1 if the household owns land, else 0	0.49	0.50
HWEALTHQ	Household wealth quintile, 1 = poorest, and 5 = wealthiest	3.18	1.36
FAMSZ	Family Size	6.26	2.47
HPRIMEDUC	=1 if husband had below primary and primary education, else 0	0.17	0.37
HMIDEDUC	=1 if husband completed middle school education, else 0	0.19	0.393
HSECEDUC	=1 if husband completed secondary education, else 0	0.21	0.41
HHSECEDUC	=1 if husband completed higher secondary education, else 0	0.14	0.35
HCOLPEDUC	=1 if husband completed college education or above, else 0	0.09	0.29
PROPHFFAR	The proportion of health institutions far away from home	0.04	0.09
DISTBANK	District proportion of bank branches	180.9	190

(continued)

Table 2 (continued)

Variables	Definition	Mean	Std.
No. of observations		35,226	
Children (0–2 years of age)			
CAGE	Child age in months	17.24	7.134
CFEMALE	=1 if gender of the child is female, 0 otherwise	0.48	0.49
HHHIGHESTEDU	Highest education of household members	3.96	1.43
IMPWATER	=1 if improved drinking water, else 0	0.89	0.31
IMPSANI	=1 if improved sanitation, 0 otherwise	0.48	0.49
OWNER	=1 if the household owns the house, else 0	0.94	0.24
No. of observations		12,470	

Source Authors' own definitions and calculations; *Notes* CAGE—Min: 0 and Max: 24 months; HHHIGHESTEDU—Min: 1 and Max: 6;

aimed to collect data from different regions of Bihar to get variations in crop insurance adoptions. Hence, we selected Nawada and Rohtas. Nawada is a drought-prone area of Bihar, while Rohtas is one of the fertile districts of the State. Crop insurance uptake is likely to vary between drought-prone and fertile regions of the States, ensuring variations in the sample. To generate a random sample, two blocks were selected randomly from each district, Nawada, and Akbarpur for Nawada district; and Sasaram and Shivsgar for Rohtas. Finally, from each block, five villages were randomly selected. On average, twenty households were selected from each village for a face-to-face interview. However, due to sparse information on crop insurance (such as Pradhan Mantri Fasal Bima Yojna and Bihar Rajya Fasal Sahayta Yojana) in Bihar, we had to rely on another agricultural scheme, Pradhan Mantri Krishi Samman Nidhi (PMKSN), which has a relatively higher penetration. Of the 400 households, only 37 reported having crop insurance, while 373 households were aware of PMKSN, and 224 benefitted from it. PMKSN is a cash benefit programme where the government provides minimum income support (Rs. 6000 per year) to small and marginal farmers. We divide the households as PMKSN beneficiaries and non-beneficiary samples. The duration of primary data collection was between October 20 and October 29, 2021. The Institute of Human Development, New Delhi, helped us refine the questionnaire through several rounds of discussion, conducting the field survey, and tabulating the raw data.

Using the raw data, we define variables for our analysis. The final sample of all individuals consists of 2,429 observations. In the primary survey, we also collected information on women aged 15–49 years who were pregnant or gave birth in the last 5 years. We selected women's last pregnancy to capture health-seeking behaviour during pregnancy. Hence, the women's file consists of 394 observations. Finally, we also use child health-related information from the young children's (child aged 0–5 years) health roster. The child file has 554 observations.

2.2.1 Variables

The primary data consists of a vast number of variables. To capture the effect of PMKSN on different household-level health and food and nutrition security parameters, we define a variable, SEEKHC, which captures whether any member of the household sought treatment during the last 12 months from the survey; if sought treatment, whether opted for immediate treatment, IMMTRT, and treatment in private (PVTHC) versus public (PUBHC) healthcare facility. Also, we identified whether treatment was sought for an adult male, female, or children (both male and female). Furthermore, we use some indicators of food and nutrition security, such as whether the household had at least three meals per day (ADQMEALSGEQ3); household got enough quantity and variety of food (ENOUGH); whether the household was worried about food shortages in the last 1 year (WORRIED); and whether any adult member of the household was required to reduce or skip their meals, and the frequency of skipping meals (SKIPPED, FREQSKIPPED).

From the women file, we define women's healthcare seeking variables as ANC equals to one is the woman sought antenatal care during her last pregnancy; the number of ANC visits (NANC), whether sought ANC during the first trimester (ANCFTRIM) or second trimester (ANCSTRIM); whether the woman received at least three tetanus toxoid injections and at least 100 iron and folic acid tablets during her last pregnancy (TTINJAT3 and IFAAT100). We also define variables for safe delivery as to whether the woman opted for institutional delivery (INSTDEL) and delivery in public or private set-up (PUBDEL or PVTDEL). We also used a variable to capture whether a woman went for an immediate (within 24 h) postnatal checkup after delivery (WIMMPOSTNATAL).

From the child file, we define child health-seeking and nutrition variables as to whether the child got immediate (within 24 h) care after birth (IMMPOSTNATAL); or opted for any immunization (IMMUNIZATION); whether received full immunization (FULL_IMMUNIZATION); and was given breast milk at least within 2 h of birth (IMMBREASTFEEDING). A detailed description of all the variables is provided in Table 3.

3 Empirical Analysis

In this section, we present the results from our empirical analysis to identify the effect of crop insurance on women's health-seeking behaviour and children's nutrition from the secondary data; and the impact of PMKSN on household's health-seeking behaviour, and food and nutritional security; pregnant women's healthcare seeking behaviour; and children's health care and nutrition.

Table 3 Variable definitions and descriptive statistics (primary data) household and individual characteristics

Variable	Variable definition	Mean	SD
GENCASTE	=1 if household belongs to the general caste, 0 otherwise	0.31	0.46
HHPOOR	=1 if a household has Antodaya, Priority Household, or BPL card, 0 otherwise	0.57	0.50
MARGINAL	=1 if household holds < 2.5 acres of land, 0 otherwise	0.81	0.39
SMALL	=1 if household holds 2.5 to < 5 acres of land, 0 otherwise	0.07	0.26
MEDIUM	=1 if household holds ≥ 5 acres of land, 0 otherwise	0.12	0.32
FAMSZ	Number of household members	6.86	2.48
HI	=1 if the household is covered by health insurance, 0 otherwise	0.05	0.23
PUBHI	=1 if the household is covered by public health insurance, 0 otherwise	0.02	0.13
PVTHI	=1 if the household is covered by private health insurance, 0 otherwise	0.01	0.10
KITCHEN	=1 if the household has a separate kitchen or cooking area, else 0	0.54	0.50
TOILET	=1 if the household has flush toilet, including septic tank, else 0	0.47	0.50
FUEL	=1 if the source of energy mainly used is LPG, 0 otherwise	0.30	0.46
CONSEXP	Average monthly household consumption expenditure on food and non-food items	8916.96	9976.69
LNCONSEXP	Log of CONSEXP	8.90	0.53
BANKAC	=1 if any member of the household has a bank account, else 0	0.95	0.21
AWAGRIPOLICY	=1 if the household is aware of public schemes in agriculture, else 0	0.99	0.12
BFAGRIPOLICY	=1 if a household has benefitted from any public schemes in agriculture, else 0	0.66	0.47

(continued)

Table 3 (continued)

Variable	Variable definition	Mean	SD
AWPMKSN	=1 if a household is aware of Pradhan Mantri Kisan Samman Nidhi (PMKSN) in agriculture, else 0	0.94	0.24
BFPMKSN	=1 if household has benefitted from PMKSN, else 0	0.58	0.49
AWMATPOLICY	=1 if a household is aware of maternity benefit schemes, else 0	0.89	0.31
BFMATPOLICY	=1 if household has benefitted from any maternity benefit schemes, else 0	0.47	0.50
CROPAREA	Area of crop production in acres (in last 1 year)	1.32	1.20
CROPPROD	Total crop production in quintals (in last 1 year)	14.62	14.06
OWNCONSUMP	Percentage of crop produced for household's consumption (in last 1 year)	68.09	33.88
CROPLOSS	=1 if the household has experienced any crop loss during the last cropping season, 0 otherwise	0.39	0.49
CINS	=1 if the crop was insured, 0 otherwise	0.10	0.29
AGEYRS	Age of individuals in year	23.89	19.78
FEMALE	=1 if an individual is female, 0 if male	0.49	0.50
MARRIED	=1 if an individual is married, 0 otherwise	0.52	0.50
EDU	=1 if an individual has completed some schooling (below primary to graduation or higher), 0 otherwise	0.58	0.49
EMP	=1 if an individual is employed, else 0	0.26	0.44
SELFEMP	=1 if an individual is self-employed, else 0	0.15	0.36
CASUALEMP	=1 if an individual is employed in casual employment, else 0	0.04	0.20
SALARIEDEMP	=1 if an individual is employed as a salaried employer, else 0	0.06	0.24

(continued)

Table 3 (continued)

Variable	Variable definition	Mean	SD
SCH	=1 if a 3–14-year-old child is attending school, 0 otherwise	0.84	0.37
SEEKHC	=1 if any member in the household sought health care in the last 12 months, 0 otherwise	0.80	0.40
IMMTRT	=1 if the household member sought immediate care (i.e. within 24 h of symptoms), else 0	0.45	0.50
PVTHC	=1 if the member sought care in a private healthcare facility, 0 otherwise	0.61	0.49
PUBHC	=1 if the member sought care in a public healthcare facility, 0 otherwise	0.17	0.38
TRTADULTMALE	=1 if an adult male member sought treatment, else 0	0.17	0.37
TRTADULTFEMALE	=1 if an adult female member sought treatment, else 0	0.38	0.49
TRTCHILDMALE	=1 if an child male member sought treatment, else 0	0.10	0.30
TRTCHILDFEMALE	=1 if an child female member sought treatment, else 0	0.18	0.39
ADQMEALSGEQ3	=1 if the household had adequate meals (at least 3) per day, else 0	0.66	0.47
FOODENOUGH	=1 if the household got enough quantity and variety of food in the past 1 year, else 0	0.26	0.44
WORRIED	=1 if household worried whether they would face food shortages, else 0	0.87	0.33
SKIPPED	=1 if any adult member in the household is ever required to reduce their food or skip meals, 0 otherwise	0.10	0.30
FREQSKIPPED	=if a household adult member skipped meal almost every month, else 0	0.01	0.12
No. of observations		2,429	

Source Author's own definitions and calculations; *Notes* FAMSZ—Min: 1 and Max: 17; CONSEXP—Min: 2050 and Max: 1,03,000; CROPAREA—Min: 0.03 acres and Max: 10 acres; CROPPROD—Min: 0.08 and Max: 98 quintals; AGEYRS—Min: 0 and Max: 99

3.1 Summary Statistics

Tables 1, 2, 3, 4, and 5 provide detailed descriptive statistics for all the outcomes and independent variables from secondary and primary data analysis. Table 1 shows that around 84% of the women received some antenatal care (ANC) during the survey period. While a majority of the women (close to 59%) received such care during the first trimester (ANFTRIM), almost 12.5% received ANC care during their second trimester (ANCSTRIM). Nearly 50% of women went for at least 4 ANC visits, and 15% went for 8 ANC visits. We also observe that around 65% of women took some iron and folic acid tablets (IFA). Close to 80% of women received tetanus toxoid injections during their pregnancy. However, only 17% received at least three TT injections (AT3TTINJ). In terms of safe delivery, around 80% of women had institutional delivery (INSTDEL), out of which close to 28% happened in private facilities (PVTINST). Finally, for postnatal care, close to 22% of women received postnatal care from a private healthcare facility (PNATALPVT). Child nutrition indicators in Table 1 show that nearly 18% of children are underweight, and 5% of children are severely malnourished.

Table 2 shows that around 4% of the households had crop insurance during the survey period. The average age of women in the sample is 26 years, nearly 18% of women completed below primary and primary education, and almost 7% college education, almost 19% of women had some form of employment, 21% received some form of maternity benefits (like JSY), nearly 40% of households had below poverty line cards, and 49% owned some form of land.

Tables 3, 4, and 5 report the summary statistics from the primary data. In Table 3, the individual sample shows nearly 31% belong to the general caste category, 57% are poor, have Antodaya, BPL, or PH card, 81% of households were marginal, 7% small, and 12% were medium farming households. Only 5% had only some form of health insurance. Nearly 94% were aware of PMKSN, while 58% benefitted. Almost 40% of households experienced crop loss, and 10% had crop insurance. The average age of individuals in the full sample is 24 years, with 49% of females and almost 58% of individuals have completed some schooling. Nearly 80% of individuals sought health care and 40% sought immediate health care. Sixty-six per cent of the household had adequate daily meals, 26% informed of having enough quantity and variety of food in the past year. However, 87% of households reported being worried about food shortages, and 10% of adults skipped meals.

The women sample in Table 4 shows that the average age of women is 27 years (Min 16–Max 48 years), with 72% of women having completed some form of schooling and 4% of women had some employment. Nearly 36% of women sought treatment for healthcare problems during their last pregnancy, and 52% received maternity benefits from some government schemes. Almost 88% of women received ANC, 50% of women sought ANC during their first trimester, 37% during their second trimester, and nearly 4% in their third trimester. Eleven per cent of women had at least three tetanus toxoid injections, and 21% had consumed at least 100 iron

Table 4 Variable definitions and descriptive statistics (primary data) women (15–49 years) characteristics

Variable	Variable definition	Mean	SD
WAGEYRS	Age in years on women	27.26	5.10
WMARRIED	=1 if the woman is married, 0 otherwise	0.98	0.14
WEDU	=1 if the woman has completed some schooling (below primary to graduation or higher), 0 otherwise	0.72	0.45
WEMP	=1 if the woman is employed, else 0	0.04	0.19
WSELFEMP	=1 if the woman is self-employed, else 0	0.02	0.15
WCASUALEMP	=1 if the woman is employed in casual employment, else 0	0.01	0.07
WSALARIEDEMP	=1 if the woman is employed as a salaried employer, else 0	0.01	0.10
TRTHP	=1 if the woman sought health care due to health problems during her last pregnancy, else 0	0.36	0.48
MATERNBENF	=1 if the woman received any maternity benefits during her last pregnancy, 0 otherwise	0.52	0.50
ANC	=1 if the woman received antenatal care (ANC) during her pregnancy, else 0	0.88	0.33
NANC	Number of antenatal visits	3.58	1.54
ANCFTRIM	=1 if ANC sought during the first trimester of pregnancy, else 0	0.50	0.50
ANCSTRIM	=1 if ANC sought during the second trimester of pregnancy, else 0	0.37	0.48
ANCTTRIM	=1 if ANC sought during the third trimester of pregnancy, else 0	0.04	0.20
TTINJAT3	=1 if the woman had taken at least three Tetanus Toxoid injections during her last pregnancy, else 0	0.11	0.31
IFAAT100	=1 if the woman had at least 100 iron and folic acid tablet during her last pregnancy, else 0	0.21	0.41
INSTDEL	=1 if the woman went for institutional delivery, 0 otherwise	0.92	0.28
PUBDEL	=1 if the woman went for institutional delivery in a public hospital, 0 otherwise	0.52	0.50

(continued)

Table 4 (continued)

Variable	Variable definition	Mean	SD
PVTDEL	=1 if the woman went for institutional delivery in a private hospital, 0 otherwise	0.39	0.49
NUTRISUP	=1 if the woman received any nutritional supplement from anganwadi centre during her last pregnancy, else 0	0.54	0.50
WIMMPOSTNATAL	=1 if the woman received post-natal care immediately (within 24 h) of child birth, 0 otherwise	0.45	0.50
No. of observations		394	

Source Author's own definitions and calculations; *Notes* WAGEYRS—Min: 16 and Max: 48; NANC—Min: 0 and Max: 16

Table 5 Variable definitions and descriptive statistics (primary data) children (0–5 years) characteristics

Variable	Variable definition	Mean	SD
CAGE	Age of a child in months	29.86	18.15
CFEMALE	=1 if the child is female, else 0	0.52	0.50
BOC	Birth order of the child	2.09	1.09
BWEIGHT	Birth weight of the child in Kgs	2.74	0.52
IMMPOSTNATAL	=1 if the child received immediate post-natal care (within 24 h of birth), else 0	0.71	0.45
IMMUNIZATION	=1 if the child received any immunization, 0 otherwise	0.99	0.11
FULL_IMMUNIZATION	=1 if the child received full immunization, else 0	0.83	0.37
IMMBREASTFEEDING	=1 if child was breastfed immediately (within 2 h) after birth, else 0	0.80	0.40
No. of observations		554	

Source Author's own definitions and calculations; *Notes* CAGE—Min: 0 and Max: 60; BOC: Min: 0 and Max: 6; BWEIGHT- Max: 5.20 kgs

and folic tablets. Ninety-two per cent had institutional delivery, with public 52% and private 39%. Almost 45% of women received some form of postnatal care.

Table 5 presents summary statistics for children in the age group of 0–5 years. The average age of children is 30 months. Fifty-two of the children are female. The average birth weight is 2.74 kgs. Seventy-one per cent of children received immediate postnatal care. Nearly 83% received full immunization. Almost 80% of children were breastfed immediately after birth.

3.2 Empirical Strategy—Secondary Data

Due to the hierarchical structure of the sample, we use multilevel regression analysis to identify the effect of crop insurance adoption on healthcare-seeking practices by women of their reproductive age. In our data set, the common identification unit in the district. Therefore, we assume that individuals are nested within districts, and hence, we use a multilevel analysis for the empirical estimation. As the outcome variables of interest are binary, we use a multilevel logistic regression model.

The empirical model can be written as,

$$\text{Logit}\left[P\left(Y_{ij}=1|X_{ij},Z_j,u_j\right)\right]=\alpha+\beta_x X_{ij}+\beta_z Z_j+u_{j,}\quad u_j\sim N\left(0,\sigma^2\right)$$

where Y_{ij} is the binary outcome variable of interest. The individuals are indexed as $i=1,\ldots,n$ and districts are denoted by $j=1,\ldots,d$. The model includes vectors of individual-level covariates X_{ij} as well as district-level covariates Z_j. u_j are the random effects, which summarize the unobserved factors at the district level affecting individual outcomes. Therefore, the standard deviation σ measures between-district variations in response that are not accounted for by simple logistic regression.

The first step in the multilevel model analysis is to examine if our sample justifies using random effects at the district level. We present the results from the random intercept-only model in Table 6. There was a significant variation in healthcare-seeking behaviour across the districts. Based on the Intra-class correlation coefficients (ICC), we find that 30% of the total variation in ANC use is attributable to the differences across districts. Similarly, nearly 55% of the variance in the institutional delivery and 40% of the variance in the postnatal care in a private facility can be attributed to differences across districts. The ICC for other measures of health-seeking behaviours in our analysis is also relatively high, indicating the justification for using a multilevel model in our empirical research.

Next, we present the results from the final model by including both individual and district-level control variables. Both fixed and random effects are included. The primary variable of interest is the proportion of district-wise crop insurance (PDCI). Table 7 shows the odds ratios for PDCI from the multilevel logit analysis. After controlling for individual-level and district-level variables in the multilevel model, we observe that PDCI is significant for most health-seeking behaviour measures. We find that the estimated coefficient of PDCI is positive and statistically significant for ANC. The odds of choosing ANC increase by almost 87% with PDCI. The finding indicates that the likelihood of seeking ANC increases if the woman belongs to a district with higher crop insurance penetration. We also observe that although there is no evidence that higher crop insurance adoption increases the likelihood of ANC utilization in the first trimester of the pregnancy, however, it positively and significantly affects antenatal care in the second trimester (OR 2.33). Similarly, the estimated coefficients of both AT4ANC (OR: 5.08) and AT8ANC (OR: 5.47) are positive and statistically significant. Therefore, we find a higher probability of ANC visits with crop insurance adoption.

Table 6 Intraclass correlation coefficient for the random intercept model

Variables	ICC
ANC	0.303
ANCFTRIM	0.242
ANCSTRIM	0.103
ANCTTRIM	0.316
AT4ANC	0.428
AT8ANC	0.437
IFA	0.299
AT100IFA	0.222
TT	0.3675
AT3TTINJ	0.229
TRTHP	0.126
INSTDEL	0.545
PVTINST	0.263
PNATALPVT	0.395
No. of observations	35,226

Source Authors' own calculations

Furthermore, we find that the likelihood of having IFA and at least three TT injections significantly increase with PDCI. The odds ratios are 2.65 and 2.31, respectively. For safe delivery practices, our regression results suggest that the likelihood of institutional delivery (OR: 2.76) and delivery in a private health facility (OR: 1.09) increase with PDCI. Finally, we find that the estimated coefficient of PNATALPVT is also positive and statistically significant, indicating a higher tendency of seeking postnatal care from private healthcare facilities by women from districts with higher crop insurance adoption. The odds ratio of PNATALPVT is 2.92.

Therefore, the findings imply that after controlling for individual and district-level heterogeneities, including financial access, social security benefits, and distance to the health facility, women in districts with higher crop insurance adoption are likely to seek more health care during their pregnancy compared to women in other districts. Thus, our estimation results provide evidence that crop insurance adoption improves women's health-seeking behaviour in their reproductive age. Moreover, crop insurance also removes the barriers to accessing institutional delivery.[3]

The effect of PDCI on children being underweight and severely underweight, although positive, is not statistically significant (See Table 8). Hence, using the data, no conclusive results can be obtained on the effect of PDCI on children's nutritional status.

[3] Results on other control variables in the model are presented in Table 12 of the Appendix.

Table 7 Odds ratios from fixed-effect estimates of PDCI from the multilevel regression for women 15–49 years

Outcome variables	Independent variable: PDCI	Likelihood ratio test
ANC	1.872*** (3.659)	1981.18***
ANCFTRIM	1.987 (1.300)	2071.46***
ANCSTRIM	2.331* (1.087)	693.07***
AT4ANC	5.076* (4.944)	4422.35**
AT8ANC	5.469** (4.155)	2641.95***
IFA	2.650*** (0.922)	2952.82***
TT	1.818 (1.057)	1913.35***
AT3TT	2.311*** (1.594)	2480.84***
TRTHP	2.091 (1.474)	975.32***
INSDEL	2.759*** (3.479)	1628***
PVTINST	1.088** (1.942)	2172.32***
PNATPVT	2.919** (1.265)	1981.4***
No. of observations	35,226	

Source Authors' own calculations; *Notes* ***, **, and * denote significance at 1, 5, and 10%, respectively. Figures in parentheses are standard errors. The likelihood-ratio test compares the model with a one-level ordinary logistic regression

Table 8 Odds ratios from fixed-effect estimates of PDCI from the multilevel regression for children 0–5 years

Independent variable	UNDERWT	SEVUNDERWT
PDCI	2.006 (0.939)	1.873 (1.050)
Likelihood ratio test	521.08***	292.20***
Observations	12,470	12,470

Source Authors' own calculations; *Notes* ***, **, and * denote significance at 1, 5, and 10%, respectively. Figures in parentheses are standard errors. The likelihood-ratio test compares the model with a one-level ordinary logistic regression

3.3 Primary Data Analysis

Tables 9, 10, and 11 show the two-sample t-test results on the outcome variables of interest from the primary survey. The samples are divided between households who have been benefitted (PMKSN = 1) from PMKSN and those who have not been benefitted (PMKSN = 0) from it. Members in the PMKSN beneficiary households sought immediate care, more care in private facilities, and higher care-seeking for both adult men and women (see Table 9). PMKSN beneficiaries also reported having adequate meals and more quantity and variety of food. They also skipped fewer meals. From the women sample in Table 10, PMKSN beneficiaries received higher ANC, especially during their first trimester of pregnancy. Children in PMKSN beneficiary households received higher immediate postnatal care (Table 11).

4 Conclusion

Understanding the role of crop insurance as a risk-mitigating strategy for poor farmers is essential. Crop insurance can help enhance the farm output and improve households' food and nutrition security and healthcare utilization by women and children.

Our study uses district-level variations in crop insurance adoption to find its effect on healthcare utilization by pregnant women in their reproductive age and children's nutritional status. We find that crop insurance adoption positively impacts prenatal care, institutional delivery, and postnatal care. We find that crop insurance leads to women seeking more ANC visits. Women belonging to districts with higher crop insurance also preferred institutional delivery. Women in these districts are more likely to choose private facilities for delivery and postnatal care than women in districts with low crop insurance exposure. Thus, the findings indicate that exposure to crop insurance allows households to opt for better health-seeking practices. However, we failed to find any statistically significant effect of crop insurance on child nutritional outcomes.

The primary data analysis also shows that government income support programme, like Pradhan Mantri Krishi Samman Nidhi, helps in increasing the treatment-seeking behaviour of households and provide food security. It also positively impacts pregnant women's early antenatal care-seeking behaviour and children's immediate care after birth.

Thus, our empirical research provides an understanding of the link between the crucial aspects of the agricultural households' decision-making, including risk mitigation through crop insurance and health-seeking and nutritional outcomes among women and children. Our primary analysis also provides a broader understanding of the role of the government's income support initiatives to the farmers and its linkage with households' health-seeking behaviour and nutritional outcomes, especially for women of their reproductive age and children below 5 years of age. A

Table 9 Two-sample T-test for the full sample of households and individuals (primary survey)

Variables	PMKSN = 0	PMKSN = 1	Diff. in means (p-values)
SEEKHC	0.760	0.829	−0.07*** (0.000)
IMMTRT	0.413	0.468	−0.054*** (0.008)
PVTHC	0.556	0.641	−0.085*** (0.000)
PUBHC	0.196	0.156	0.04** (0.010)
TRTADULTMALE	0.149	0.179	−0.03** (0.047)
TRTADULTFEMALE	0.360	0.393	−0.033* (0.096)
TRTCHILDMALE	0.105	0.092	0.013 (0.276)
TRTCHILDFEMALE	0.170	0.190	−0.019 (0.222)
HI	0.057	0.053	0.004 (0.669)
PVTHI	0.004	0.015	−0.011*** (0.008)
PUBHI	0.019	0.016	0.003 (0.555)
ADQMEALSGEQ3	0.627	0.677	−0.05** (0.011)
FOODENOUGH	0.234	0.286	−0.052*** (0.005)
WORRIED	0.881	0.868	0.013 (0.358)
SKIPPED	0.115	0.085	0.030** (0.014)
NSKIPPED	0.022	0.009	0.012** (0.011)
LNCONSEXP	8.885	8.912	−0.027 (0.218)
No. of observations	1,016	1,413	

Source Authors' own calculations; *Notes* ***, **, and * denote significance at 1, 5, and 10%, respectively. Figures in parentheses indicate p-values

Table 10 Two-sample T-test for pregnant women (15–49 years) (primary survey)

Variables	PMKSN = 0	PMKSN = 1	Diff. in means (p-values)
TRTHP	0.354	0.370	−0.016 (0.743)
ANC	0.846	0.902	−0.057 (0.100)
NANC	3.506	3.634	−0.128 (0.429)
ANC_FIRSTTRIM	0.451	0.543	−0.092* (0.078)
ANC_SECONDTRIM	0.390	0.361	0.030 (0.558)
TTINJAT3	0.098	0.112	−0.014 (0.646)
IFAAT100	0.201	0.211	−0.010 (0.807)
INSTDEL	0.919	0.916	0.003 (0.921)
PUBDEL	0.486	0.553	−0.068 (0.184)
PVTDEL	0.434	0.363	0.071 (0.157)
WIMMPOSTNATAL	0.483	0.421	0.061 (0.226)
No. of observations	177	218	

Source Authors' own calculations; *Notes* ***, **, and * denote significance at 1, 5, and 10%, respectively. Figures in parentheses indicate p-values

Table 11 Two-sample T-test for children (0–2 years) (primary survey)

Variables	PMKSN = 0	PMKSN = 1	Diff. in means (p-values)
IMMPOSTNATAL	0.664	0.753	−0.089** (0.022)
IMMUNIZATION	0.984	0.990	−0.006 (0.543)
FULL_IMMUNIZATION	0.834	0.833	0.001 (0.970)
IMMBREASTFEEDING	0.775	0.829	−0.055 (0.107)
BWEIGHT	2.754	2.723	0.031 (0.495)
No. of observation	254	300	

Source Authors' own calculations; *Notes* ***, **, and * denote significance at 1, 5, and 10%, respectively. Figures in parentheses indicate p-values

prudent strategy to improve household finance opportunities can play an essential role in mitigating the challenges arising due to health shocks—a timely and adequate crop insurance hedge against the income volatility linked to harvests. Crop failure can cause financial distress among these rural households leading to uncertainty and income constraints. In these circumstances, they will not be able to manage the expenses on healthcare-seeking, such as transportation costs and the opportunity cost of time. Therefore, crop insurance or other government income support can at least ensure some degree of certainty and provide income smoothing, which in turn can ensure better healthcare-seeking practices and nutritional outcomes, leading to household welfare.

However, policymakers often ignore these dynamics and look at policy in isolation. Many Indian farmers are small and illiterate and are, therefore, excluded from the formal financial service. As a result, these poor farmers are deprived of quality food intake and denied basic healthcare facilities. Health is a significant risk for rural households, especially pregnant women in rural India. Given the continuous rise in healthcare costs and ever-increasing out-of-pocket expenditure, mere health insurance coverage (primarily public health insurance) may not be enough, especially when the household is under distress due to crop failure. Crop insurance or income support in such circumstances can play a vital role in improving households' welfare parameters by addressing the needs of the vulnerable. Therefore, developing a comprehensive nationwide survey that captures multidimensional aspects of crop insurance, income support, and household welfare indicators in terms of healthcare-seeking and nutrition can provide additional insights and should be carried out in the future.

Acknowledgements First, we would like to thank Professor Mahendra Dev, Dr. A Ganesh Kumar, and Dr. Vijaylaxmi Pandey for selecting us for the SPANDAN grant and giving us this excellent opportunity to work on an exciting research topic. We are grateful to SPANDAN Grants for providing us with financial assistance. We are also thankful to Prof. Manoj Panda for his invaluable suggestions on our paper. His recommendations have tremendously helped us refine our work. We appreciate the comments and directions given by Professor Brinda Viswanathan during the interim presentation to improve our work. We are incredibly grateful to all the participants of the SPANDAN workshop held on February 14, 2020, and June 25, 202, for their insights. We would like to sincerely extend our gratitude towards Prof. Alakh Sharma, who provided invaluable mentorship to this project. We are also thankful to the entire team of IHD, especially Dr. Ashwini Kumar and Mr. BKN Singh, without whose guidance and help the primary survey would not have been possible. We would also like to thank Mr. Anurag Banerjee for his continuous research support.

Appendix

See Table A1.

Table A1 Odds ratios from fixed-effect estimates of other covariates from the multilevel regression for women 15–49 years

Variables	ANC	IFA	TT	INSTDEL	PVTIINST	PNATPVT
AGE	0.992**	0.993**	0.992**	1.011***	1.028***	1.028***
	(0.0040)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
MPRIMEDUC	1.511***	1.460***	1.595***	1.202***	1.323***	1.389***
	(0.079)	(0.062)	(0.077)	(0.059)	(0.071)	(0.082)
MMIDEDUC	1.789***	1.594***	1.924***	1.532***	1.393***	1.528***
	(0.105)	(0.071)	(0.102)	(0.085)	(0.074)	(0.089)
MSECEDUC	2.081***	1.938***	2.047***	1.980***	1.565***	1.719***
	(0.139)	(0.094)	(0.120)	(0.126)	(0.086)	(0.103)
MHSECEDUC	2.411***	2.001***	2.348***	2.782***	1.938***	2.109***
	(0.204)	(0.115)	(0.173)	(0.237)	(0.120)	(0.141)
MCOLPEDUC	2.666***	2.153***	2.312***	3.892***	2.435***	2.571***
	(0.301)	(0.158)	(0.219)	(0.495)	(0.183)	(0.202)
BO	0.916***	0.960***	0.941***	0.789***	0.790***	0.804***
	(0.015)	(0.013)	(0.014)	(0.013)	(0.014)	(0.015)
EMP	0.939	1.242***	1.010	0.714***	0.884***	0.948
	(0.045)	(0.044)	(0.043)	(0.031)	(0.035)	(0.038)
JSY	2.637***	1.681***	2.400***	4.463***	0.216***	0.249***
	(0.150)	(0.058)	(0.115)	(0.249)	(0.010)	(0.012)
DIAGCHRONIC	1.358***	1.286***	1.364***	1.0272	1.179***	1.259***
	(0.060)	(0.042)	(0.055)	(0.043)	(0.040)	(0.045)
HINDU	1.036	1.088	1.036	0.913	0.912	0.889*
	(0.072)	(0.056)	(0.065)	(0.063)	(0.052)	(0.054)
MUSLIM	0.923	0.994	0.918	0.709***	1.149*	1.040
	(0.098)	(0.077)	(0.087)	(0.070)	(0.094)	(0.089)
SC	0.896***	1.009	0.888**	0.865**	0.760***	0.780***
	(0.055)	(0.043)	(0.048)	(0.049)	(0.035)	(0.038)
ST	0.725***	0.876**	0.742***	0.712***	0.759***	0.764***
	(0.053)	(0.046)	(0.049)	(0.048)	(0.046)	(0.049)
OBC	0.933	0.905**	0.927	1.026	1.002	1.049
	(0.249)	(0.037)	(0.049)	(0.057)	(0.042)	(0.045)
BPL	1.053	1.062*	1.019	0.995	0.932**	1.001
	(0.044)	(0.033)	(0.038)	(0.039)	(0.033)	(0.038)
PUCCA	1.067	1.103***	1.075*	1.029	1.206***	1.215***
	(0.051)	(0.036)	(0.044)	(0.047)	(0.041)	(0.043)
FUEL	1.302***	1.080**	1.189***	1.641***	1.474***	1.429***
	(0.071)	(0.039)	(0.055)	(0.091)	(0.052)	(0.053)

(continued)

Table A1 (continued)

Variables	ANC	IFA	TT	INSTDEL	PVTIINST	PNATPVT
ELEC	0.923	1.102	0.970	1.564	0.989	0.945
	(0.382)	(0.381)	(0.366)	(0.661)	(0.375)	(0.374)
OWNSLAND	1.063	1.026	1.051	(0.958)	1.189***	1.194***
	(0.044)	(0.031)	(0.039)	(0.037)	(0.039)	(0.041)
HWEALTHQ: 2	1.047	0.998	1.066	0.746***	0.744***	0.797***
	(0.073)	(0.049)	(0.067)	(0.053)	(0.037)	(0.042)
HWEALTHQ: 3	0.953	0.987	0.942	0.746***	0.544***	0.588***
	(0.069)	(0.052)	(0.062)	(0.055)	(0.029)	(0.034)
HWEALTHQ: 4	0.965	0.898*	0.908	0.671***	0.435***	0.477***
	(0.080)	(0.054)	(0.067)	(0.055)	(0.028)	(0.032)
HWEALTHQ: 5	0.656***	0.725***	0.650***	0.504***	0.365***	0.399***
	(0.053)	(0.044)	(0.048)	(0.041)	(0.024)	(0.028)
FAMSZ	1.020**	0.992	1.013*	1.015**	0.977***	0.978***
	(0.008)	(0.005)	(0.007)	(0.007)	(0.006)	(0.006)
HPRIMEDUC	1.401***	1.407***	1.446***	1.043	0.993	1.056
	(0.079)	(0.064)	(0.074)	(0.055)	(0.057)	(0.066)
HMIDEDUC	1.480***	1.495***	1.517***	1.146**	1.146**	1.209***
	(0.088)	(0.070)	(0.082)	(0.065)	(0.064)	(0.074)
HSECEDUC	1.510***	1.391***	1.523***	1.229***	1.249***	1.203***
	(0.096)	(0.067)	(0.086)	(0.074)	(0.069)	(0.073)
HHSECEDUC	1.543***	1.338***	1.624***	1.152**	1.451***	1.469***
	(0.115)	(0.073)	(0.109)	(0.082)	(0.089)	(0.096)
HCOLPEDUC	1.812***	1.419***	1.836***	1.585***	1.875***	1.663***
	(0.173)	(0.092)	(0.152)	(0.152)	(0.129)	(0.121)
PROPHFFAR	0.005***	0.055***	0.009***	0.000***	0.009***	0.015***
	(0.005)	(0.045)	(0.008)	(0.000)	(0.009)	(0.015)
DISTBANK	2.945***	3.842***	3.061***	3.246***	2.772***	3.279***
	(1.018)	(1.322)	(1.014)	(1.161)	(0.919)	(1.092)
CONSTANT	3.950***	0.982	2.758**	4.081***	0.276***	0.143***
	(1.831)	(0.371)	(1.149)	(1.898)	(0.114)	(0.061)
No. of observations	35,226	35,226	35,226	35,226	35,226	35,226

Source Authors' own calculations; *Notes* ***, **, and * denote significance at 1, 5, and 10%, respectively. Figures in parentheses are standard errors. The likelihood-ratio test compares the model with a one-level ordinary logistic regression

References

Ahsan, S., Ali, A. A. G., & Kurian, N. J. (1982). Towards a theory of agricultural crop insurance. *American Journal of Agricultural Economics, 64*(3), 520–529. https://doi.org/10.2307/1240644

Barnwal, P., & Kotani, K. (2013). Climatic impacts across agricultural crop yield distributions: An application of quantile regression on rice crops in Andhra Pradesh, India. *Ecological Economics, 87*, 95–109. https://doi.org/10.1016/j.ecolecon.2012.11.024

Bhuiya, M. M. M., Khanam, R., Rahman, M. M., & Nghiem, H. S. (2018). The relationship between access to microfinance, health-seeking behaviour and health service uses: Evidence from Bangladesh. *Economic Analysis and Policy, 60*, 9–17.

Birthal, P. S., Khan, T. M., Negi, D. S., & Agarwal, S. (2014). Impact of climate change on yields of major food crops in India: Implications for food security. *Agricultural Economics Research Review, 27*(347-2016-17126), 145–155. https://doi.org/10.5958/0974-0279.2014.00019.6.

Burgess, R., Deschenes, O., Donaldson, D., & Greenstone, M. (2014). *The unequal effects of weather and climate change: Evidence from mortality in India.* Massachusetts Institute of Technology, Department of Economics. Manuscript.

Chambers, R. G., & Quiggin, J. (2002). Optimal producer behavior in the presence of area-yield crop insurance. *American Journal of Agricultural Economics, 84*(2), 320–334. https://doi.org/10.1111/1467-8276.00300

Cole, S. A., & Xiong, W. (2017). Agricultural insurance and economic development. *Annual Review of Economics, 9*, 235–262.

Davies, M., Guenther, B., Leavy, J., Mitchell, T., & Tanner, T. (2008). 'Adaptive social protection': Synergies for poverty reduction. *IDS Bulletin, 39*(4), 105–112.

Dowie, J. (1975). The portfolio approach to health behaviour. *Social Science & Medicine (1967), 9*(11–12), 619–631.

FAO. (2015). *Nutrition and social protection.* Food and Agriculture Organization of the United Nations. Retrieved December 20, 2019, from http://www.fao.org/3/a-i4819e.pdf.

Hau, A. (2006). Production under uncertainty with insurance or hedging. *Insurance: Mathematics and Economics, 38*(2), 347–359. https://doi.org/10.1016/j.insmatheco.2005.09.006.

He, J., Zheng, X., Rejesus, R. M., & Yorobe, J. M. (2019). Moral hazard and adverse selection effects of cost-of-production crop insurance: Evidence from the Philippines. *Australian Journal of Agricultural and Resource Economics, 63*(1), 166–197. https://doi.org/10.1111/1467-8489.12290

Leary, N., Adejuwon, J., Barros, V., Batimaa, P., Biagini, B., Burton, I., ... & Wehbe, M. (2007). *A stitch in time: Lessons for climate change adaptation from the AIACC Project*. International START Secretariat, Washington, DC.

Möhring, N., Dalhaus, T., Enjolras, G., & Finger, R. (2020). Crop insurance and pesticide use in European agriculture. *Agricultural Systems, 184*, 102902. https://doi.org/10.1016/j.agsy.2020.102902

Nair, R. (2010). Crop insurance in India: Changes and challenges. *Economic and Political weekly, 55*(6), 19–22. https://www.jstor.org/stable/25664084.

Panda, A. (2013). Climate variability and the role of access to crop insurance as a social-protection measure: Insights from India. *Development Policy Review, 31*, 057–073.

Patt, A., Suarez, P., & Hess, U. (2010). How do small-holder farmers understand insurance, and how much do they want it? Evidence from Africa. *Global Environmental Change, 20*(1), 153–161.

Smith, V. H., & Goodwin, B. K. (1996). Crop insurance, moral hazard, and agricultural chemical use. *American Journal of Agricultural Economics, 78*(2), 428–438.

Van Ittersum, M. K. (2015). Crop yields and global food security. Will yield increase continue to feed the world? *European Review of Agricultural Economics, 43*(1), 191–192. https://doi.org/10.1093/erae/jbv034.

Woldemicael, G., & Tenkorang, E. Y. (2010). Women's autonomy and maternal health-seeking behavior in Ethiopia. *Maternal and Child Health Journal, 14*, 988–998.

Gender Dimensions of Health and Nutrition

Are Gender Budgets Necessary for Reducing Inequalities in Health Outcomes? An Exploratory Analysis

Indrani Gupta, Avantika Ranjan, and Kanksha Barman

1 Introduction

Achieving gender equality and empowerment has been a global goal for many years and since 2015 has been the focus of Sustainable Development Goals (SDGs) as well. Given the challenges in reducing gender inequality, there was a global consensus that national budgets should specifically focus on gender. Australia was the first country to initiate gender budgeting or gender-responsive budgeting (GRB) and presented a Women's Budget Statement at a meeting of the Organization for Economic Co-operation and Development (OECD) Working Party on Women and the Economy in February 1985 (Sharp & Broomhill, 2014). Initiatives were begun in other countries as well, and GRB was first discussed at a global level at the Fourth World Conference on Women in 1995 in Beijing, China (Stotsky, 2016), attended by representatives from 189 countries, which gave the movement further impetus. Countries agreed to look at their national budgets through a gendered lens and integrate a gender perspective in their budgetary policies (UN Women, 1995).

The Council of Europe in 2005, defined gender budgeting as a 'gender-based assessment of budgets incorporating a gender perspective at all levels of the budgetary process and restructuring revenues and expenditures in order to promote gender equality' (Council of Europe, 2005). However, while the movement started with a somewhat narrow focus on bridging the gap between men and women, it was subsequently expanded to include the needs of all people. OECD in 2016 defined it as 'integrating a clear gender perspective within the overall context of the budgetary process through special processes and analytical tools, with a view to promoting gender-responsive policies' (Downes et al., 2017). A 2016 IMF paper defined it as 'an approach to budgeting that uses fiscal policy and administration to promote gender equality, and girls' and women's development' (Stotsky, 2016).

I. Gupta (✉) · A. Ranjan · K. Barman
Institute of Economic Growth, New Delhi, India
e-mail: indrani@iegindia.in

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_9

Approaches towards GRB differed and continuously evolved across countries in the framework adopted, mainly because of the diverse ways in which gender inequalities manifested themselves in different settings. Emerging economies faced different challenges compared to high-income economies, with larger informal economic sectors that typically employed a larger proportion of women, weaker political accountability, and larger gender gaps in terms of education and access to health services. It has been observed that gender budgeting is closely interlinked with economic development in emerging economies (Nolte et al., 2021).

Though the approaches for different countries have certainly been heterogeneous and diverse, there are certain common essential components that go into a GRB, irrespective of the setting. The most important element is of course the collection and analysis of gender-disaggregated data for a variety of indicators; without such data, GRBs cannot be meaningful. The other elements are the involvement of multiple stakeholders in recognizing and identifying gender-based needs assessment; all levels of government including the parliament, policymakers and managers, civil society organizations, especially women's groups and researchers, need to collectively be able to push the agenda on GRB. Finally, robust tracking alongside sound monitoring and evaluating systems are required to assess implementation gaps and progress. The last is critical because a truly gender-responsive budget should be able to track how funds are being raised, allocated, and spent. Such information is critical to help make government spending more efficient and effective. These are the minimum requirements of a sound system of GRB, and such a system will lend flexibility to the tool, which is important for adapting and adjusting to a dynamic situation.

Approaches, and tools, for gender-responsive budgeting are varied—they can be adapted for specific and national contexts. No particular approach for GRB has been described as standard or ideal; what works in one country context may not necessarily work in another and as a result, different countries have seen various levels of success in their approaches. Diane Elson developed a set of analytical tools in 1995 that helps bring in a gender perspective at all levels of decision-making, and other tools have been developed in the following years based on work from Budlender, Sharp, and Elson (Elson, 1999). Tools may be used separately or in combination, according to the country's situation as well as the particular approach being followed.

One way of classifying tools is by the stage of the budgetary process they may be applied in, as discussed in the OECD typology (Downes et al., 2017), which mentions mainly three types of approaches; ex ante budgeting, concurrent budgeting, and ex post budgeting. The ex ante approach does the analysis in advance of inclusion in the budget, does a baseline analysis, and uses a needs-assessment exercise which is mostly qualitative. Belgium and Japan are two examples of this approach. The concurrent GRB approach is one where requirements for a minimum pre-specified allocation linked to GRB policies are mandated and some form of gender-related budget incidence analysis is undertaken to assess the overall impact. India is a good example of concurrent GRB. Finally, the ex post approach is mainly based on a post-allocation audit of spending to determine the extent to which gender equality objectives are being attained through the policies detailed in the annual budget.

Sweden, the Netherlands, and Norway undertake *ex post* gender audits as part of their budgeting process.

There has been growing interest globally in linking GRB processes with broader public finance management or PFM reforms and in institutionalizing gender-responsive PFM reforms (Anwar et al., 2016). A fully implemented gender-responsive budget that tracks allocations of funds and their implications on gender equality outcomes, can represent an advanced form of PFM reform (Kovsted, 2010). However, in practice, most existing GRB initiatives are simpler analyses of allocations within sectors.

Though there is an abundance of literature on the definition, implementation, and justification of gender budgeting, there are far fewer resources for measuring its performance and impact. Many countries have not formally adopted a nation-wide GRB approach; however, informal and fragmented applications of the process have been undertaken by governments as well as non-government agencies and these frequently are not taken into account when it comes to documenting and assessing the real-world impacts of gender budgeting. Further, there has been limited application of a gender perspective in spending review even in developed countries. A small collection of quantitative papers has measured the impact of gender budgeting through labour force participation (Chakraborty et al., 2018), school enrolment (Stotsky & Zaman, 2016), and macro-aggregates like growth (Chakraborty et al., 2019). The results have allowed researchers to conclude that gender budgeting has had an undeniable impact on the increased representation of women in decision-making processes, better labour market conditions, education and employment for women, and financial independence for women as primary bank account holders. It has also helped in the inclusion of transgenders as potential beneficiaries for receiving direct benefit transfers under social schemes, with explicit mention of schemes earmarked for the third gender across many Indian states (Nair & Moolakkattu, 2018).

One area that has sparse literature is the impact of GRB on health outcomes. Given the stark inequalities in health outcomes across genders requiring policy focus, an important question to raise is whether GRBs have helped reduce such inequalities over the years.

A 2019 study (Heymann et al., 2019) reviewed existing literature on programmes that aimed to reduce gender inequality and improve health. The results indicated that improved equality in education and at work, in the form of policies such as tuition-free primary education and paid maternity and parental leave policies, have had a positive impact on health outcomes. The study also found that greater gender balance in governance and decision-making roles made it easier for such policies to be introduced and successfully implemented. The study concluded that for sustainable change to the status quo and quantifiable improvements in health outcomes, programmes should be multi-sectoral, have a multi-level approach, work in a bottom-up manner, and extend beyond the health sector.

Another scoping review (Crespí-Lloréns et al., 2021) looked at identifying and analysing policies aimed at reducing gender inequalities in health between 2002 and 2018 and found that very few policies have been formulated, implemented, or evaluated to address this problem. The review found that though the number of studies

about tackling gender inequalities in health had increased in recent years, these had not all, however, been successful. The reasons ranged from flawed study designs and implementation processes to the lack of availability of accurate sex-disaggregated data and gender inequality indexes. Interventions were also found to be under-financed, plagued by bureaucratic issues, lacked adequate women's participation in decision-making, and were difficult to implement.

In this background of increasing focus on GRB and lack of sufficient evidence on the impact of GRBs on health outcomes, this paper explores whether selected major health outcomes improved in countries that introduced gender budgets and whether countries that adopted GRB and did not adopt GRB had different paths of improvements over the years.

The main concern in adopting a quantitative approach to measuring the impact of GRB on health outcomes is the lack of uniformity in approaches. Since countries incorporated GRB in a variety of ways, over different time periods, and made incremental course corrections, a straightforward quantitative approach with GRB as a simple explanatory variable can yield misleading results. The differences could be attributed to the approach, the methods, and the range of services where GRB was introduced, rather than whether or not the countries had a GRB.

The other problem is that most countries globally have adopted some or the other form of GRB, making it difficult to get enough data on countries that have not. Data is also not readily available on whether health sector budgets in all countries have followed a GRB format, though one can assume that health being a key sector, any adoption of GRB would be implemented in the health sector as well.

Instead, we try and piece together evidence from a variety of sources on how countries did on health after the adoption of GRB, to what extent inequalities could be brought down, compare trajectories of change in key health outcomes for countries that did adopt and the few countries that did not and offer possible explanations on what could explain the observed patterns. We take a closer look at India and attempt to understand whether its adoption of GRB made a substantial impact on health inequalities. Finally, we look at other possible factors that might have impacted gender inequalities in the health sector and could be prioritized over gender budgets.

2 Gender Inequality, Gender Gaps, and Health Outcomes

Given the problem of attribution and diversity of approaches in GRB, it is not entirely clear how exactly to assess the impact of GRB on health outcomes.

We look at four indicators to explore possible impact. Gender inequality as gleaned from available global data, Maternal Mortality Ratio (MMR), all-cause mortality ratio for males and females, and treatment-seeking behaviour by gender. Since most countries have implemented ministry-wise gender budgets, health ministries, and departments—it can be assumed—would also have addressed gender gaps in their allocations. Also, improvements on other human development fronts via GRB would also indirectly impact health outcomes.

2.1 Gender Inequality and Gender Budgets

UNDP's Gender Inequality Index (GII) (UNDP, 2020) measures gender inequalities in three aspects of human development: reproductive health (measured by MMR and adolescent birth rates); empowerment (measured by proportion of parliamentary seats occupied by women and proportion of men and women with higher education); and economic status (measured by labor force participation rate of men and women). The higher the GII value, the more disparities between females and males, and the more loss to human development. Figure 1 depicts GII values across human development groups and Fig. 2 depicts GII values across regions, for the year 2019. It shows that the level of human development is negatively related to GII; lower is human development, higher is GII. Figure 2 shows GII across regions and indicates that developed countries tend to have lower gender inequalities. Whatever the mechanisms, progress in human development would ensure reduction in gender disparities.

The Global Gender Gap Index (GGI) published by the World Economic Forum (WEF) ranks over 150 countries on the current status of gender-based gaps in four key domains—Economic Participation and Opportunity, Educational Attainment, Health

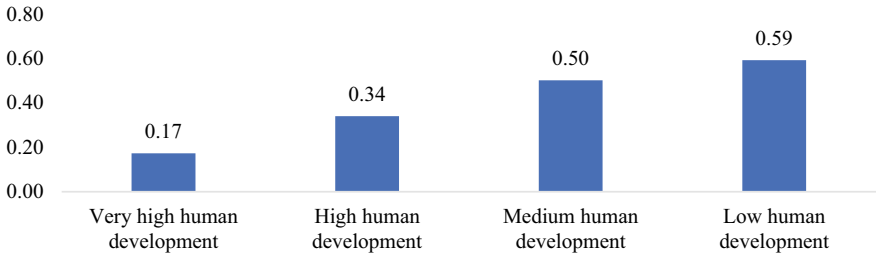


Fig. 1 Gender inequality index across human development groups, 2019. *Source* Gender inequality index, human development report, UNDP, 2020

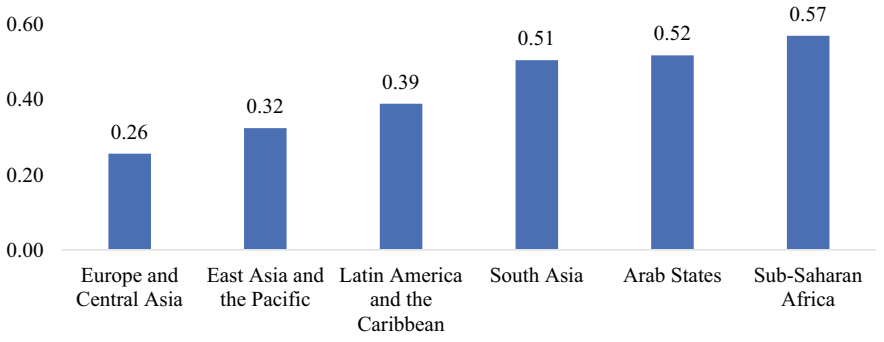


Fig. 2 Gender inequality index across regions, 2019. *Source* Gender inequality index, human development report, UNDP, 2020

Table 1 Gender gaps, global gender gap report, 2021

Top 10 countries that have closed the gender gap	Gender budget	Bottom 10 countries	Gender budget
Iceland	Yes	India	Yes
Finland	Yes	Saudi Arabia	No
Norway	Yes	Chad	No
New Zealand	No	Mali	Yes
Sweden	Yes	Congo	No
Namibia	Yes	Syria	No
Rwanda	Yes	Pakistan	Yes
Lithuania	No	Iraq	Yes
Ireland	No (equality budgeting)	Yemen	No
Switzerland	No	Afghanistan	Yes

Source Global gender gap report, WEF, 2021 and Budget documents of various countries

and Survival, and Political Empowerment—and tracks their progress in closing these gaps in an annually published report (WEF, 2021). Table 1 depicts the top ten ranked countries according to this index, along with whether or not these countries have undertaken any GRB efforts.

As can be seen, not all the countries among the top ten ranks have undertaken gender budgeting, though four of the top five have. Similarly, for the bottom ten countries that have yet to close the gender gaps, many countries, including India, have undertaken GRB processes, indicating the possibility of GRBs being neither necessary nor sufficient for bringing about greater gender equality.

2.2 Maternal Mortality Ratio

While the MMR only pertains to women, GRBs would require investments in the prevention of maternal mortality by allocating sufficient resources to a variety of interventions. Changes in MMR, therefore, would reflect changes in policies and investments in reproductive health.

Table 2 gives the MMR and also adolescent birth rate—another indicator which needs focus in the health sector—for countries with different levels of human development.

The first thing to note is that both MMR and adolescent birth rates are worse for countries with lower levels of human development. For the low human development countries, MMR is 40 times higher compared to countries with very high human development. This straightaway indicates that countries with better human development would be able to achieve better outcomes in any case. This could also be due to better allocations to health, with or without gender budgets. While many factors

Table 2 Maternal mortality and adolescent birth rates across groups of countries based on human development

Human development groups	MMR	Adolescent BR
Very high human development	14	17
High human development	62	34
Medium human development	161	35
Low human development	572	103

Source Gender Inequality Index, Human Development Report, UNDP, 2020

go into adverse health outcomes, from a policy perspective, one key tool is health financing, a point to which we return later in the paper.

MMR for several countries over the period 1990–2017 has been plotted in Fig. 3 to see the trends and patterns. Figures 3a, b depict the MMR trends in high-income countries and low- and middle-income countries, respectively. The years mentioned denote the year during which GRB processes were started in the country; no year mentioned indicates that the country has not undertaken any GRB exercises.

For the richer countries, MMR was already very low, so the introduction of GRB did not make much of a difference. For countries like Cuba and Denmark, that had somewhat higher MMR around the 1990s, the fall started quite soon. While Cuba does not have a GRB, Denmark introduced GRB in 2000, but MMR started falling after 1995 in any case.

A similar story can be seen for low- and middle-income countries as well. There is a noticeable fall in MMR before the implementation of GRB in countries like Ethiopia and Bangladesh. In some other countries, the downward trend is visible despite a lack of introduction of GRB.

2.3 All-Cause Mortality Rates by Gender

Male–female differences in mortality rates are governed by complex factors ranging from epidemiology to social and cultural factors that impact behaviour (Crimmins et al., 2019). There remains a gap between male and female all-cause mortality, with males having higher death rates than females. In relatively high mortality settings, there is scope to reduce the rates for both the genders, and in fact, bring down male mortality faster with better allocations to prevention of non-communicable diseases and other lifestyle behaviour interventions. We look at all-cause mortality rates for males and females for selected countries in the low-middle-income categories, including India. While we cannot predict without knowing the design of policy under GRB which way the narrowing will go—whether male or female or both rates would come down—any difference might give us proof of some impact from GRB.

Figure 4 shows the trends for mortality rates for 1000 persons from 1990 to 2018 for four countries with high mortality compared to developed countries—India,

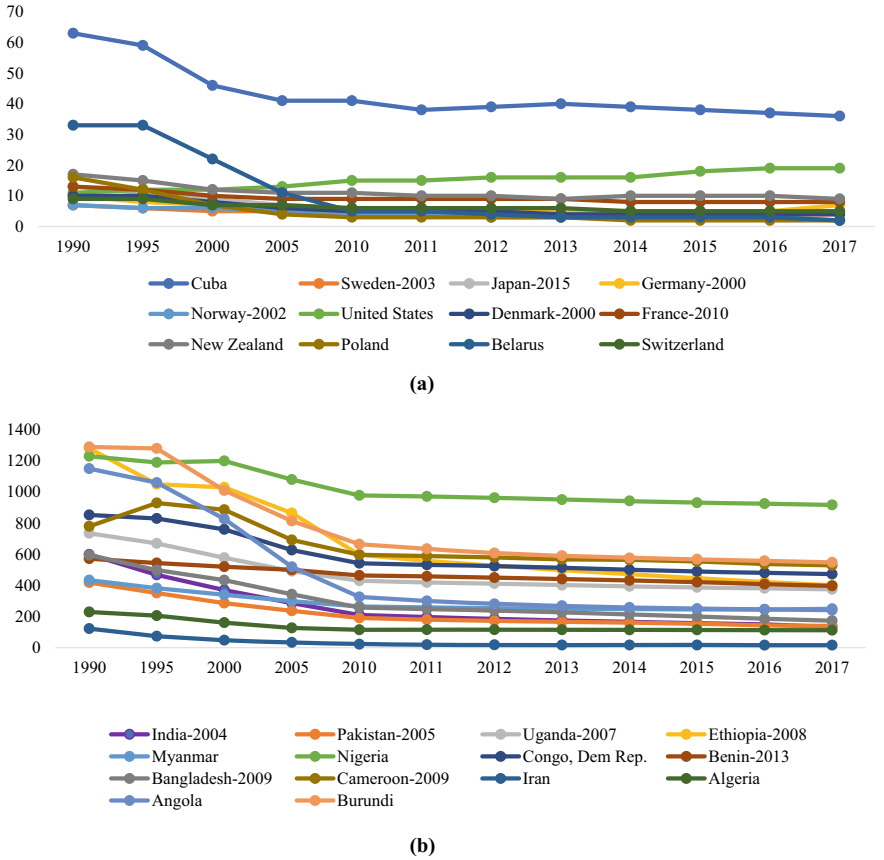


Fig. 3 **a** MMR Trends—High-income countries. **b** MMR Trends—Low- & middle-income countries. *Source* WHO, global health observatory data, budget documents of various countries

Pakistan, Bangladesh, and Uganda. The dotted line in each graph indicates the year when GRB was started in the country. As can be seen, overall mortality rates are decreasing over the years, and the declines started before the introduction of GRB in each of these countries. There is a secular decline in male and female mortality, but not sharp enough and the gaps have not changed over the years in any perceptible way.

How do these countries look when compared to trends in all-cause mortality for males and females in countries that have not undertaken GRB?

Figure 5 shows the trends for mortality rates for 1000 persons from 1990 to 2018 for four selected countries which have not adopted GRB measures yet—Nigeria, Congo, Burundi, and Iran. All these countries also have high mortality rates. As can be seen, all the four countries have managed to lower mortality rates, even in the absence of GRB, and certain countries, such as Iran have also managed to narrow the gender gap.

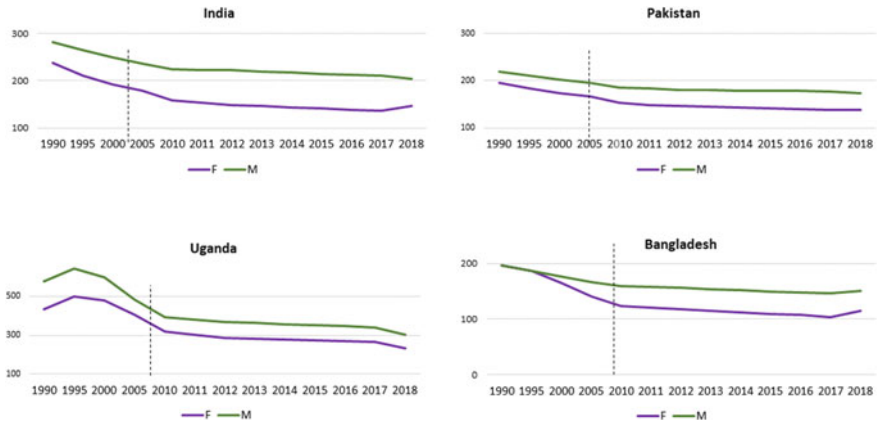


Fig. 4 Mortality rates per 1000 for selected countries with gender budgets. *Source* WHO, global health observatory data, budget documents of various countries

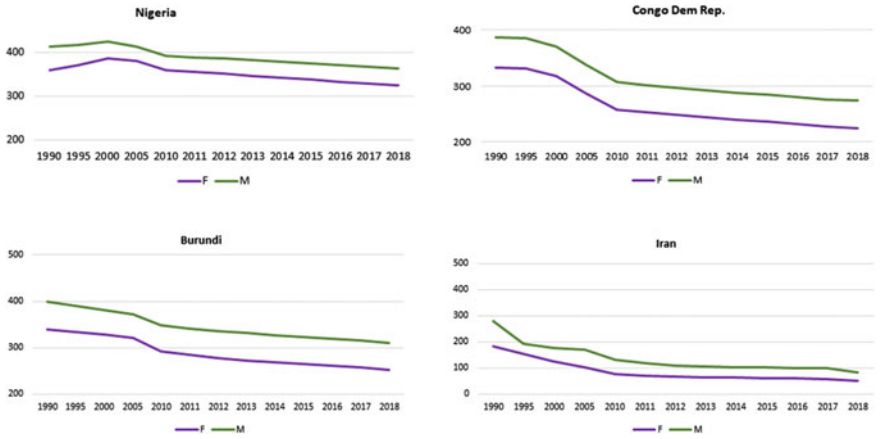


Fig. 5 Mortality rates per 1000 persons for countries with no gender budgets. *Source* WHO, global health observatory data

These pieces of evidence seem to indicate that GRB has not mattered much for changing major health outcomes across countries.

2.4 Treatment-Seeking Behaviour and Out-Of-Pocket Spending

It is much less easy to identify whether out-of-pocket spending (OOPS) has a gendered angle to it, given that much of the data remains at the household level

and is at times difficult to attribute to different family members. However, there is adequate evidence that women are especially disadvantaged seeking care compared to men and some evidence of their relatively higher OOPS.

In a sample of 65 developing countries, cost was identified as a key factor that affected women's ability to access care (UN Women, 2018). When women lack financial autonomy, they are forced to rely on men to meet their transport needs as well as treatment costs. In low-income settings, women may have to resort to informal healthcare providers and low-cost medicines, whereas men spend a greater share of resources on their own health needs. This has been observed especially in more low- and middle-income patriarchal cultures such as in Bangladesh (Pike et al., 2021) and Uganda (Morgan et al., 2017). Men, mothers-in-law, or older family members are often gatekeepers for women's access to health care, and a husband's consent for the provision of treatment is often required by health providers and is even mandated by law in certain countries. Further, women incur more out-of-pocket payments than men. This is because out-of-pocket expenditure for delivery care and other reproductive health services places a higher financial burden on women, and this also adversely impacts women's utilization of essential services.

A study analysing the differences in out-of-pocket and total healthcare expenditures among adults with diabetes in the US found that women with diabetes had significantly higher expenditures compared to men, particularly for healthcare services including office visits, home-based care, and prescriptions (Williams et al., 2017). Earlier studies have also found that women with diabetes tend to have higher estimated annual medical spending and additional lifetime incremental expenses compared to men with diabetes (Zhuo et al., 2014).

A recent WHO-PAHO (Pan-American Health Organization) report compiled evidence that indicated that women's OOPS is systematically higher than that of men (PAHO, 2021).

The evidence on OOPS is closely related to health coverage and health expenditures in countries. Evidence from both high- (e.g. the USA) and middle-income countries (e.g. South Africa) with significant private health insurance coverage indicates that private health insurance is inequitable because it excludes those who are unemployed and socio-economically disadvantaged. A study of privately insured households in South Africa found that less than half of privately insured households were only partially insured, and on average, household heads in partially insured households were more often found to be female, unmarried, with primary school education or no education, Black and unemployed (Govender et al., 2014).

In India, household members within male-headed households were twice as likely to be insured as those in female-headed households (Witter et al., 2017), and this has implications for healthcare access as well. There are voluntary, community-based health insurance schemes which aim to close the gap in insurance coverage through low premiums. These schemes target women, along with poor and rural populations, however, they have also been unable to provide coverage for those without access to cash.

In contrast, women's increased decision-making autonomy and access to economic resources are positively associated with their use of healthcare services

in many sub-Saharan African countries (Lee et al., 2017). Similarly, a study from Pakistan found that a 1% increase in women's decision-making power was correlated with a nearly 10% increase in their use of maternal health services (Heise et al., 2019). Another study on the effect of health expenditure on health outcomes for the period 2000–2015 for 177 countries found a significant positive relationship between health expenditure and infant mortality rate, and maternal mortality ratio for the study period across 11 quantiles, with the most impact observed in developing economies (Owusu et al., 2021).

A study on the association between medical spending and health status across eight African countries also had similar findings—increase in public healthcare spending is expected to lead to a reduction in female mortality, male mortality, number of maternal deaths, incidence of tuberculosis, and prevalence of HIV (Bein, 2020).

The last set of evidence on treatment-seeking behaviour and health coverage points towards health financing as a key policy knob for improving health outcomes in countries, with concomitant spread of UHC.

3 Gender Budgeting in India

In India, the first gender-focused analysis of economic policy issues was done by the National Institute of Public Finance and Policy (NIPFP) in 2002 (Chakraborty, 2013). The report analysed the Union Budget from a gendered perspective, following which in 2003, the Indian government asked each ministry and department to include a section on gender issues in their respective annual reports. In 2004, the Ministry of Finance instructed all ministries to establish GRB Cells. From here on, all ministries were expected to include a note in the budget circulars that would reflect gender allocations in two categories; Part A: schemes that were targeted towards women with 100% of the budget allocation and Part B schemes where at least 30% of the budget was allocated for women (Ministry of Women and Child Development).

In 2005–06, the first Gender Budget Statement (GRBS) included ten demands for grants. Each one was presented by a particular ministry and included a statement of the total provision of funds required for a given service along with a statement of the detailed estimate of the grant divided into line items. In addition to departments and ministries, some states also incorporated GRB into their budget planning.

GRB efforts in the country have continued since then, as the Indian government was cognizant of the need for programmes and policies on gender equality and had made efforts over the years to make budgets gender-responsive, including setting up of a separate ministry that could further facilitate gender-focused policymaking in the country.

In order to analyse whether these efforts have translated into better outcomes, we use the GGI to track India's progress in reducing gender gaps, since the index is inclusive of a number of indicators. As of 2020, India is ranked 112th globally on the GGI and 4th within the South Asian region. Other countries in the region, such as Bangladesh, have achieved better gender parity. The 2021 rankings are worse as

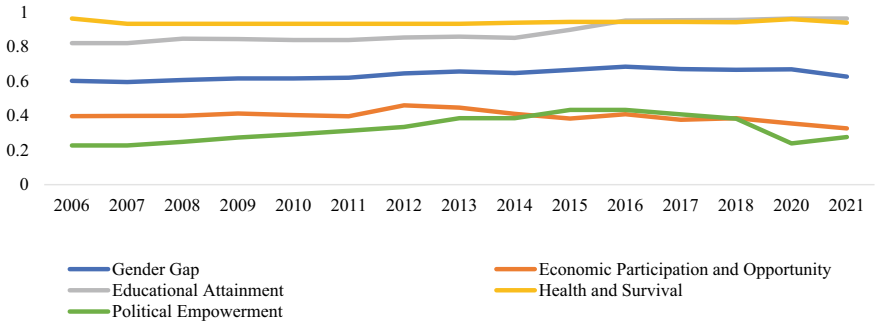


Fig. 6 Gender gap indicators for India: 2006–2021. *Source* Gender gap index reports, world economic forum

the COVID-19 pandemic amplified the pre-existing gender gaps leading to the gaps being asymmetrically intensified between men and women. In 2021, India ranked 140 out of 156 countries with a score of 0.625, falling by 28 ranks compared to 2020. The economic gender gap runs particularly deep in India with only 35% of the gap having been bridged in this area, and since 2006, the gap has significantly widened. India is the only country where the economic gender gap is larger than the political gender gap.

Figure 6 plots the scores of India on five parameters as per the GGI Reports from 2006 to 2021. India has the most gender gap in the domain of health and survival, followed by educational attainment. It does the best in political empowerment of women.

As the graph indicates, despite an early start and continued gender budgeting efforts in the country, not much has changed over the years for any of the indicators, including health and survival. There has been some slight improvement in the economic participation and opportunity indicator, however.

Numerous experts have analysed India's GRB processes to understand why the efforts have not resulted in better outcomes. One possible explanation is the nature of the main tool in use—the Gender Budget Statement. The GRBS essentially brings out the percentage of the total expenditure of the budget that flows to women and is the main feature of India's GRB process. Like with any tool that requires accurate classification, the GRBS has also faltered in categorizing items accurately. For instance, schemes under Part A and B were cross-classified and some schemes were excluded because they did not mention specific coverage for women. Further, for schemes categorized in Part B of the statement, it was not always evident what methodology was used to estimate the percentage of funds allocated to women (Mishra & Sinha, 2012). In any case, the rationale of allocation for various categories in Part B has not been clearly stated anywhere. Also, ministries that are considered gender-neutral did not have proper guidance on how to apportion their budgets (Mehta, 2020).

Even if these challenges are rectified, the GRBS might work well as an accounting tool and enable a good understanding of changing allocations across interventions

over time. But merely an accounting tool to analyse allocations is not helpful unless backed by *ex ante* gender-disaggregated data. Without a thorough understanding of what is required, what has been spent, and what has been achieved, the process seems like a routine exercise of fulfillment of a reporting obligation rather than a well-thought-out planning exercise.

There are some areas where GRB processes have probably played a part in improving outcomes—for example, in education and labor market under the National Rural Employment Scheme (MGNREGA). However, there still remain significant inequalities in terms of health outcomes.

4 Gender Budgets or Health Allocations?

Countries that have made good progress on health outcomes and inequalities are mainly countries that have been able to increase their health spending and expand universal health care (UHC), with or without GRB.

Developed countries undertaking gender budgeting mostly focus on specific issues pertaining to inequalities in political participation, labor market, salaries, tax burden, leave rules, etc. These countries do not require to focus specifically on health because they have already achieved significant improvements in health indicators.

For developing countries, the issues are much more complex, ranging from prevention and eradication of diseases and universal immunization to more complex areas of NCD and triple burden of diseases including new and emerging pathogens. At the same time, countries require significant health systems strengthening, especially of public health services. Countries without UHC are mostly in the low development–low health financing space with adverse health outcomes. The primary focus for these countries should be to raise resources for health and UHC. As seen in the preceding section, UHC—achieved via significant investment in the health sector—is one significant way of reducing gender inequalities in access and outcomes.

Figure 7 plots the GII (which includes health and survival sub-index) against domestic general government health expenditure in GDP and shows that there is a negative relationship between the two: higher is government expenditure in GDP, lower is GII indicating more equality between sexes.

For fast-tracking improvements in health outcomes like MMR (Fig. 8), the key policy knob remains health expenditures; as the figure shows, there is a strong negative relationship between government health expenditure and MMR, and higher health spending by government would ultimately help reduce gender gaps in health outcomes, if the investments are being made sensibly.

For health investments to be gender-sensitive in a GRB approach, it is important to collect granular data on a number of indicators that would help policymakers narrow in on the key gender gaps in health. While a number of studies indicate that women are especially disadvantaged, truly gender-responsive analyses would need to focus on both the genders. For example, a systematic review finds that being unmarried put men at higher risk of stroke and all-cause mortality compared to women (Wang et al.,

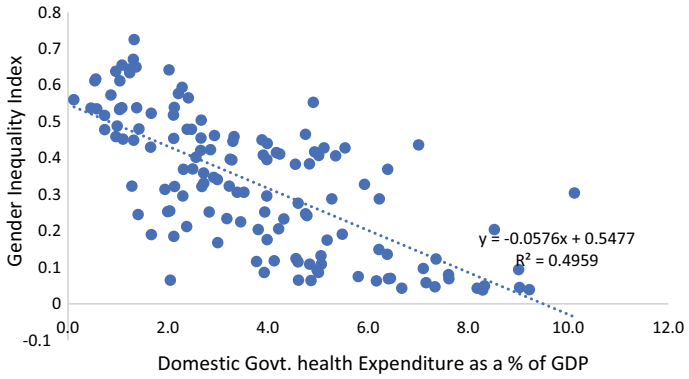


Fig. 7 Gender inequality index and domestic general government health expenditure (as a % of GDP) 2019. *Source* Gender inequality index, HDR, UNDP, World Bank Open Data

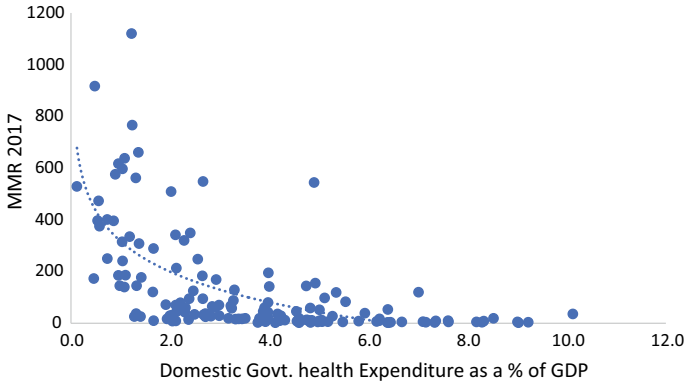


Fig. 8 MMR 2017 versus domestic general government health expenditure (% of GDP) 2019. *Source* World Bank Open Data

2020). It further reported that divorced/separated men had a higher risk of cancer mortality and cardiovascular disease (CVD) mortality. Similarly, many studies exist that find that among patients with COVID-19 infection, men had a significantly higher mortality than women; one study using a multinational database had a similar finding and further reported that this difference could not be explained fully by the higher prevalence of comorbidities in men (Alkhouli et al., 2020). A study on European countries indicates that musculo-skeletel pain was higher among women compared to men (US-based study found that men were twice as likely as women to die during the first and second years after hip fracture (Cimas et al., 2018). A study from Italy found that lower cardiovascular risk profile may reduce all-cause and CVD mortality in older people, and the benefits are stronger and longer in women (Trevisan et al., 2021).

These examples show that such granular gender-based data are the only way to understand where the gender gaps are and how these might be bridged. However, it also indicates the difficulty that countries would have to collect such nuanced data. Most developing countries and many developed countries as well are not currently equipped to collect this kind of detailed data required for gender budgets. A routine budget allocation model cannot serve the dynamic and fluid scenario around gender equality, for which one requires a different gender planning exercise. Redistributing meagre health expenditure to fulfil gender budget obligations in the departments and ministries of health may be counterproductive and give a false sense of achievement.

5 Conclusion

While gender budgeting has resulted in special attention being given to health outcomes in countries such as Brazil, Japan, and Mexico, for other developing countries that still have adverse health indicators, outcomes may respond better to higher health allocations rather than allocation of meagre funds to separate gender. Expansion of a well-defined UHC agenda would in any case ensure greater gender equality in access and outcomes, and the only way to expand UHC is through higher health allocations by governments, with the concomitant reduction in OOPS.

In any case, in the absence of clear objectives of GRB in health, proper needs assessment, availability of gender-disaggregated data, and sound post-implementation evaluation, a GRB exercise can become a mechanical one, to meet administrative requirements. It can also become counter-productive if it gives an illusion that GRB would lead to improvements in outcomes. It might be better for governments and development agencies to emphasize gender-responsive budgeting in fewer targeted areas such as labour markets, political empowerment, and specific programmes targeting genders, instead of forcing all allocations to follow GRB guidelines. For health, the best step forward to address gender inequality would remain investment in health and adequate levels of health financing to further the UHC agenda. UHC—if designed with evidence—would address existing inequalities across genders, and may not need additional focus on GRB. For the health sector, therefore, GRB is neither necessary nor sufficient to address gender inequalities.

References

Alkhouli, M., Nanjundappa, A., Annie, F., Bates, M. C., & Bhatt, D. L. (2020). Sex differences in case fatality rate of COVID-19: insights from a multinational registry. In *Mayo Clinic Proceedings* (Vol. 95, No. 8, pp. 1613–1620). Elsevier.

Anwar, S., Downs, A., & Davidson, E. (2016). *How can PFM reforms contribute to gender equality outcomes?* UN Women and DFID Working Paper.

Bein, M. (2020). The association between medical spending and health status: A study of selected African countries. *Malawi Medical Journal, 32*(1), 37–44.

Chakraborty, L. (2013). *A case study of gender responsive budgeting in India* (pp. 1–13). Res Report Common wealth Publication.

Chakraborty, L., Ingrams, M., & Singh, Y. (2018). *Fiscal policy effectiveness and inequality: Efficacy of gender budgeting in Asia Pacific* (No. 18/224).

Chakraborty, L., Ingrams, M., & Singh, Y. (2019). *Macroeconomic policy effectiveness and inequality: Efficacy of gender budgeting in Asia Pacific* (Vol. 920). Levy Economics Institute, Working Papers Series.

Cimas, M., Ayala, A., Sanz, B., Agulló-Tomás, M. S., Escobar, A., & Forjaz, M. J. (2018). Chronic musculoskeletal pain in European older adults: Cross-national and gender differences. *European Journal of Pain, 22*(2), 333–345.

Council of Europe. (2005). *Council of europe final report of group of specialists on gender budgeting*. Directorate of Human Rights.

Crespí-Lloréns, N., Hernández-Aguado, I., & Chilet-Rosell, E. (2021). Have policies tackled gender inequalities in health? A scoping review. *International Journal of Environmental Research and Public Health, 18*(1), 327.

Crimmins, E. M., Shim, H., Zhang, Y. S., & Kim, J. K. (2019). Differences between men and women in mortality and the health dimensions of the morbidity process. *Clinical Chemistry, 65*(1), 135–145.

Downes, R., Von Trapp, L., & Nicol, S. (2017). Gender budgeting in OECD countries. *OECD Journal on Budgeting, 16*(3), 71–107.

Elson, D. (1999). *Tools for GRB*. Commonwealth Secretariat.

Govender, V., Ataguba, J. E., & Alaba, O. A. (2014). Health insurance coverage within households: The case of private health insurance in South Africa. *The Geneva Papers on Risk and Insurance-Issues and Practice, 39*(4), 712–726.

Heise, L., Greene, M. E., Opper, N., Stavropoulou, M., Harper, C., Nascimento, M., ... & Gupta, G. R. (2019). Gender inequality and restrictive gender norms: framing the challenges to health. *The Lancet*, *393*(10189), 2440–2454.

Heymann, J., Levy, J. K., Bose, B., Ríos-Salas, V., Mekonen, Y., Swaminathan, H., ... & Gupta, G. R. (2019). Improving health with programmatic, legal, and policy approaches to reduce gender inequality and change restrictive gender norms. *The Lancet*, *393*(10190), 2522–2534.

Kovsted, J. A. (2010). Integrating gender equality dimensions into public financial management reforms. *Gender Equality, Women's Empowerment and the Paris Declaration on Aid Effectiveness*. Issues Brief 6: OECD.

Lee, R., Kumar, J., & Al-Nimr, A. (2017). Women's healthcare decision-making autonomy by wealth quintile from Demographic and Health Surveys (DHS) in sub-Saharan African countries. *International Journal of Womens Health Wellness, 3*(054), 2474.

Mehta, A. K. (2020). Union budget 2020–21: A critical analysis from the gender perspective. *Economic and Political Weekly, 55*(16).

Mishra, Y., & Sinha, N. (2012). Gender responsive budgeting in India: What has gone wrong? *Economic and Political Weekly, 47*(17).

Morgan, R., Tetui, M., Muhumuza Kananura, R., Ekirapa-Kiracho, E., & George, A. S. (2017). Gender dynamics affecting maternal health and health care access and use in Uganda. *Health Policy and Planning*, *32*(suppl_5), v13–v21.

Nair, N. V., & Moolakkattu, J. S. (2018). Gender-responsive budgeting: The case of a rural local body in Kerala. *SAGE Open, 8*(1), 2158244017751572.

Nolte, I. M., Polzer, T., & Seiwald, J. (2021). Gender budgeting in emerging economies–a systematic literature review and research agenda. *Journal of Accounting in Emerging Economies.*

Owusu, P. A., Sarkodie, S. A., & Pedersen, P. A. (2021). Relationship between mortality and health care expenditure: Sustainable assessment of health care system. *PLoS ONE, 16*(2), e0247413.

Pan American Health Organization. (2021). *Out-of-pocket expenditure: The need for a gender analysis*. Pan American Health Organization.

Pike, V., Kaplan Ramage, A., Bhardwaj, A., Busch-Hallen, J., & Roche, M. L. (2021). Family influences on health and nutrition practices of pregnant adolescents in Bangladesh. *Maternal & Child Nutrition, 17*, e13159.

Sharp, R., & Broomhill, R. (2014). *A case study of gender responsive budgeting in Australia.* Commonwealth Secretariat.

Stotsky, M. J. G. (2016). *Gender budgeting: Fiscal context and current outcomes*. IMF working papers: 1–50. International Monetary Fund.

Stotsky, M. J. G., & Zaman, M. A. (2016). *The influence of gender budgeting in Indian states on gender inequality and fiscal spending*. International Monetary Fund.

Trevisan, C., Capodaglio, G., Ferroni, E., Fedeli, U., Noale, M., Baggio, G., ... & Sergi, G. (2021). Cardiovascular risk profiles and 20-year mortality in older people: gender differences in the Pro.V.A. study. *European Journal of Ageing, 19*(1), 37–47.

United Nations Development Programme. (2020). *Human development report 2020: The next frontier—Human development and the anthropocene.* United Nations Development Programme.

UN Women. (1995). *Beijing declaration and platform for action: Beijing+5 political declaration and outcome.*

UN Women. (2018). *Turning promises into action: Gender equality in the 2030 agenda for sustainable development*. United Nations Women.

Wang, Y., Jiao, Y., Nie, J., O'Neil, A., Huang, W., Zhang, L., ... & Woodward, M. (2020). Sex differences in the association between marital status and the risk of cardiovascular, cancer, and all-cause mortality: a systematic review and meta-analysis of 7,881,040 individuals. *Global Health Research and Policy, 5*(1), 1–16.

Williams, J. S., Bishu, K., Dismuke, C. E., & Egede, L. E. (2017). Sex differences in healthcare expenditures among adults with diabetes: Evidence from the medical expenditure panel survey, 2002–2011. *BMC Health Services Research, 17*(1), 1–8.

Witter, S., Govender, V., Ravindran, T. S., & Yates, R. (2017). Minding the gaps: health financing, universal health coverage and gender. *Health Policy and Planning*, *32*(suppl_5), v4–v12.

World Economic Forum. (2021). *Global gender gap report 2021.* World Economic Forum.

Zhuo, X., Zhang, P., Barker, L., Albright, A., Thompson, T. J., & Gregg, E. (2014). The lifetime cost of diabetes and its implications for diabetes prevention. *Diabetes Care, 37*(9), 2557–2564.

Revisiting Women's Empowerment as an Agriculture–Nutrition Pathway Using the Framework of Intersectionality

Simantini Mukhopadhyay

1 Introduction

The second goal of Sustainable Development Agenda set in 2015 by the United Nations General Assembly seeks to end hunger and all forms of malnutrition, and double agricultural productivity by 2030. It has been laid down that sustainable access to nutritious food would require sustainable agricultural production and practices. The pathways through which agriculture affects nutritional outcomes have been well-documented; the linkages operate through improving access to food, affecting agricultural incomes and prices, and 'feminising' the agricultural workforce (Gillespie & Kadiyala, 2011; Kadiyala et al., 2012). An important pathway from agriculture to nutrition operates through the increased empowerment of women. Increasing feminization of agricultural labour empowers women and enables them to exercise greater bargaining power in household decision-making. This in turn leads to better health and nutrition for women and children. Recent literature highlights the need to empirically examine this pathway in India (Rao & Pingali, 2018). Comparison and validation of various measures and concepts of women's empowerment merit attention both from academic and policy perspectives.

Undernutrition among women in India is higher than that in many Sub-Saharan African countries that are poorer and have lower rates of growth (Coffey, 2015). Moreover, nutrition of women in India is characterized by the 'dual burden'; while the proportion of underweight women has been declining, that of overweight and obesity has been increasing, even among the poor and in rural areas. Data shows that health and nutrition outcomes for women and children have been systematically worse in rural India. The percentage of underweight women was 22.9 at all-India level and 26.7 in the case of rural areas in 2015–16. At the national level, 20.6% of women were overweight. The corresponding figure was 15% for rural India. While

S. Mukhopadhyay (✉)
Institute of Development Studies Kolkata, Kolkata, India
e-mail: simantinihalder@gmail.com

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_10

the percentage of underweight women declined, the percentage of overweight women increased in both rural and urban India between 2005–06 and 2015–16. The latest round of NFHS, which was conducted in the year 2019–20, shows the same trend for most of the states for which the figures are available.

Studies have shown that health outcomes vary systematically across different dimensions of social power (such as sex, region of residence, religion, caste, and class) and their intersections in India (Mukhopadhyay, 2015, 2016; Sen et al., 2009). Intersectional inequality, a notion that was popularized within the realm of feminist studies, has only recently captured the attention of quantitative enquiries. Different dimensions of social power have been shown to simultaneously interact in a complex web, with an individual being placed at a mix of advantages and disadvantages that are associated with different identities. It has been shown that nutrition in India is characterized not only by single-axis inequalities but also by intersectional inequalities (Mukhopadhyay & Chakraborty, 2018).

This study intends to focus on women in agricultural households and examine how their empowerment varies across the social spectrum. It asks how the intersections of the different dimensions of social power shape empowerment outcomes of women belonging to agricultural households. We measure empowerment using three indices, the Survey-based Women's emPowERment index (SWPER) (Ewerling et al., 2017), Index of Women's Empowerment (IWE) and the Index of Women's Empowerment in Nutrition (IWEN). While the first is a concise measure using fewer items, the second is more conventional and uses a larger number of items. The third includes many more items and is formulated following recent studies pointing out the need for a nutrition-focused index of women's empowerment. Recent literature has shown how the traditional indicators of women's empowerment fail to uncover the relationship between women's intra-household status and child nutrition. The construction of IWEN draws heavily from the Women's Empowerment in Nutrition Index, which tries to capture the processes that enable women to be well-nourished and healthy and has been shown to be a better indicator than the conventional measures (Narayanan et al., 2019).

The paper also intends to conduct validation exercises by examining how women's empowerment is associated with their health in agricultural households, given their intersectional positionalities in the social spectrum. We use unit-level data from India Human Development Survey (IHDS) 2012 and ask if using the more comprehensive and nutrition-focused indicator of women's empowerment yields additional insights.

The next section briefly discusses the relevant literature. The third section discusses the data and the methods. The fourth section discusses the results and the fifth section concludes the paper.

2 Background

This paper refers to two sets of literature, which use both theoretical and empirical methods. The first comprises studies which seek to understand if benefits leveraged from advantageous social positions can offset or are offset by the disadvantages stemming from other simultaneous social positions. While comparison of outcomes of the extreme social groups (for instance non-poor upper caste and poor backward caste) often lead to expected results, studying the middle part of the social spectrum often yields interesting findings. Also, one may question if social group affiliation, such as caste-identity plays a significant role within a particular class or vice versa. Quantitative attempts to understand these processes comprise frontier literature in social sciences.

The second set of literature that this study refers to engages with the notion of women's empowerment. Recent studies have proposed newer methods of measuring women's empowerment. This paper aims to understand the agriculture–nutrition pathways operating through the channel of women's empowerment, at the intersections of the different axes of social power.

2.1 Intersectional Inequality

While the importance of identities associated with particular group affiliations is irrefutable with regard to well-being (in our context health) outcomes, the complex interactions of multiple identities have also attracted scholarly attention, particularly within the realm of feminist studies (Davis, 2008). Different axes of social power, such as gender, economic class, ethnicity, and caste are often simultaneously operative, with significant interactions among each other. Crenshaw (1989) coined the term 'intersectionality' to capture the multifaceted discriminations (associated with gender and race) faced by Black women to defy to the 'single-axis framework' that implicitly assumed all women to be White and all Blacks to be men. A growing body of research has addressed the issue of intersectionality (Weber & Parra-Medina, 2003), mostly adopting qualitative methodologies. Sen et al. (2009) have devised a simple and powerful methodology for quantitative analysis of the interactions of different axes of social power. Using this method, recent literature has asked important questions to analyse multidimensional inequalities in healthcare-seeking behaviour of individuals (Iyer et al., 2007; Sen & Iyer, 2012; Sen et al., 2007, 2009). Rigorous statistical testing has helped identify the varying importance of different social inequalities in different social settings.

Mukhopadhyay and Chakraborty (2018) point out that in India child undernutrition is characterized by an absent sex gap, though the country is infamous for gender disparity, reflected in indicators such as sex ratio, child mortality, and son preference. They invoke the framework of intersectionality to investigate the variations in the nutritional status of children across the intersections of the two axes, sex, and caste.

2.2 Alternative Ways of Measuring Women's Empowerment

The conceptual framework for computing women's empowerment put forth by Kabeer (1999) paved the way for most of the work in this realm. The framework consists of three interlinked dimensions: resources, agency, and achievements. Resources are referred to as the preconditions or endowments which help in facilitating women's empowerment. This includes economic resources and human and social resources, which strengthen the capacity to make choices. The dimension of agency is defined as: 'the ability of the woman to define her goals and act upon them, often measured through decision-making power'. (Kabeer, 1999). Finally, the achievements are defined as: 'the extent to which potential is realised and whether it has transformative power' (Kabeer, 1999, 2005).

One of the recent applications of this framework to formulate a measure of women's empowerment can be found in the WEI Report (UNICEF, 2020). It has considered four domains pertaining to the resources and agency. The domains are Economic Domain, Human and Social Resources, Household and Sexual/Reproductive Decision-Making, and Attitude towards Socio-Cultural Norms. The first two domains are associated with the resources component, whereas the last two are related to the agency component of empowerment.

Ewerling et al. (2017) formulate a parsimonious index of women's empowerment, Survey-based Women's emPowERment index (SWPER) using only 15 survey questions in three domains: social independence, decision-making, and attitude to violence. This index has been validated and shown to reflect the effect of empowerment on health outcomes better than other indices in low- and middle-income countries (Ewerling et al., 2020). This index can be conveniently constructed and used for cross-sectional and temporal comparisons.

The recently formulated Women's Empowerment in Nutrition Index (WENI) emphasizes that women's nutritional statuses matter in their own right (Narayanan et al., 2019). This framework identifies four dimensions of nutritional empowerment: resources, agency, achievement, and knowledge. The first three dimensions are derived from the conceptual framework of Kabeer (1999). Knowledge, resources, and agency are the dimensions of empowerment and would be used in computing WENI. There are three domains relevant to nutritional empowerment—food, health, and institutions. Another sub-domain, fertility, is incorporated in the list as a critical aspect of nutritional empowerment for women of reproductive age.

This paper uses three indices of women's empowerment (details provided in the next section), similar to the ones described above, and explores how they are associated with intersectional positionalities of women in agricultural households. It then examines how these indices predict women's BMI status, controlling for religion, caste, and class, and their intersections.

3 Data and Methods

3.1 Data

We use unit-level data from the second round of the India Human Development Survey (IHDS), a nationally representative panel survey, conducted jointly by the National Council of Applied Economic Research (NCAER) and the University of Maryland. So far, two rounds of IHDS have been conducted. IHDS-1, conducted in 2004–05, covered 41,554 households 1503 villages, and 971 urban neighbourhoods across India. The second round of IHDS re-interviewed most of these households in 2011–12. IHDS-2 covered 42,152 households in 1420 villages and 1042 urban neighbourhoods throughout India. There is an 85% re-interview rate between two surveys. IHDS-1 and 2 were designed to complement existing Indian surveys by covering a wide range of topics in a single survey. It covered topics concerning health, education, employment, economic status, marriage, fertility, gender relations, social capital, village infrastructure, wage levels, and panchayat composition. The data provides information on female members of the household belonging to the age range of 15–80 years. Since this paper intends to study the agriculture–nutrition pathway operating through women's empowerment, the analysis is conducted only on women from households associated with agriculture. Thus, the analysis has been restricted to 15,688 women.

3.2 Methods

This paper understands class as economic class. Households are divided into quintiles of per capita income and the bottom two quintiles are considered poor. Class has been constructed as a dichotomous variable, with the three upper quintiles labelled 'non-poor'. Social group affiliation is defined by intersecting religion and class. We consider seven social groups. The caste-based Hindu society is divided into Brahmins, Forward Castes, Other Backward Castes, Scheduled Castes and Scheduled Tribes. The other two social groups are Muslims and 'Other Religions'. The latter have been clubbed together because of small sample size. The control variables used in our regression exercises are woman's age, marital status, and number of household members. In the last block of Table 4, we consider the intersectional groups. To limit the number of groups and to facilitate interpretation, we club Brahmins, Forward Castes, and OBCs as Upper Castes (UC). We thus have five social groups (UC, SC, ST, Muslims, and Other Religions), two economic classes (poor and non-poor), and ten intersectional categories across the axes of social group affiliation and economic class (details in Table 5).

3.2.1 Construction of SWPER

Ewerling et al. (2017) have constructed a parsimonious index of women's empowerment using 15 items, easily available in household surveys like the Demographic and Health Surveys. Most of the items are available in IHDS. The questions on attitude to wife-beating have been replaced with the question asking if wife-beating on the particular grounds was common in the community (Tables 1, 2, and 3).

Using these indicators, principal components analysis is conducted, following Ewerling et al. (2017). After an examination of the scree plot, the third component is taken to be SWPER.

Table 1 Items used in the development of the survey-based women's empowerment index (SWPER) Source: Author's calculations from NFHS unit-level data

Items in Ewerling et al. (2017) framework	The relevant IHDS question
Beating not justified if wife goes out without telling husband	In your community is it usual for husband to beat his wife if she goes out without telling him?
Beating not justified if wife neglects the children	In your community is it usual for husband to beat his wife if she neglects the house or the children?
Beating not justified if wife argues with husband	Replaced with: beats the wife if she does not respect elders of the family
Beating not justified if wife refuses to have sex with husband	Replaced with: beats the wife if he suspects her of having relation with other men
Beating not justified if wife burns the food	In your community is it usual for the husband to beat his wife if she does not cook properly?
Frequency of reading newspaper or magazine	How often do women in your household read newspaper?
Respondent worked in past 12 months	Are you currently working on the farm OR for pay/wages
Woman's education in completed years of schooling	Years of education
Education difference: woman's minus husband's completed years of schooling	Constructed
Age difference: woman's age minus husband's age	Constructed
Age at first cohabitation	Age first started living with husband/had Gauna (in years)
Age of woman at first birth*	Constructed
Who usually decides on respondent's health care	Who has the most say in deciding what to do when you fall sick?
Who usually decides on large household purchases	Most say in buying expensive items for household like TV or fridge/buying land or property?
Who usually decides on visits to family or relatives	Do you have to ask for permission to go to the home of relatives or friends?

3.2.2 Construction of IWE

This study uses a similar framework as the report by UNICEF (2020) in order to construct the IWE. Pertinent variables from the data were identified and added to each domain. An empowerment cut-off was set for each indicator; an individual having a value below the empowerment threshold was considered to be disempowered. Then, the variables were converted to binary variables and assigned the value of 1, indicating empowered, or 0, indicating disempowered.

Economic domain:

The WEI report included two indicators in this domain: paid employment and house or land ownership. IHDS has variables pertaining to these two indicators. IHDS asks if a woman is currently working for pay/wages. Home or land ownership is represented in IHDS by asking if a woman has her name enlisted on the ownership or rental papers for her home. Also, IHDS provides information on whether or not a woman's name is on any bank account. This too is added to the economic domain. A woman is considered empowered in the indicator of ownership if she has her name on rental papers or any bank account.

Human and social resources:

In the original framework, this domain is represented by educational attainment, exposure to media, exposure to family planning, knowledge about modern contraception, knowledge about access to contraception, and knowledge about HIV/AIDS. Educational attainment can be found as years of education completed in IHDS. The variable is continuous but has been reconstructed as a binary variable based on a cut-off value in which a woman is considered empowered if she has completed primary education. How often women in a household read a newspaper is taken into consideration for the indicator on exposure to media. A woman is considered disempowered if she never reads the newspaper and anything otherwise is considered to empowering. IHDS does not provide any information regarding access to family planning information directly. However, it asks the women if they have any knowledge about post-sterilization weakness in men. This has been used as a proxy for the access to family planning information indicator. A woman is considered empowered if she has apt knowledge about it, if she is aware of the fact that sterilization does not cause weakness in men. IHDS asked a woman about what method of contraception she was using to prevent or delay pregnancy. This has been used for the indicator of knowledge about modern methods of contraception. A woman is considered empowered if she uses any kind of contraceptive method and disempowered if she does not use anything. IHDS enquired about what method of contraception the woman was using. This has been used for the indicator of knowledge about access to contraception. A woman is considered empowered if she uses condom. It is assumed that if she uses the method, she has knowledge about how to access it. IHDS provides information on whether or not a woman is aware of HIV/AIDS. This has been used for the indicator of knowledge about transmission of HIV/AIDS. A woman is considered empowered if she has heard of it and disempowered if she is not aware of the illness.

Household and sexual/reproductive decision-making:

From WEI Report (2020), the indicators for this domain include birth spacing and limiting, decision-making power on large household purchases, own health care, visiting family or relatives, husband/partner's earnings, ability to refuse sex, and freedom/ability to ask partner to use condom during sexual intercourse. IHDS asks a woman if she has any say in the number of children she wants to have. This is an indicator for the say in birth spacing and limiting. A woman is considered empowered if she has a say in the number of children she wants to have. For the next four indicators of decision-making power on large household purchases, own health care, vising family and husband/partner's earnings, IHDS provides information on whether or not a woman has a say in buying expensive items for the household (T.V., Fridge)/land or property, what to do when she falls sick, she needs to ask for permission before visiting relatives or friends and if she discusses with her husband about what to spend money, respectively. A woman is considered empowered if she can make decisions herself or jointly with her partner or does not need to take permission and disempowered if she does not have a say in any decision-making process. No data concerning the last two indicators could be found in IHDS. Thus, these two were not incorporated into the index.

Attitude towards socio-cultural norms and phenomena:

This domain has six indicators: whether the woman justifies wife beating in the following five situations (1) if she goes out without telling him, (2) if the wife neglects the children, (3) if the wife argues with the husband, (4) if the wife refuses to have sex with the husband, (5) if the wife burns food. Information on the woman's attitude to wife beating is not available in IHDS data. IHDS has asked if wife-beating is common at the community level due to certain reasons, namely, if it is usual for the husband to beat his wife when she goes out without telling him, when she neglects the house or children, when the wife does not respect elders in the family, when she is suspected of having relation with other men. A woman is considered empowered if she is not used to wives getting beaten up in her community in the aforesaid situations and considered disempowered otherwise.

Using these indicators, principal components analysis is conducted, following Ewerling et al. (2017), so that the indices are comparable. After an examination of the scree plot, the third component is taken to be IWE.

3.2.3 Construction of IWEN

Following this framework of Narayanan et al. (2019), we have seven domain-dimensions (D-D) for women and ten for women of reproductive age. For each D-D, relevant indicators are identified, modified, and incorporated in the formulation of the index. An empowerment cut-off was set for each indicator, women having a value below the empowerment threshold were considered to be disempowered. Then, the variables were converted to binary variables and assigned the value of 1,

Table 2 Items used in the development of the Index of Women's Empowerment (IWE) Source: Author's calculations from NFHS unit-level data

UNICEF (2020) framework	IHDS question
Domain: Economic	
Woman is in continuous, paid employment	Are you currently working on the farm OR for pay/wages?
Woman owns house/land alone or jointly with her partner	Is your name on the ownership or rental papers for your home? Is your name on any bank account?
Domain: Human and social resources	
Woman has completed secondary or higher education	Years of education completed
Woman has exposure to media	How often do women in your household read newspaper?
Woman has exposure to family planning information	Do men become physically weak even months after sterilization?
Woman has knowledge of at least two methods of modern contraception	Which method of contraception are you using to prevent or delay pregnancy?
Woman has knowledge about where male/female condoms can be accessed	Which method of contraception are you using? (considering Condom)
Woman has knowledge about HIV/AIDS prevention and transmission, including mother-to-child transmission (MTCT)	How is HIV/AIDS transmitted?
Domain: Household and sexual/reproductive decision making	
Birth spacing and limiting	Who has the most say in the number of children you have? When do you want your next child to be born?
Woman decides alone or with husband about large household purchase	Who has the most say in buying expensive items for household like TV or fridge/buying land or property
Woman decides alone or with husband about seeking healthcare for herself	Who has the most say in deciding what to do when you fall sick?
Woman decides alone or with partner about visiting family or relatives	Do you have to ask for permission to go to the home of relatives or friends?
Woman decides alone or with partner about where/how husband's earnings would be spent	Do you and your husband talk about what to spend money on?
Woman can refuse sex with husband/partner	NA
Woman can ask her partner to use a condom during sexual intercourse	NA
Woman can seek permission to get medical treatment for herself without a problem	Who has the most say in deciding what to do when you fall sick?
Domain: Attitude towards socio-cultural norms and phenomena	
Woman thinks that wife-beating is not justified if the wife goes out without telling him	In your community is it usual for husband to beat his wife if she goes out without telling him?

(continued)

Table 2 (continued)

UNICEF (2020) framework	IHDS question
Woman thinks that wife-beating is not justified if the wife neglects the children	In your community is it usual for husband to beat his wife if she neglects the house or the children?
Woman thinks that wife-beating is not justified if the wife argues with the husband	In your community is it usual for husband to beat his wife if she does not respect elders of the family
Woman thinks that wife-beating is not justified if the wife refuses to have sex with the husband	In your community is it usual for husband to beat his wife if he suspects her of having relation with other men?
Woman thinks that wife-beating is not justified if the wife burns the food	In your community is it usual for the husband to beat his wife if she does not cook properly?

indicating empowered, or 0, indicating disempowered. The D-D-specific variables are discussed elaborately as follows:

Food:

Food Knowledge: It includes knowledge of calcium and iodine. IHDS does not provide any information on this. However, it has information on whether or not a woman has any knowledge about the impact of the smoke from wood/dung burning traditional chulha. This has been used as a proxy indicator of health knowledge. A woman is considered empowered if she is aware of the fact that the smoke is harmful and disempowered if she has no knowledge about it. In addition to this, two more relevant indicators were added to this D-D from IHDS data. It also provides information on awareness regarding drinking milk (1–2 glasses every day) during pregnancy and the first yellow milk that comes out post-delivery of a child. A woman is considered empowered if her answer to these questions is correct.

Food Resources: Originally this D-D includes nine indicators: does paid work, participation in non-agriculture, participation in agriculture, aid for crop and livestock production, financial support for business, access to food aid and employment scheme, asset owned by individual, no imposed dietary restrictions and eating together. IHDS provides information on whether woman has her name on rental papers or any bank account. This has been used for the indicator of asset ownership. A woman is considered empowered if she has any bank account or has her name on ownership or rental papers of her home. IHDS provides information on the dietary practices of the household members. It asks if any member of the household consumes non-vegetarian food items. This has been used as a proxy for dietary restrictions. IHDS provides information regarding the eating order of household members. It is considered to be empowering when all the family members eat together and the woman eating last is disempowering.

Food Agency: This D-D includes six indicators: say in cultivation decision, kitchen garden production, major/minor decision regarding household enterprise, rent or sell of own asset, expenditure of own contribution to income, and purchasing food

items. Say in cultivation decision is represented by whether or not the wife discusses with the husband about the things that happen on farm/work. A woman is considered empowered if she discusses farm/work-related things with her husband. Say in kitchen garden production could not be included because IHDS does not provide any information on the same. IHDS provides information on whether or not a woman has a say in the decision of how much money to spend on social functions such as marriage, to buy an expensive item such as TV, fridge, and land or property. These are used as proxies for say in major/minor decisions regarding household enterprise and rest or sell off own assent. A woman is considered empowered if she has a say in the decision-making process in the aforementioned situations. IHDS asks who has the most say in decisions about a woman's work and this has been used as a proxy for expenditure of own contribution to income. A woman is considered empowered if she herself has the most say in the decision regarding her work and disempowered if others make the decision for her. IHDS provides information on who does the food and vegetable shopping in the household and this is used as a proxy for the indicator of say in purchasing food items. A woman is considered empowered if she herself does the vegetable shopping assuming that this would mean she has a say in purchasing food items for the house. Three additional indicators were added to this D-D: say in livestock production, farm decision, and what to cook on daily basis. IHDS provides information on whether or not a woman has any say in decision regarding livestock production and farm-related work. IHDS also provides information on whether or not the woman has any say in deciding what to cook on daily basis. A woman is considered empowered in all of the three indicators if she has any say in the decision-making process related to livestock production, farm work, and cooking.

Health:

Health Knowledge: This includes: knowledge of anaemia, ORS, and Malaria. IHDS does not provide any information on anaemia and it has been dropped from the D-D. How much should be given to drink when children have diarrhoea is used for the indicator of knowledge of ORS. A woman is considered to be empowered, that is, has ORS knowledge, if she knew that more than usual quantity of drinks were to be given during diarrhoea. IHDS also provides information on whether or not a woman is aware of what illness spreads through drinking impure water -TB, Typhoid, or Cancer. This too is included in this D-D. How malaria spreads is used for the indicator of knowledge of malaria.

Health Resources: The D-D includes questions asking if the woman does no activity, paid or unpaid, which is heavy, does no activity, paid or unpaid, with risk of injury or health problems, has help with domestic and care work, was not ill in past 30 days (chronic or otherwise) or sought treatment when ill, has help with housework when ill, has access to improved water, sanitation, and smoke-free kitchen. There is no data available related to the first two indicators in IHDS. IHDS provides information on whether or not a household employs any help or servants for cleaning, cooking, and childcare. This has been used for the indicator of household help. For the indicator

of treatment-seeking when ill, information regarding treatment seeking behaviour of an individual in case of major morbidities in the last 12 months from IHDS has been used. A woman is considered empowered if she receives any treatment or advice from the doctor. The rest of the indicators were dropped from the computation of the index due to the lack of data availability.

Health Agency: This D-D includes indicators on if a woman can go alone to the health care centre, does not need to take permission for going to healthcare centre, and can take decision on own health. These are represented by the respective indicators from IHDS, if a woman can go alone to the health centre, and if she has any say in the decision about what to do when she falls sick. A woman is considered empowered if she can go alone or does not have to ask for permission before going to the health centre and also if she herself has a say in deciding what to do when she falls sick. Another relevant indicator from IHDS data was added to this D-D: If a woman has any say in deciding what to do when her child falls sick. A woman is considered empowered if she has a say in what to do in case her child falls sick. For the indicators of access to improved water and sanitation, IHDS has information regarding the household's accessibility to water and toilet. A woman is considered empowered if the household has access to water and toilet facilities. Access to smoke-free kitchen has been represented by two pertinent variables from IHDS. It provides information on what kind of chulha a household uses and if there is a window or vent in the cooking area. A woman is considered empowered in these indicators if she has access to a kitchen with chimney and if there is a window or vent present in the kitchen area.

Institutions:

This D-D includes seven indicators: membership (member or non-membership of groups out of their own volition), access to information about government schemes, intimate partner violence: freedom of movement, no risk of sexual harassment in paid or other work, veil use, and public/civic engagement.

IHDS provides information on whether or not a woman is a member of mahila mandal/SHG/credit or saving group/political organization. A woman is considered empowered if she is associated with any of the groups. Information on access to information about government schemes is not available in the IHDS dataset and is dropped from the calculation.

Intimate partner violence is represented by a series of questions in IHDS: if it is usual in the community for the husband to beat his wife if she goes out without telling him/having relation with other men/natal family does not give money or jewellery/neglects the house or children/does not respect elders of the family/does not cook properly. A woman is considered to be empowered if she finds it unusual when the husband beats the wife in the aforementioned situations. IHDS provides information on whether or not a woman can go alone to the home of relatives or friends/kirana shop/short distance by train or bus. These are used for the indicator of freedom of movement. A woman is considered empowered if she can go to these places alone. There is no information available workplace harassment in IHDS. However, the data

provides information on how frequently are unmarried girls harassed in your village or neighbourhood. This has been used as a proxy for sexual harassment at workplace. It is considered to empowering when unmarried girls are rarely harassed in the village or neighbourhood.

IHDS provides information on whether or not a woman practices any sort of veil: ghunghat/burkha/purdah/pallu. A woman is considered to be empowered if she does not practice any kind of veil. Finally, whether or not a woman has attended public meeting/gram sabha/nagarpallika/ward committee in the last year has been taken into consideration for the indicator of public or civic engagement. A woman is considered to be empowered if she engaged herself in any of these pubic or civic meetings.

Fertility:

Fertility Knowledge: The D-D is represented by two indicators: knowledge of menstrual cycle and pregnancy and knowledge of different diets during pregnancy. IHDS provides information on whether or not a woman has adequate knowledge about menstrual cycle and pregnancy. It asks a woman if she knows in which part of her menstrual cycle she is most likely to get pregnant.

Fertility Resources: The D-D includes Ability to secure an adequate, appropriate, and diverse diet during pregnancy, if the woman did not undertake heavy physical activity after the eighth month of pregnancy, did not do heavy physical activity after a month of delivery, received support in housework during pregnancy, had at least one antenatal check-up and at least one postnatal check-up. IHDS provides information on whether or not a woman received any meals from ICDS and this has been used as an indicator of ability to secure adequate diet during pregnancy. IHDS does not provide any information pertinent to the next three indicators. Thus, they have been dropped from the index. IHDS has information on antenatal and postnatal check-up. A woman is considered empowered in these two indicators if she receives any antenatal and postnatal check-ups.

Fertility Agency: The D-D includes four indicators: say in use/not use of contraceptives, say in the choice of facility for delivery, say in total no of children, say in spacing of children. Say in use/not use of contraceptives is obtained from the IHDS variable which provides information on whether or not a woman and her husband is using any method of contraception. Assuming that she has a say in it (empowered) if the couple is currently using any method of contraception. IHDS also asks who motivated a woman to go to the health facility for delivery. A woman is considered to have a say in the choice of facility for delivery if she herself is the motivator. IHDS asks a woman if she has any say in the number of children she wants to have. This is an indicator for the say in total number of children a woman wants to have. A woman is considered empowered if she has a say in the number of children she wants to have. IHDS also provides information regarding a woman's preference on when to have the next child and this is considered an indicator for say in spacing of children. A woman is considered to be empowered if she has any preference in this matter.

Using these indicators, principal components analysis is conducted, following Ewerling et al. (2017), so that the indices are comparable. After an examination of the scree plot, the third component is taken to be IWEN.

Table 3 Items used in the development of the Index of Women's Empowerment in Nutrition (IWEN) Source: Author's calculations from NFHS unit-level data

Narayanan et al. (2019) framework	IHDS variables
Food knowledge	
Knowledge of calcium	Is smoke from wood/ dung burning traditional chulha good or harmful for health o do you think it does not matter?
Knowledge of iodine	Is it harmful to drink 1–2 glasses of milk every day during pregnancy?
	Do you think the first yellow milk that comes out after delivery is good for the baby?
Food resource	
Does paid work as employee	NA
Participation in non-agricultural household enterprise	NA
Participation in agriculture and allied activities	NA
Aid for crop and livestock production	NA
Financial support for business	NA
Access to food aid and employment schemes	NA
Assets owned by individual	Is your name there on any bank account? Is your name on the ownership or rental papers for your home?

(continued)

3.2.4 Econometric Analysis

Following Sen et al. (2009) and Mukhopadhyay and Chakraborty (2018), this study will use the regression approach to capture intersectionality quantitatively. This method has been pioneered in the last decade as a simple and elegant tool to capture

Table 3 (continued)

Narayanan et al. (2019) framework	IHDS variables
No imposed dietary restrictions	Does anyone in your household eat non-vegetarian?
Eating order (all eat together)	Family meal: who eats first?
Food agency	
Say in cultivation decision	Discuss with husband about things that happen on the farm/ work
Say in kitchen garden production	NA
Say in major/minor decision regarding household enterprise	Respondent's say in the decision of how much money to spend on social functions such a marriage?
Say in rent or sell off own asset	Respondent's say in the decision of whether to buy an expensive item such as TV or Fridge and Whether to buy land or property?
Say in expenditure of own contribution to income	Who has the most say in decisions about your work?
Say in purchasing food items	Who does the food and vegetable shopping in your household?
	Say in livestock production
	Say in Farm related work
	Say in what to cook on daily basis
Health knowledge	
Knowledge of anaemia	NA
knowledge of ORS	How much should be given to drink when children have diarrhoea? Which illness spread through drinking impure water-TB, Typhoid or Cancer?

(continued)

Table 3 (continued)

Narayanan et al. (2019) framework	IHDS variables
Knowledge of Malaria	How Malaria spreads?
Health resource	
Does no activity, paid or unpaid, which is heavy	NA
Does no activity, paid or unpaid, with risk of injury or health problems	NA
Has help with domestic and care work	Do you employ any household help or servants for cleaning, cooking or childcare?
Not ill in past 30 days (chronic or otherwise) or sought treatment when ill	In the last 12 months has he/she received any treatment or advice?
Has help with housework when ill	NA
Access to improved water	What is the main source of water for drinking in your house?
Access to improved sanitation	Does the household have access to any toilet?
Access to smoke-free kitchen	What type of chulha does the household use and is there a window or vent in the cooking area?
Health agency	
Can go alone to health centre when required	Can you go alone to the local health centre?
Does not need to take permission for going to health centre	Do you have to ask for permission from your husband or anyone else to go to the local health centre?
Takes decision on own health	Respondent's say in the decision when she falls sick?
	Say in what to do when her child falls sick

(continued)

Table 3 (continued)

Narayanan et al. (2019) framework	IHDS variables
Institution	
Membership: member or non-membership of groups out of their own volition	Are you a member of mahila mandal/SHG/ credit or savings group/political organization?
Access to information about government schemes	NA
Intimate partner violence: does not experience it or gets family support in such a situation	Husband beats wife if goes out without telling him/having relation with other men/natal family does not give money or jewellery/ neglects the house or children/does not respect elders of the family/does not cook properly
Freedom of movement: has visited bank/post office unaccompanied/can visit family alone	Can go alone to the home of relatives or friends/kirana shop/short distance by train or bus
No risk of sexual harassment in paid or other work	How frequently are unmarried girls harassed in your village or neighbourhood?
Veil use: does not practice it	Do you practice ghunghat/burkha/pardah/ pallu?
Public/civic engagement: participated in rally/ protests/petition/speaking in public	Have you attended public meeting/gram sabha/ nagarpallika/ward committee in the last year?
Fertility knowledge	
Knowledge of menstrual cycle and pregnancy	In which part of the menstrual cycle a woman is likely to get pregnant?
Knowledge of different diets during pregnancy	NA
Fertility resource	
Ability to secure an adequate, appropriate, and diverse diet during pregnancy	Has received any food/meals from ICDS?
Did not undertake heavy physical activity after the 8th month of pregnancy	NA
Did not do heavy physical activity after a month of delivery	NA
Received support in housework during pregnancy	NA
At least one antenatal check-up	Did you have an antenatal check-up while you were pregnant?
At least one postnatal check-up	After 2 months of delivery, did any doctor or other health professional check your health or the health of your baby?

(continued)

Table 3 (continued)

Narayanan et al. (2019) framework	IHDS variables
Fertility agency	
Say in use/not use of contraceptives	Are you and your husband currently using any method to delay or prevent pregnancy?
Say in the choice of facility for delivery	Who facilitated or motivated you to go to a health facility for delivery?
Say in total no of children	Most say in the number of children you have?
Say in spacing of children	When would you want your next child to be born?

intersectionality quantitatively (Sen et al., 2009). The method requires creation of a set of dummy variables for each intersecting category. With two dimensions, for example, economic class (categorized into poor and non-poor) and caste (taken as a dichotomous variable, with two castes, backward and other), there would be four categories in the heuristic matrix: d1 = poor backward caste; d2 = non-poor backward caste, d3 = poor, other caste and d4 = non-poor other castes. The differences between the dummies can be then tested using regression, where empowerment status is regressed on a list of covariates and these intersectional dummies. We run quantile regression since the empowerment scores have asymmetric distributions.

For the second research question (how empowerment is associated with women's BMI status), we include these intersectional dummies as covariates in an ordered logistic model. The dependent variable is BMI status (grouped into three categories, underweight normal, and overweight) and the woman's empowerment scores (SWPER, IWE, and IWEN) are used as regressors in three different models.

4 Results and Discussion

We discuss our findings on the factors associated with IWE and IWEN in the agricultural households of rural India. We examine if the statistical significance of social group affiliation, class, and intersectional positionalities differs when we use the nutrition-specific indicator of women's empowerment. We also intend to see if the pattern of association between women's empowerment and caste, class, and their intersections differs across the distribution of empowerment.

Another objective of the paper is to find out if the two indices differentially affect maternal health, measured in terms of body mass index. We examine this by controlling for the positionalities along social group affiliation and class.

4.1 The Correlates of Women's Empowerment

Following the method outlined in Sect. 3, SWPER, IWE, and IWEN are taken to be the third components after an examination of the scree plots following the respective principal component analysis. Figures 1, 2, and 3 represent the Kernel Density Plots of SWPER, IWE, and IWEN respectively. While SWPER has a bimodal distribution with a median score of 0.04, IWE and IWEN both have multimodal, positively skewed distributions, with median scores of −0.12 and 0.01, respectively.

The nature of the distributions suggests that quantile regression may have its advantages over OLS regression, when we intend to find out the correlates of empowerment of women. We also intend to see if the degree of association of a correlate (particularly the caste-class intersections) vary across the distribution of empowerment.

The Association of Religion, Caste, Class, and their Intersections with SWPER

Table 4 shows that women from poorer agricultural households have lower SWPER scores. However, compared to Brahmins, all other social groups have significantly higher SWPER scores. Testing the differences within categories, we find that women from backward castes and Muslim women do not have significantly different scores compared to Non-Brahmin Forward Castes and OBCs. There is a large body of literature which suggests that women from Brahmin households may be less empowered (Chakravarti, 2018/2003). The institution of Brahmanical patriarchy operates by upper caste women subjecting themselves to dominance, since they often have greater stakes in the market and lesser fallback options outside the marriage. Mukhopadhyay (2016) has shown that while a significant sex disparity is absent in child nutrition in India, girls from upper caste households are more likely to be stunted than boys.

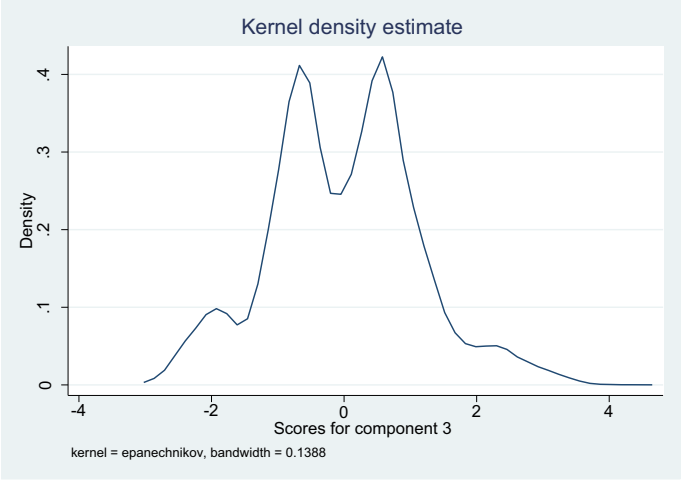


Fig. 1 Kernel density plot of SWPER Source: Author's calculations from NFHS unit-level data

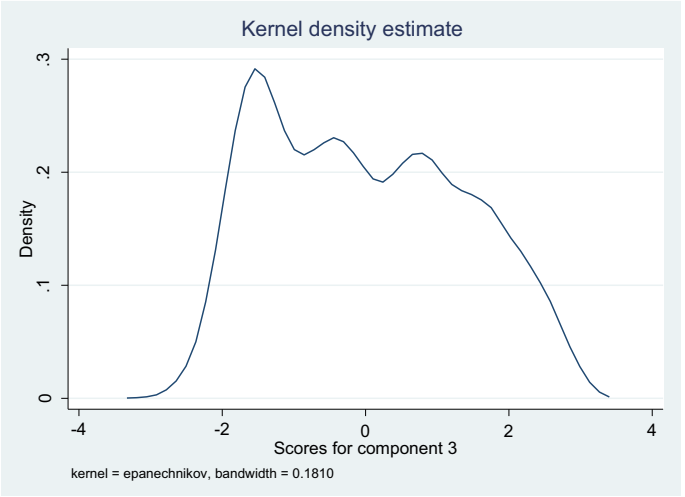


Fig. 2 Kernel density plot of IWE Source: Author's calculations from NFHS unit-level data

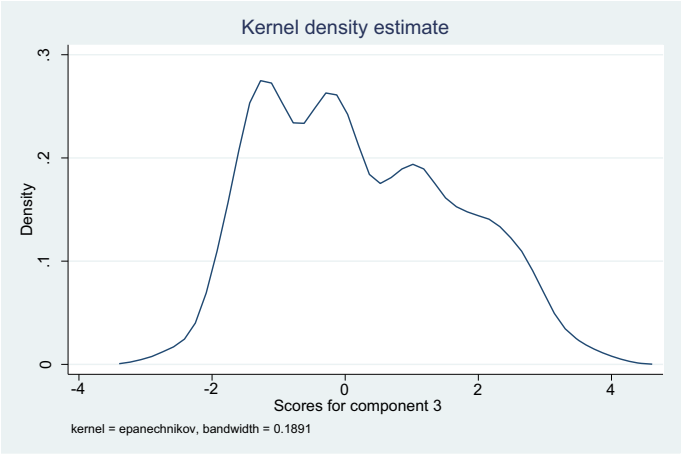


Fig. 3 Kernel density plot of IWEN Source: Author's calculations from NFHS unit-level data

Model 2 in Table 4 shows that among the intersectional groups, women from poor Scheduled Tribe households and poor upper caste households have significantly lower empowerment than the reference group comprising non-poor upper caste women. While within Scheduled Castes and Scheduled Tribes, poor women are less empowered than non-poor women, there is no significant class advantage among Muslims.

When we model the conditional quartiles, we find that our major results remain unaltered for the first and third quartiles (results not reported).

Table 4 Quantile regression of SWPER, IWE, and IWEN of women in agricultural households in India on social group affiliation and class and their intersections

Correlates^		SWPER	IWE	IWEN
Model 1				
Social group (base: Hindu Brahmin)	Hindu forward caste	0.40***	0.05	0.07
	Hindu OBC	0.22***	−0.88***	−0.76***
	Hindu SC	0.28***	−0.94***	−0.87***
	Hindu ST	0.23***	−1.31***	−1.18***
	Muslim	0.27***	−1.07***	−0.87***
	Other religions	−0.03***	1.05***	1.07***
Class (base: non-poor)	Poor	−0.15	−0.56***	−0.51***
Model 2 (with intersectional dummies)				
Intersectional positions (base: non-poor UC)^	Poor SC	−0.13	−1.12***	
	Non-poor SC	0.06	−0.52***	
	Poor ST	−0.18***	−1.47***	
	Non-poor ST	0.19	−0.78***	
	Poor UC	−0.13***	−0.86***	
	Poor Muslim	0.05	1.24***	
	Non-poor Muslim	−0.10	1.26***	
	Poor other Religion	−0.11	−1.20***	
	Non-poor Other Religion	−0.40***	−0.60***	

Source Author's calculations on unit-level dataset of IHDS, round 2
^We control for woman's age, marital status, and household size

The Association of Religion, Caste, Class, and their Intersections with IWE

Table 4 shows the results of the quantile regression of IWE. Model 1 shows that controlling for age, marital status, and household size of women, we find that the poor have significantly lower IWE scores than the non-poor. However, once we consider IWE instead of SWPER, Brahmins have significantly higher empowerment scores than all other social groups, except Non-Brahmin forward caste Hindus and 'Other Religions'. This may be because IWE includes a longer list of items pertaining to resource and access. We test the statistical significance of the differences between the other social groups and find that Scheduled Tribe women have significantly lower IWE scores than Scheduled Caste and Muslim women.

Model 2 shows how IWE differs across the caste-class intersections. We find that all the intersectional categories have significantly lower IWE scores compared to non-poor upper castes. We also find that within each social category in the caste-based Hindu society and within Muslims, there are significant class differences, with the non-poor having significantly higher IWE than the poor. This result, however, does not hold for the 'Other Religions'.

Quantile regression shows that class and social group affiliation have similar patterns of association with IWE along the distribution of IWE. To wit, the non-poor and the Upper Caste Hindus have significantly higher IWE scores both at the first and the third quartiles of IWE. As in the case of the median regression, when we model the conditional quartiles, we find that the last result does not hold for 'Other Religions'. Again, at both the first and third quartiles, we find that within each social group, the class difference is significant (results not reported).

Using IWEN as the Regressand

Table 4 also shows the results of quantile regression of IWEN. Model 1 shows that when we consider the nutrition-specific index of women's empowerment instead of the general index, the class advantage is retained. Compared to women from poor agricultural households, those from non-poor agricultural households are more likely to be nutrition-empowered. The results with respect to social group affiliation are also similar to that for IWE, presumably due to the same reason.

The main findings regarding the significance of the intersectional positionalities of women in agricultural households remain unaltered when we consider IWEN scores instead of IWE scores as the regressand. Again, modelling the conditional quartiles of IWEN instead of IWE, we find that the results remain unchanged (not reported).

Robustness Checks

We run OLS regressions of SWPER, IWE, and IWEN using the same set of covariates and see that our findings are robust (results not reported).

4.2 The Association Between Women's Empowerment (SWPER, IWE, and IWEN) and Health

Controlling for women's age, marital status, number of household members, class, and caste, we find that a lower SWPER score is associated with a higher likelihood of a woman in an agricultural household being underweight (Table 5). Likewise, a higher SWPER score is associated with a higher likelihood of being overweight and obese. Poorer women and women from SC and ST households are more likely to be underweight and less likely to be overweight.

Table 5 Ordered logistic regressions of BMI status on SWPER, IWE, and IWEN

Empowerment index^	Odds ratio of being in a higher BMI class
SWPER	1.12***
IWE	1.35***
IWEN	1.28***

Source Author's calculations on unit-level dataset of IHDS, round 2
^We control for woman's social group affiliation, class, age, marital status, and household size

Table 6 Logistic regressions of morbidity on SWPER, IWE, and IWEN

Empowerment index^	Odds ratio of being in a higher BMI class
SWPER	0.98***
IWE	0.94***
IWEN	0.85***

Source Author's calculations on unit-level dataset of IHDS, round 2
^We control for woman's social group affiliation, class, age, marital status, and household size

Irrespective of how we choose to measure empowerment (using IWE or IWEN instead of SWPER), we find that women with higher empowerment scores in agricultural households are less likely to have a body mass index below the cut-off level. However, they are the ones who have a greater likelihood of being overweight and obese. It is somewhat surprising that even IWEN, the nutrition-specific indicator of women's empowerment, which includes domains like food knowledge is positively associated with the likelihood of being overweight or obese.

Robustness Check

We check the association of the empowerment scores with BMI, taken as a continuous indicator, and find that our results are robust (results not reported).

Explaining Morbidity

As an additional exercise in validation of the empowerment indices, we also check the association of the empowerment indices and find that all three are significantly associated with the likelihood of being indisposed for more than 15 days in a year. To wit, a woman with higher empowerment scores (according to all three indices) is less likely to be suffering from a chronic ailment due to which she was indisposed for more than 15 days during the last year. This strengthens our scepticism regarding the usefulness of more elaborate measures of measurement for empirical evaluations (Table 6).

5 Conclusion

This study shows that the choice of the index of women's empowerment may be crucial to the substantive conclusions. Caution needs to be exercised by policymakers and analysts when they choose an index as the summary measure of women's status. This paper finds that SWPER is higher for women from backward castes, compared to those from Brahmin agricultural households, corroborating the findings of historical and sociological studies on the operations of Brahmanical patriarchy. However, this finding no longer remains once SWPER is replaced by alternative and broader indices like IWE and IWEN. This may be because the latter includes a number of items on access and resource, which are compromised for disadvantaged social groups.

With respect to the association of women's empowerment with their health in agricultural households, the three indices lead to an unambiguous result: body mass index is significantly higher for women with higher empowerment scores. It is somewhat surprising that the likelihood of being overweight and obese is higher for women with higher IWEN, just as it is with SWPER and IWE. Higher scores of IWEN, the nutrition-specific index, which includes domains like food knowledge, are not associated with lower likelihoods of being overweight and obese. Likewise, all three indices are associated with the likelihood of a woman being indisposed due to a chronic morbidity. We thus question, if we should use more parsimonious indices like the SWPER, since it has been validated and requires much less resources for data collection.

Recent literature has pointed out that India has an immense potential in exploring the agriculture–nutrition pathways by making agriculture pro-poor and pro-nutrition (Kadiyala et al., 2012; Mukhopadhyay, 2012). Systematic disparities across historically and politically relevant identities and their intersections are normatively unacceptable and deserve immediate policy attention. Exploring how inequalities operate across the axes of caste and class and at their intersections thus has important policy relevance. This study contributes to the understanding of the role of agriculture in empowering women and how it varies across the social spectrum.

Overweight and obesity are rising at alarming rates in India, even among the rural poor. Since the IHDS is a panel dataset, the issue of weight gain of women over time can be addressed using the dataset in the future research. Also, recent work has examined the sustainability of women's empowerment in terms of durability and diffusion using two rounds of IHDS data (Akter & Chindarkar, 2020). One limitation of the paper is that our empowerment indices are all static measures. Extending the framework of Akter and Chindarkar (2020) to conduct similar validation exercises would be interesting.

Acknowledgements This work has benefitted greatly from the comments and suggestions received at the two Workshops for the SPANDAN Grants, held on 14th February 2020 and 25 June 2021. I thank Prof. Alakh Sharma, the discussant of the paper, for his insightful suggestions on the paper. Thanks are also due to Prof. Achin Chakraborty for his comments and to Debopriti Bhattacharya for excellent research assistance.

References

Akter, S., & Chindarkar, N. (2020). An empirical examination of sustainability of women's empowerment using panel data from India. *The Journal of Development Studies, 56*(5), 890–906.

Chakravarti, U. (2018/2003) Gendering Caste Through a Feminist Lens. SAGE-Stree.

Coffey, D. (2015). Prepregnancy body mass and weight gain during pregnancy in India and sub-Saharan Africa. *Proceedings of the National Academy of Sciences, 112*(11), 3302–3307.

Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum, 1989*(1), 139–167.

Davis, K. (2008). Intersectionality as buzzword: A sociology of science perspective on what makes a feminist theory successful. *Feminist Theory, 9*(1), 67–85.

Ewerling, F., Lynch, J. W., Victora, C. G., van Eerdewijk, A., Tyszler, M., & Barros, A. J. D. (2017). The SWPER index for women's empowerment in Africa: Development and validation of an index based on survey data. *Lancet Global Health, 5*, e916–e923. https://doi.org/10.1016/S2214-109X(17)30292-9

Ewerling, F., Raj, A., Victora, C. G., Hellwig, F., Coll, C. V., & Barros, A. J. (2020). SWPER Global: A survey-based women's empowerment index expanded from Africa to all low- and middle-income countries. *Journal of Global Health, 10*(2), 020343. https://doi.org/10.7189/jogh.10.020434

Gillespie, S., & Kadiyala, S. (2011, February 10–12). Exploring the agriculture-nutrition disconnect in India. In *2020 Conference Brief 20, Prepared for the IFPRI 2020 International Conference, "Leveraging Agriculture for Improving Nutrition and Health"*.

Iyer, A., Sen, G., & George, A. (2007). The dynamics of gender and class in access to health care: Evidence from rural Karnataka. *India, International Journal of Health Services, 37*, 537–554.

Kabeer, N. (1999). Resources, agency, achievements: Reflections on the measurement of women's empowerment. *Development and Change., 30*, 435–464.

Kabeer, N. (2005). Gender equality and women's empowerment: A critical analysis of the third millennium development goal 1. *Gender & Development, 13*(1), 13–24.

Kadiyala, S., Joshi, P. K., Dev, S. M., Nanda Kumar, T., & Vyas, V. (2012). A nutrition secure India: Role of agriculture. *Economic & Political Weekly, XLVII*(8), 21–25.

Mukhopadhyay, S. (2012). Agriculture-nutrition pathways: Recognizing the obstacles. *Economic and Political Weekly, XLVII*(16), 79–80.

Mukhopadhyay, S. (2015). The intersection of gender, caste and class inequalities in child nutrition in India. *Asian Population Studies, 11*(1), 17–31.

Mukhopadhyay, S. (2016). On the apparent non-significance of sex in child nutrition in India. *Journal of Biosocial Science, 48*(2), 267–282.

Mukhopadhyay, S., & Chakraborty, A. (2018). Caste gender intersectionalities and the curious case of child undernutrition in India: A methodological exposition. In S. Banerjee & N. Ghosh (Eds.), *Caste and Gender in Contemporary India: Power, Privilège and Politics* (pp. 213–237). Routledge.

Narayanan, S., Lentz, E., Fontana, M., De, A., & Kulkarni, B. (2019). Developing the women's empowerment in nutrition index in two states of India. *Food Policy, 89*, 101780. https://doi.org/10.1016/j.foodpol.2019.101780

Rao, T., & Pingali, P. (2018). The role of agriculture in women's nutrition: Empirical evidence from India. *PLoS ONE, 13*(8), e0201115. https://doi.org/10.1371/journal.pone.0201115

Sen, G., & Iyer, A. (2012). Who gains, who loses and how: Leveraging gender and class intersections to secure health entitlements. *Social Science and Medicine, 74*(11), 1802–1811.

Sen, G., Iyer, A., & George, A. (2007). Systematic hierarchies and systemic failures: Gender and health inequities in Koppal District. *Economic and Political Weekly, 42*, 682–690.

Sen, G., Iyer, A., & Mukherjee, C. (2009). A methodology to analyse the intersections of social inequalities in health. *Journal of Human Development and Capabilities, 10*(3), 397–415.

UNICEF. (2020). Women's empowerment in Kenya: Developing a measure, Kenya National Bureau of Statistics, United Nation's Entity for Gender Equality and the Empowerment Women (UN Women) and United Nation's Children Fund. Retrieved June 19, 2021, from https://www.unicef.org/esa/media/8466/file/UNICEF-Kenya-2020-Womens-Empowerment-in-Kenya-2020.pdf.

Weber, L., & Parra-Medina, D. (2003). Intersectionality and women's health: Charting a path to eliminating health disparities. In: M. T. Segal, V. Demos, J. J. Kronenfeld (Eds.), *Gender Perspectives on Health and Medicine* (pp. 181–229). Elsevier Science Ltd.

Inter-Disciplinary Perspective on Food Security

Socio-legal Analysis of the Impact of Food Insecurity and Hunger on the Right to Health of Urban Poor Living in the State of Gujarat

S. Shanthakumar and S. Dhanya

1 Introduction

The World Summit 1996 proclaimed that 'Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (Food & Agriculture Organization of the United Nations, 1996). Life Science Research Office (LSRO) has defined food security as '*access to enough food for leading an active, healthy life*' (Committee on National Statistics, 2006). '*Food insecurity exists whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways are limited or uncertain*'. Hence, we can say that food insecurity is '*the limited and inadequate access to healthy and nutritious food which is sufficient to lead a healthy and productive life*'.

The term food security implies mainly four points namely availability of food, accessibility of food, utilization, and stability (Nations, 2008). Availability of food implies enough food production, i.e. ample amount of food is being produced or imported to fulfil the need of the present without compromising the needs of future generations. The term accessibility simply denotes economic and physical access to food, which means that the financial incapability shouldn't deprive people from accessing adequate food. Utilization means the effective consumption of the nutritious quality of the food to meet the dietary needs of the individual, it refers to feeding practices, food preparation, diversity of the diet, and intra-household distribution of food. Finally, stability means food security, i.e. the individual should have access to adequate food at all times (FAO, 2006). Food security analysts opine that there

S. Shanthakumar · S. Dhanya (✉)
Gujarat National Law University, Gandhinagar, Gujarat, India
e-mail: sdhanya@gnlu.ac.in

S. Shanthakumar
e-mail: vc@gnlu.ac.in

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_11

exist two major forms of food insecurity. It would be chronic food insecurity (long-lasting) if there is a deficiency in the bare minimum requirement of food grains to the vulnerable class for an ongoing period of time without any interruption, due to exertion, poverty, non-accessibility to financial sources, or other possessions. On the other hand, it would be termed as transitory food insecurity (short-term), when there is an unexpected loss of food or downfall in production process or plunge in accessibility to food, due to momentary fluctuations in food attainability or accessibility, in addition to annual fluctuation in domestic food production, cost of production and standard income. It shows that food security is quite a colossal and complex issue that is inherently tied to poverty, so much so that this strategic situation has been consistent for over a period of time. It is not food production that acts as a stumbling block, but rather the distribution of food that raises potent question against non-availability of food. For enumerating the share of food insecurity in each household, considering uncertainty, incompetency, and ineffective utilization or access to food, is deemed to be the standard method.

The roots of 'Human Right to food' can be traced to the 'Universal Declaration on Human Rights 1948', (UDHR, 1948). Under article 11 'The International Covenant on Economic, Social and Cultural Rights' also recognizes right to food as part of an adequate standard of living and proclaims that every individual has a right to be free from hunger (International Covenant on Economic, Social & Cultural Rights, 1966). When we peep into Indian Legal System, India is a signatory to many of the above-mentioned International Instruments and hence there is an obligation on the country to ensure food security to its citizens. The Indian Constitution doesn't have an express provision which guarantees the right to food to its citizens, however, there are certain indirect tacit provisions. Right to food is coherently interlinked with the concept of food security and the Constitution under Article 21 provides for the fundamental right to life which in its essence includes right to food also (Constitution of India, 1950). Further, the apex court once expressed 'life is not mere animal existence (Francis Coralie Mullin Vs. Administrator, Union Territory of Delhi, 1981) but life with dignity' (Maneka Gandhi versus Union Of India, 1978) and widened the scope of Article 21 to include all qualifying needs which are required to lead a dignified life. It is essential for an individual to get access to adequate food to lead a dignified life hence we can say that right to food is an inherent part of Article 21. The turning point in the event of ensuring food security in India can be said to be the Hon'ble Supreme Court's decision in PUCL versus UoI and the subsequent implementation of the Food Security Act in 2013. Even after routing many programmes and policies aiming to pull out people from the curb of hunger, the country is still undergoing severe instances of hunger and food insecurity.

Food security for any country is vital as the same plays a major role in the country's economic development. Non-accessibility to adequate food shall impair the enjoyment of other human rights such as right to health, education, and the fullest enjoyment of right to life. Food and health are having direct nexus with each other as nutritious food is an important factor in physical wellbeing. The food insecurity and hunger can bring in innumerable complications, the most significant being escalation

in innumerable chronic afflictions like malnutrition, stunting, and wasting in children; anaemia; obesity; diabetes, deliberate protein and iron deficiency, etc., which has directly jeopardized the living standards of poor population residing in urban areas (Ke & Ford-Jones, 2015). Hence, we can say that food insecurity is leading to unhealthy population and adding to the disease burden of the country and this unhealthy population will not contribute to the development of the country. Iron deficiency, especially in connection with pregnant and lactating mothers and children, has endured as a public health concern (Tamura et al., 2002). Iron deficiency can even have a negative impact on the school-going children and this can lead to unbidden hesitation and circumspection and those children would fail to gain fewer opportunities from school that are essential for their primary development.

The Global Hunger Index (GHI) 2021 ranked India 101th out of 116 participated countries is a matter of grave concern (Concern Worldwide; Welthungerhilfe, 2021). And the country ranked 71st by the Global Food Security Index, 2021 (Drishti IAS, 2021). Though the country has made some progresses since 2000 in both health and hunger-related indicators, still there exist issues in relation to accessibility of quality and nutritious food. India has made relative progress in indicators like malnutrition, stunting, IMR, MMR, etc., but is criticized for having the highest wasting rate of all countries participated in GHI (Concern Worldwide & Welthungerhilfe, 2021). Although there is a decrease in the GHI point of India from 38.8 in 2000 to 27.5 in 2021, still the level of hunger in the country is termed as serious. Malnutrition is a gross challenge which is contributing to the disease burden of the country. NFHS-5 reported despite Integrated Child Development Programme (ICDS) and Mid-day Meal, India continues to grapple with the issues of under-nutrition and stunting. One in every three children below the age of 5 years is reported to be underweight in India. As per the report the country has shown slight progress in stunting and underweight as the number of children under the age of 5yeas who are stunted has come down to 35.5% from 38.4% and number of underweight children from 35.8% to 32.1% (NFHS-5).

In addition to the aforementioned challenges, in India, majority of the urban poor population is reliant on the food distribution system for their improvised living standards. In spite of there being an elevated economic development in the last 30 years, there has not been sufficient improvement in the mechanisms functioning for the removal of hunger, insecurity, and malnourishment. Despite production and stockpiling of surplus food grains and products, there are starvation-related deaths reported in India even in this century. Shouldn't starvation be regarded as a crime? It is the appropriate time to evaluate the developments undertaken and to interrogate if the efforts instigated thus far will help nation-states to achieve sustainable development goals. This research study was carried out to understand the current extent and severity of food insecurity faced by the urban poor in the state of Gujarat. The research team has also deliberated on the factors responsible for such perpetual situation. It is significant to explore the success ratio of governmental programmes aiming at the removal of hunger because if the attention is not paid to the present food consumption patterns by the urban poor, food security in Gujarat will never be restored.

2 Background

Food insecurity is quite a myriad concept that originated around six decades ago, a period when the world faced global food catastrophe. It is quite ponderous to put forward exact definition of the term 'food insecurity' (Maxwell & Frankernberger, 1992). World Bank report has stated it as; '*when there is no access of all the individuals around the clock with adequate amount of food, required for a vigorous, dynamic and healthy life*' (Food & Agriculture Organization of the United Nations, 1996). Poverty shares a strong nexus with food insecurity and has been the foremost reason behind prevailing hunger, malnourishment, starvation, low income, homelessness, racial and social inequality, discrimination, illiteracy, etc. India stands by as one of the leading nations having 17% of the hungry population which as per the Food and Agriculture Organization accounts for 195 million people (United Nations, n.d.).

The escalation in per capita income has failed to make any difference in the empty stomachs of 820 million people living on the globe and those in need are off the beaten track of food and nutrition so much so that the intermission between those having proper access to food and those facing the crises is increasing on an everyday basis (United Nations, 2019). On the other hand, with an increase in urbanization, a considerable growth in the population residing on roadside tents can be observed. India, being a constant producer of quality food grains has made a positive influence, thereby feeding hungry population residing on the streets but some hurdles in the last one decade, including shortage of rain, dry-spell, and other natural calamities in the central and southern regions have made an impact on feeding nutritive food to the entire population. A pivotal piece of information was laid down that it is also the weather or atmospheric pattern that acts as a deciding factor in the positive or negative outcome of the crops in the nations because of the consequential dependency of farmers on the rainy season for agriculture (Food & Agriculture Organization of United Nations, 2015).

The present pandemic situation has not only forced 830 million people to sleep with an empty stomach but around 3 billion people have also been the victims of several dispositions of hunger (Food & Agriculture Organization of the United Nations, 2021). Around one-third of the food produced is either wasted or unused due to the prevailing financial constraints. Hence, hurdles pertaining to food production and distribution are not only extensive but also pitted in different spheres. On a regular note, category belonging to the rock-bottom socio-economic background or those who lack the political power tend to be the victims of food insecurity and hunger, they either be residing in the remote tribal areas or be settled in the marginalized sections of urban areas. The prevalence of disproportionate hunger and undernourishment in every arrangement is deeply embedded in imbalance and unevenness of socio-economic and political potentialities.

Due to several economic constraints and elevation in low-purchasing power, majority of urban poor cannot afford quality food and good standard of living. It has been put forward a several times that at majority wholesale markets, dealers who sell off their food products to the affluent class or upper-middle class, make choices

of the food quality, such that it suits best to their standard of living while on the other end, stale food is supplied to poor urban residents. This approach makes a way ahead for bringing in food insecurity and getting around to set down their health standards. Food that lacks quality majorly comprises of expired products that are left over for decomposition. To quite not a surprise, such inhuman treatment has been practiced for over a long period of time because consumption of balanced and nutritive food has never been a matter of precedence in urban poor households. Following such practice would be nothing but just an addition to their diet.

In the year 2016, the Sustainable development goals set forward by the United Nations were taken into consideration to conduct some efforts over the coming decenniums to put an end to every semblance of existing poverty, hunger, inequality, geographical and climate modifications, while certifying that none, either from rural or urban areas are left behind. Even the second SDGs made an effort towards achieving 'end to poverty and hunger' slogan, thereby achieving adequate food security and competent nutritional scale that can help in sustaining agriculture. However, it has failed to call attention to various courses of actions in which several clusters have been the victims of malnourishment. The SDGs 10 on the other hand have laid down their absolute focus on socio-economic, political, and health imbalance, but has however made no speculation about hunger, under-nutrition, starvation, and malnutrition, even though there exist the groups who have turned out to be the consistent assailants of starvation, poverty, deficiencies, polyphagia, obesity, and high blood pressure.

At this point of time, the world is moving ahead at quite a different pace as compared to where it was a decade ago, carrying a positive notion to put an end to hunger, food insecurity, poverty, under-nutrition, and malnourishment. There was a wave of optimism that such reformative and cathartic approach would result in the acceleration of laidback approach adopted in the past and put this globe, back on track to pull off the reasonable target. The studies conducted on this subject matter reveal that this world has not moved ahead towards the path of achieving and ensuring access to nutritive, abundant, healthy food for vulnerable population, around the year. Politics, rivalries, climate, changeability, mutability, antithesis, economic backdrop, and failures act as the major drivers in slacking down the efficiency, especially when inconsistency and variation are high.

3 Methods and Practices

This study was conducted in the urban areas of Gujarat state to understand the current extent and severity of food insecurity and hunger on health of the people in the state. The authors adopted a multi-method approach in this study, which comes to light as a combination of both doctrinal and empirical methodology. To understand the status of right to food in India, global and Indian status of hunger, food insecurity, malnutrition and its impact on health, the authors have looked into the primary authoritative sources like international covenants, conventions, declarations, the Constitution of

India, Legislations and the Judicial Pronouncements, and the secondary sources like reports of international and national organizations, websites of United Nations Organizations, Government of India and Government of Gujarat, Articles published in reputed journals, reports of NGOs and other organizations working on the same subject area, coupled with an assessment of the present ground reality existing in the State of Gujarat. This study was conducted in five districts of Gujarat, namely, Ahmedabad, Gandhinagar, Vadodara, Surat, and Rajkot. To collect the data from the primary target group, the 'urban poor', the authors have adopted a survey method. Data were collected using a semi-structured questionnaire.

4 Findings and Discussion

The research team in the current study has placed under cover the severity of food insecurity faced by the urban poor in the state of Gujarat and to also understand the impact of food insecurity on nutrition status and health of the urban poor. In the initial stage, the team relied on a doctrinal survey of various International, National, and Regional legislations, judgements, articles, reports, etc., to unveil and understand the various aspects involving food security and hunger. The findings of the secondary analysis are as follows.

4.1 Legal Spectrum Regulating Food Insecurity and Hunger

Food and nutrition being the undermining determinants of health is of great importance both internationally and nationally. India's obligation to ensure food security for all arises from both International Law as well as National Legal frameworks. This obligation can be categorized as obligation under:

1. International Law
2. National Legislations
3. Constitution of India
4. Judicial Pronouncements
5. Obligation of a Welfare State
6. Right-based Approach.

Table 1 India's obligation to provide food security

India's obligation to ensure food security to its citizens		
National/International law	Declaration/Covenant/ Convention/Legislations	Article/Section
International law	Universal declaration on human rights	Article 25
	The international covenant of economic, social and cultural rights, 1966	Article 11
	Committee on economic, social, and cultural rights	General comments 12
	Convention on Elimination of all forms of discrimination against women 1979	Preamble
	Convention on rights of child 1989	Article 24(c) & 27 (3)
	Convention on rights of persons with disabilities 2006	Article 25(f) & 28 (1)
National legal frame work	Constitution	Article 39 (a), 47 should be read with Article 21
	Judicial precedents	Kishen Pattnayak & Anr versus State of Orissa, 1989
		M/S. Shantistar Builders versus Narayan Khimalal Totame, 1990
		(Chameli Singh And Others Etc. versus State of U.P. and Another, 1995
		(People's Union of Civil Liberties … versus Union Of India (Uoi) And Anr., 1996
		Koili Devi versus Union of India, 2019
	Legislations	The National Food Security Act (NFSA), 2013

Right to food is a complex concept and it cannot be discussed in isolation. Access to adequate food is a prerequisite for the fullest enjoyment of life, it is essential to maintain good health too. The first ever document to recognize human right to food is the Universal Declaration on Human Rights (UDHR) 1948. The declaration under Article 25 declares that '*Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food*' (Organisation & UNDP, 1948). Subsequent to UDHR, the International Covenant of Economic, Social & Cultural Rights, 1966 under article 11(1) reaffirmed the right of individuals to adequate standard of living and under article 11(2) the Covenant provides

for '*individuals right to be free from hunger*'. The Committee on Economic, Social, and Cultural Rights under General Comments 12 has mentioned that '*the right to adequate food is indivisibly linked to the inherent dignity of the human person and is indispensable for the fulfilment of other human rights enshrined in the International Bill of Human Rights. It is also inseparable from social justice, requiring the adoption of appropriate economic, environmental and social policies, at both the national and international levels, oriented to the eradication of poverty and the fulfilment of all human rights for all*' (Committee on Economic, n.d.). Around the world, it is women, children, and other vulnerable sections like disabled, migrants, etc., are the most disadvantaged group who is deprived of access to adequate food. This is evident from the health Index that these categories are suffering from malnutrition, anaemia, and other health issues. As a response, the international community has given special attention to these vulnerable categories by addressing their basic rights through special instruments, which include the Convention on Elimination of All Forms of Discrimination Against Women 1979, the Convention on Rights of Child 1989, and the Convention on Rights of Persons with Disabilities 2006. These instruments recognize the right to food of women, children, and disabled people, respectively. In addition to this, there are a number of binding and non-binding instruments developed regionally and internationally to provide for access to food.

In India, the Constitution does not provide for the fundamental right to food; however, it has been recognized as a right within the ambit of Article 21 which provides of *'right to life and personal liberty'*. Under Article 21, the Constitution mandates the state to protect life with dignity. To understand the state obligation under the Directive Principles of State Policy towards right to food, the Articles 39 (a) and 47 should be read with Article 21. Under Article 39(a), the Constitution directs the state to make policies to attain an adequate standard of living for its citizens and under 47 to take steps to raise the level of nutrition and standard of living of the people (Jain, 2018). The preamble to the Constitution provides for socio-economic justice and in addition to that the Constitution establishes the country as a welfare state, the primary obligation of the welfare state is the welfare of its people and without achieving universal access to food, social justice cannot be achieved.

The role played by the judiciary in recognizing the 'right to food' is commendable. In 1989, the Hon'ble Supreme Court considered a letter from two social workers highlighting the miserable conditions of people living in the Kalahandi district of Orissa on account of extreme poverty as a writ petition. Directed the Government of Orissa to take adequate social welfare measures and prompt actions to curb the starvation deaths happening in Kalahandi district (Kishen Pattnayak & Anr versus State Of Orissa, 1989), Food clothing and shelter are the basic human rights (*M/S. Shantistar Builders versus Narayan Khimalal Totame*, 1990). Right to life guaranteed by a civil society should include right to food, clothing, descent environment, and a reasonable accommodation to live in (*Chameli Singh And Others Etc. versus State Of U.P. And Another*, 1995).

In PUCL Vs. UoI, Court established a constitutional human right to food and created a basic nutritional floor for India's underprivileged millions. This judgement marked a watershed in the history of right to food in India. The People's Union for

Civil Liberties (PUCL) filed a 'writ petition' before the Supreme Court on the right to food in April 2001. This petition was filed at a time when the country's food reserves were at an all-time high and hunger in drought-stricken areas was also on the higher side. The government of India, the Food Corporation of India (FCI), and six state governments were slammed by the apex court on grounds of inadequate drought relief. This case became one of the breakthrough judgements on chronic hunger and malnutrition. The case highlighted the failure of government in two aspects namely the collapse of the public distribution system (PDS) and the inadequacy of drought relief efforts. The judgement addressed a wide range of issues involving right to food such as execution of food-related projects, urban poverty, the right to work, starvation deaths, and general transparency and accountability concerns (*People's Union Of Civil Liberties … versus Union Of India (Uoi) And Anr.*, 1996).

The Supreme Court gave the first major interim order which focuses on eight food-related programmes, namely, the 'Public Distribution System (PDS); the Antyodaya Anna Yojana (AAY); the National Program of Nutritional Support to Primary Education, also known as the mid-day meal scheme; the Integrated Child Development Services (ICDS); Annapurna; the National Old Age Pension Scheme (NOAPS); the National Maternity Benefit Scheme (NMBS); and the National Family Benefit Scheme (NFBS (NFBS)'. The interim order of November 28, 2001, essentially changed the advantages of these eight schemes into legal privileges. This means that if someone has an Antyodaya card but isn't getting her full monthly quote of 35 kg of grain at official pricing (Rs 3/kg for rice and Rs 2/kg for wheat), she has the right to sue for what she's owed, even if it means going to court. The administration was also ordered to replace monthly dry rations of grain with daily, cooked mid-day meals. In addition to the aforementioned the court ordered the government to finish the identification of BPL categories and start providing them with ration cards and 25 kg of grains per family per month; to ensure accessibility to ration stores and regular grain supply; to make the dealer and shopkeeper accountable for their actions denying access to ration to the eligible candidates; Awareness to BPL families about their entitlements, etc. (*People's Union Of Civil Liberties … versus Union Of India (Uoi) And Anr.*, 1996).

Another development after this judgement was the implementation of the National Food Security Act 2013 by the country. The act provides for the food and nutritional security of the public in human life cycle approach. As per the act the government is under an obligation to provide food entitlement to 75% of the rural India and 50% of the urban population; the eligible household can claim 5kgs of food grains/person/month; the entitlement under the Antyodaya Anna Yojana shall be 35ks per household; age-appropriate food to be issued by anganwadi's and under mid-day-meal to children. In addition, the act suggested the constitution of the State Food Commission to monitor and evaluate the implementation of the scheme and suggested PDS reforms both at state and central levels (The National Food Security Act, 2013).

Even after all these instructions by the apex court, another incident which spooked the conscience of the country occurred in 2017 in Jharkhand. A writ petition was filed by HRLN for the mother and sister of Santoshi, an 11-year-old girl from Simdega, Karimati who lost her life due to starvation on September 28, 2017, before the Apex

court of India, and that the petition clearly instigated the hurdles faced by millions of people who fail to receive benefits of ration card due to Aadhar card-related complications. In particular, it addressed how death of the victim shared a direct nexus with denial to providing her a ration card since she belonged to the Dalit community and her ration card was not linked with Aadhaar card. The petition had drawn attention to the interconnection of food security schemes that were put together for poor population with Aadhar card as a binding element and how it could have the most ravaging impact on their health and well-being. It is therefore, the need of the hour, to look into the cases of food insecurity that repudiates the life of an individual and to make sure that nothing interferes with the elicit distribution of food and other prerogatives that are meant for the poor population. It was pleased that the Court must hold on to the responsibility to guarantee that no sanctioned person is dissented from receiving subsidized food grains under the respected schemes for unavailability of Aadhaar card. Other than this, it was also requested that the court must surpass the order to the authorities to put hold on the mandatory usage of Adhaar card-based biometric authentication methodology to dispense food products and other essentials (*Koili Devi versus Union Of India*, 2019).

The role played by the Government of India in increasing food production and combating food insecurity is notable. The government activities intending to curb the challenges thrown by food insecurity can be classified under various heads, namely, (i) Initiatives to boost Agriculture production; (ii) Initiatives to control food price; (iii) Initiatives to create employment opportunities, poverty reduction, and economic growth; (iv) Initiatives to improve the public healthcare system; and (v) Initiatives to improve education and human development. In addition to that India has always put its hand forward in affiliating itself with food security organizations and programmes conducted by them on a regular basis. One of the notable steps by the Government of India (GoI) intending to boost the farming was integration of technology into agriculture. Some notable government programmes to support farming includes the National Food Security Mission; Rashtriya Krishi Vikas Yojana; Integrated schemes on pulses, palm oil, oilseeds, and maize; Pradhan Mantri Fasal Bhima Yojna; e-market; Massive Irrigation and Soil and Water Harvesting Programme, etc. These programmes have helped the country to move away from dependence on food aid to become a food exporter. As a step towards mitigating and removing the impacts of food insecurity on the health of the people, the government introduced Public Distribution Systems for distribution of food grains to vulnerable sections of the society at an affordable rate. To take care of the malnutrition issues in children the government introduced mid-day meals at schools and under this scheme the children are given access to wholesome freshly cooked lunch. The Ministry of Health and Family Welfare through Anganwdi's distribute ration, health powders, and supplements to pregnant women and children.

The Constitution under Directive Principles of State Policy (DPSP) declares India as a Welfare State and as per this the state plays a vital role in ensuring the socio-economic development of the people. A welfare state aims at creating economic equality and ensuring equitable standard of living to its citizens. The provisions laid down in the DPSP are though not enforceable but they are fundamental to

the governance of the country. Hence, being a welfare state guaranteeing access to adequate food and proper health are the obligation of our country.

In addition to this United Nations has adopted the *'Human Right Based Approach'* (HRBA) as the key principle for the UN Common Country Programmes. Prior to this UN had *'Basic Need Approach'* before 1997 in which they identified the basic requirements of the beneficiaries and the policies and programmes were made to address the same (United Nations Population Fund, n.d.). Whereas in the case of HRBA, the duty bearers develop their capacity to encourage the right holders to claim their rights. secondly to strengthen the capacity of duty-bearers who have the obligation to respect, protect, promote, and fulfil human rights (*Why a Human Rights-Based Approach?*, n.d.). Human Right-Based Approach is based on 'Participation, Accountability, Non-discrimination and Equality, Empowerment and Legality' (European Network of National Human Right Institutions, n.d.). The right-based approach is capable of guaranteeing the human right required to attain the food security. This approach addresses the deprivation of basic needs and any other interventions which are root causes of hunger and food insecurity.

4.2 Findings of Field Investigation Conducted in the State of Gujarat

Gujarat ranks in 4th position in the list of most urbanized states in India, as reflected by Census data 2011 (Sivakumar, 2011). It shows that the state is one of those economies that has achieved growth and development at an accelerated rate, surpassing the domestic scale for almost four decades. However, the economy has observed imbalance, and it is the most prominent issue that has made a detrimental effect on the state's burgeoning path. Statistics laid down by planning commission encapsulates the prominence of poverty in the state that has a direct effect on the purchasing power of majority of population. NITI Aayog has reported that 18% of the population in Gujarat lives below poverty line and the reason behind such poverty is their employment only in informal and colloquial sectors (Aayog, 2021).

It goes back to the year 2013 when the Government of Gujarat made history of not implementing the schemes that were significant for increasing the magnitude of food security. There was criticism towards the central government for repudiating the procedure of taking states into confidence and pre-determining the population of macro-beneficiaries. The most accurate reason behind vulnerability in the state of Gujarat is its susceptibility to disasters like drought, flood, earthquake, and other calamities. This has nothing but a direct impact on the mass production of food grains, thereby leading to dissipation of livestock, loss of human productivity, and other significant assets that would ultimately run a deep impact on the state economy. The schemes formulated for the vulnerable class are in need of formalized discussion since they are the 'lived realities' of innumerable people who are in grief for over a long period.

As per the data provided by International Food Policy Research reports, Gujarat still encounters food insecurity at a scale which makes it a gravely food self-effacing state. It demands nothing but auxiliary improvisation in the schemes and strategies formulated for uplifting the nutritional values and dietary intake of women and children in the state. In spite of there being an escalation in multiple health indicators and ethical indices, the level of food insecurity encompasses over 1% in the nation. The state government, together with public departments and organizations, has put forward its interest to resolve the prevailing hurdle by seeking assistance from experts, organizations, consultancies, and public servants at the grass-root level. The State Government, through Swarnim Gujarat goals, somehow have set the priorities to lean on the agendas designed to diffuse the complications created by food insecurity and reduce the level of under-nutrition, peculiarly among pregnant women, adolescents, and children below 5 years of age, noting that they receive an optimum amount of care and attention.

Even when a research study was conducted by M. S. Swami Nathan Research Foundation (2013, 2014), they handed down 16 significant factors for the urban patch and came down to the conclusion that Gujarat among all the states in India can be termed as 'severely insecure'. This illustrates the primary concern that fault impugns over accessibility and not over the production of food grains. Technically, in the past, glitches with regard to public distribution system had acted as a major obstacle for the vulnerable population. Other than this, inability and laidback approach of the fair prices shops has further emanated into taking off an opportunity from the poor communities to have access to food grains.

The current status of Gujarat is alarming as the state is facing huge challenges of malnutrition as per the NFHS data. Table 1 shows that in all pointers, namely, stunting, wasting, underweight, and overweight, there is increase in the percentage of the total cases as compared to NFHS-4 data.

Hence, it can be said that there is no rampant advancement in undertaking obligations and financing to the health system or nutrition cycles which ultimately is affecting the strenuous cycle of achieving sustainable development goals. There also seems to be a gap in the appropriate projection of the population that requires an immediate action to fill the food accessibility gaps and thereby save their lives. It is high time that the State bodies now must streamline policies for targeting all issues which have an impact on malnutrition indicators, deploying IEC and SBCC tools for education and sensitization of the vulnerable sections towards their nutritional health and the inclusion of nutrition and food security within the ambit of universal health coverage for the attainment of better health outcomes amongst the entire population of the state.

The current study has examined and explored the issues and challenges concerning food and nutrition security of the urban poor in Gujarat. The situation in the major cities in Gujarat was studied by surveying the same through a questionnaire.

4.2.1 Personal Profile of the Respondents

In the present study, the research team considered different age groups for the study. Out of 400 total respondents, the majority belonged to the age group 19–35 years followed by 30–60 years. About 1.0% fall in the 0–6 years' age group, 14.5% fall in the 7–18 years' age group, 53.1% of the respondents in the 19–35 years' age group, 23.6% and 7.8% fall in the 36–60 years and 61 years and above age groups, respectively. And 34% of the respondents were males and majority that is 66% were females.

Of the total female respondents, 12.09% are 'pregnant', 11.29% are 'adolescent', 18.14% are 'lactating women', and majority that is 58.46% belong to 'other' category. One of the major facts identified by the researchers from ground is that considerable percentage of family surveyed are having more than four children and majority of the above-mentioned pregnant ladies are pregnant with their fourth or fifth child.

Majority of the surveyed population were migrants, either interstate or intrastate migrants. The study had 62.75% of the respondents having Domicile in Gujarat and out of which 49% belong to various parts of Gujarat including the tribal region. 11.5% belonged to Rajasthan and Madhya Pradesh (11.5%), Uttar Pradesh (7.25%), and Bihar (3%) among others in a decreasing order. There were very less migrants from states like Andhra Pradesh, Punjab, West Bengal, and Haryana.

From the surveyed population, 55.50% are daily wage workers and 35.75% were not working only 8.75% of respondents are either salary earning, beggars, household workers, self-employed, or students.

4.2.2 Household Profile

It has been found in the study that majority of respondents have more than two family members of which 18.5% were having five family members and 25.75% were having six family members. 85.75% of the respondents were having less than four kids in their family followed by 10.5% having 4 kids in their family and the rest with more than 4 and up to 10.

Majority of the respondents, i.e. 81% were not in possession of land and only 19% agreed that they possess their own land in their respective state or region. The data reflected that only 14% of the surveyed population is having their own house at their place of origin, whereas majority (86%) were homeless. And 59.25% of the surveyed population were living in temporary houses such as tents or other arrangements on pavements. Three per cent of the respondents live in dwellings that are designed to be solid and permanent (Pukka House) and 37.75% live in kutcha houses or houses made with un-burnt bricks, bamboos, mud, grass, reeds, thatch, loosely packed stones, etc.

Figure 1 demonstrates that out of the total surveyed respondents 62.75% are earning between 4166 and 8334 as monthly income followed by 18.5% of the respondents earning RS. 20,000–50,000 annually. 12.75% is earning between 1 and 2 lakhs; 3.5% earning 2 lakhs and above and only 2.5% earning 20,000 annually. The data set shows that majority of the respondents who earn the least are daily wage workers.

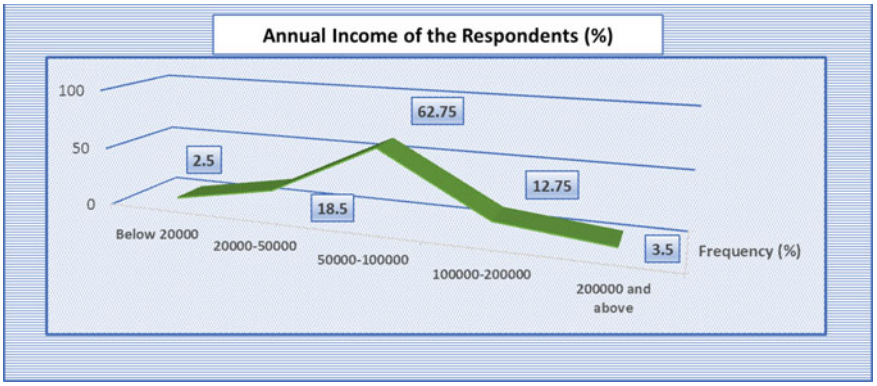


Fig. 1 Annual income of the respondents *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

As shown in the above Figs. 2 and 3, only 70% of the total participants, i.e. 279 respondents were having ration card. Out of 279 respondents, 61% were having BPL[1] category card, 13% with each having AAY[2] and PHH[3] followed by 12% of the respondents holding APL-1 category and 1% holding APL-2 category ration card.[4]

4.2.3 Current Extent and Severity of Food Insecurity Faced by the Urban Poor in the State of Gujarat

The question on the consumption of food in a day received a mixed opinion. As mentioned in Table 2, majority of the respondents including their family members consumed food two times per day. Maximum respondents didn't respond to the question on consumption of food by their other family members (356), father (306), mother (286), wife (47), and children (58). The reasons for going unanswered are mainly two; (i) is that they were not having that family member; and (ii) that family member is not staying with them as they have migrated to urban areas of Gujarat

[1] BPL is a card under Targeted Public Distribution System (TPDS). The beneficiaries holding this card receive 10–20 kg food grains per family per month at 50% of economic cost.

[2] "Antyodaya Anna Yojana (AAY) and Priority Household (PHH) are two types of ration card provided under NFSA. AAY is provided to impoverished families identified by the state governments specifically to people without stable income. The eligible people under this category include unemployed people, women and old aged people. Under this scheme they receive 35kg of food grains per month per family and food grains at the subsidized price of Rs.3 for rice, Rs.2 for wheat and Rs.1 for coarse grains".

[3] "Families not covered under AAY are covered under PHH. The state governments identify priority household families under the Targeted Public Distribution System (TPDS) as per the guideline. 5kg of food grains per person per month and Food grains at the subsidised price (Rs.3 for rice, Rs.2 for wheat and Rs.1 for coarse grains) are provided to the PHH cardholders".

[4] "APL families receive 10–20kg food grains per family per month at 100% of economic cost".

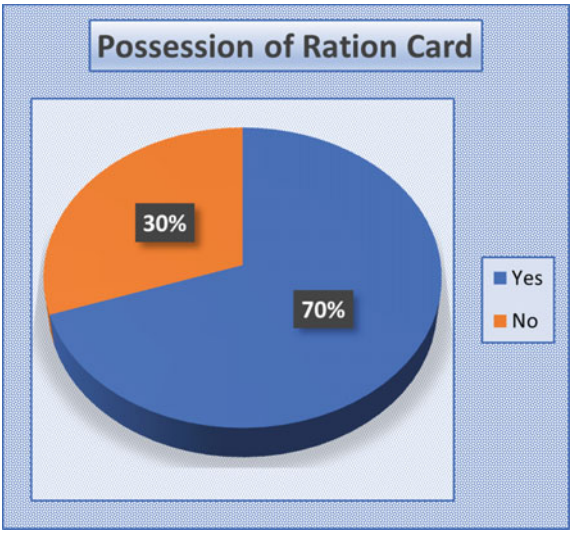


Fig. 2 Possession of ration card and its type *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

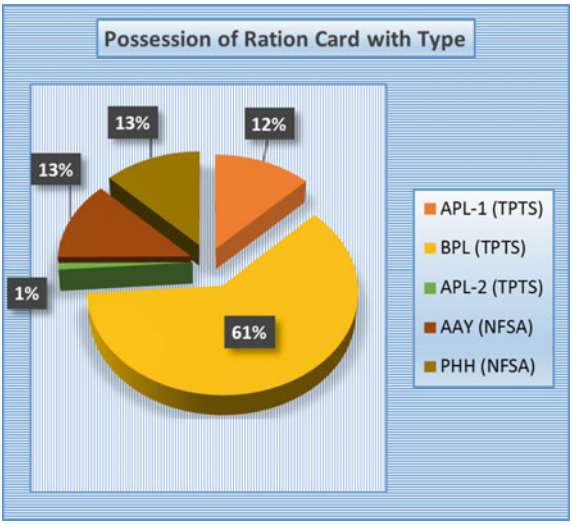


Fig. 3 Possession of ration card and its type *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

for work either from other districts of Gujarat or from outside Gujarat. The table represents that most of the people in the above categories either consume food twice a day or three times a day and none of the respondents or their family members are consuming food based on the hunger (Tables 3 and 4).

Table 2 NFHS-4 versus NFHS-5 for Gujarat state

NFHS-Year	Stunted	Wasted	Under weight	Over weight
2019–2020	39	10.6	39.9	3.9
2015–2016	38.5	9.5	39.3	1.9
Difference	0.5	1.1	0.6	2

Source NFHS 4 and 5 report

Table 3 Pattern of food consumption of respondent, child/children, wife/husband, mother, father, and other members in the family

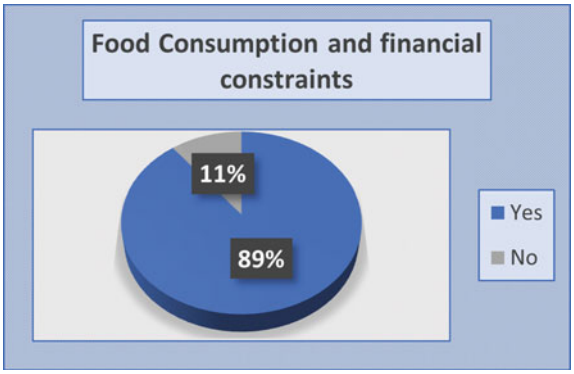
Consumption of food in a day	Respondent	Children of the respondent	Spouse of the respondent	Mother of the respondent	Father of the respondent	Other members of the family
Once in a day	24	7	23	5	3	2
Twice in a day	280	207	260	87	70	32
Three times a day	94	127	70	22	21	10
More than 3 times a day	1	1	0	0	0	0
Whenever I am hungry	0	0	0	0	0	0
Not responded	1	58	47	286	306	356

Source the survey conducted by the autors in state of Gujarat during January to June 2021

Table 4 Whether respondents consume less than what they should due to lack of money to buy food?

Yes/No	Frequency
Yes	355
No	42

Source the survey conducted by the autors in state of Gujarat during January to June 2021



During the field study, it has been found that the respondents don't consume what they should and some of them are (77.75%) not even able to fulfil the needs of their children when it comes to choice of food. There is a lack of variety, every day they consume the same items. During the field study, 89% of the respondents expressed that they are not able to access the food of their/families' choice due to financial constraints, whereas 11% answered against the majority opinion (Fig. 4).

The above-mentioned problems due to financial constraints are faced by most of the respondents almost equally. Majority of the respondents ranging between 98 and 98.5% agreed that they worry about exhausting the food grains, they eat same food for days as there is no money to purchase variety, and they compromise on the quantity of the food to feed other members of the family and few agree that they often starve.

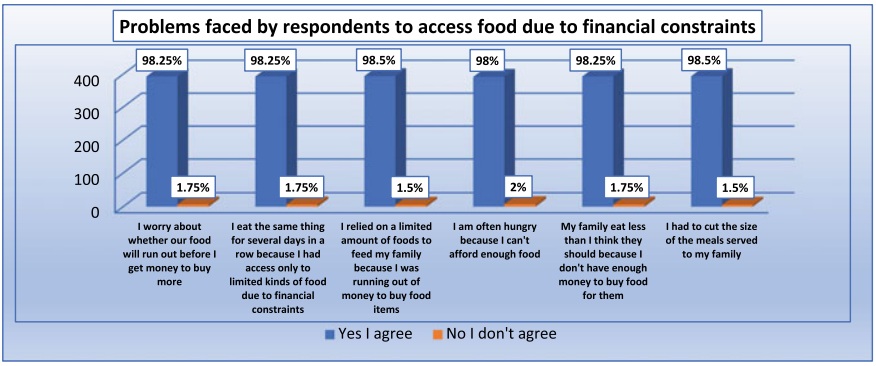


Fig. 4 Problems faced by respondents due to financial constraints *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

Table 5 Problems faced by respondents to access food due to unavailability of resources

Problems faced due to the unavailability of resources	In the past four weeks, we were not able to eat the kinds of foods we prefer to eat because of a lack of resources	In the past four weeks, we had to eat a limited variety of foods due to a lack of resources	In the past four weeks, we were forced to eat a smaller meal than we needed due to unavailability of food	I ate the same thing for several days in a row because I had access only to limited kinds of food due to unavailability of food grains	My family eat less than I think they should due to the unavailability of food	I had to cut the size of the meals served to my family due to lack of resources
Yes, I agree	388 (97%)	388 (97%)	388 (97%)	395 (98.75%)	389 (97.25%)	390 (97.5%)
No, I don't agree	12 (3%)	12 (3%)	12 (3%)	5 (1.25%)	11 (2.75%)	10 (2.5%)

Source the survey conducted by the autors in state of Gujarat during January to June 2021

Table 5 illustrates that majority of the respondents faced problem in accessing food. For every given situation, 97–97.5% of the respondents agreed. This may be due to the prevailing COVID situation also as the data is collected during the COVID lockdown.

In our survey, it has been found that majority of the urban poor (as per our operational definition) are migrants either from within the state or outside the state. Many of them are out of Public Distribution System as they belong to different regions of the state or the country. Hence, they are spending a considerable amount of their family income in purchasing food. Figure 5 depicts that majority (61.5%) of the respondents are spending RS. 4000/- and above to purchase food per month followed by 22.25% spending RS. 3000–4000/-, 8% each spending RS. 2000–3000/- and RS. 1000–2000/-, and only 1.25% spending up to Rs.1000/- or not spending anything on purchase of food.

Table 6 illustrates that majority of the respondents have regularly included cereals (66.3%), vegetables (75.8%) and milk (52.25%) in their diet or otherwise their access is only limited to the aforementioned three food items. The study found that majority of the respondents don't consume meat (67%) and egg (65.5%). Not consuming non-vegetarian food is highlighted as one of the reasons for the malnutrition by the experts during the Focus Group Discussion too.

As given in Fig. 6 the field investigation found that the respondents were facing difficulty in accessing food other than economic inefficiency and non-availability of food. Sixty-four per cent of such reasons accounted for unemployment, 30% faced challenges as they were not having ration card, and 6% of them quoted pandemic as one of the reasons adding to their struggle (Table 7).

It has been found in the study that during crisis majorly the urban poor are dependent on the neighbours for getting food (33.60%), some of them go to other public

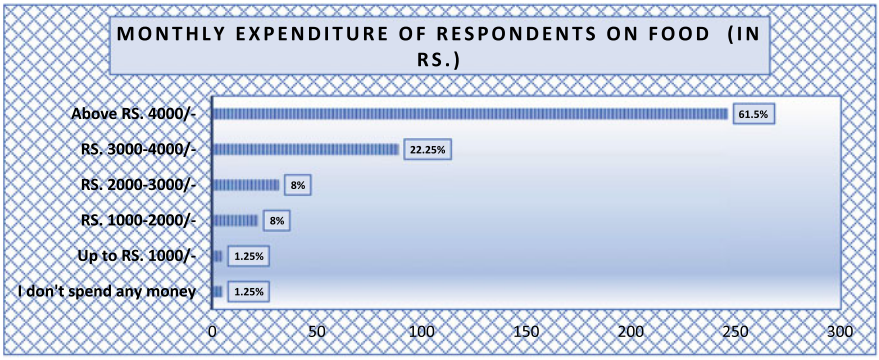


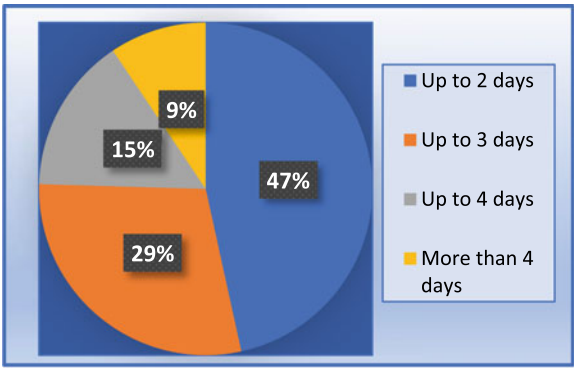
Fig. 5 Monthly expenditure on food items by respondents *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

Table 6 Frequency of consumption of cereals, pulses, fruits, vegetables, meat, eggs, fish, milk, and junk by respondents

No. of times respondents consume specific food items	Cereals (%)	Pulses (%)	Fruit (%)	Vegetables (%)	Meat (%)	Eggs (%)	Milk (%)	Junk Food (%)
Every day	66.3	13.75	3.25	75.8	0.5	0.5	52.25	0.5
Weekly once	27.5	49.5	15	14.5	4.75	6.25	6	8.75
Monthly once	0.25	13.5	12.8	1.25	6	4.75	1.5	2
Whenever I have access to them	3.25	19	53.5	8.5	21.8	23	29.25	13.25
I don't consume them	2.75	4.25	15.5	0	67	65.5	11	75.5

Source the survey conducted by the autors in state of Gujarat during January to June 2021

other than neighbours for assistance (30.16%), a few prefer to starve (21.83%), and very less take the assistance of government and NGO's, 8.60 and 5.82%, respectively.



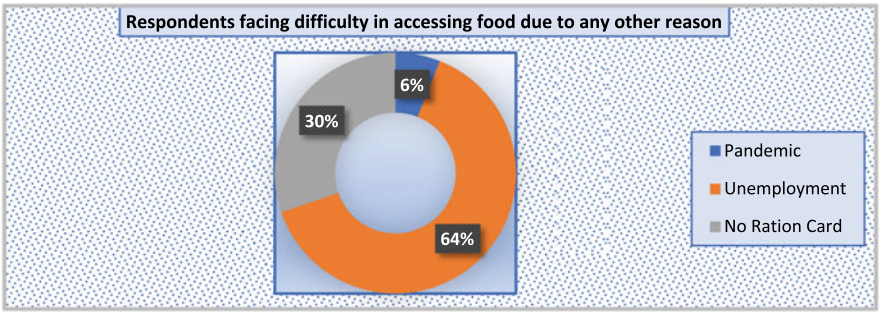


Fig. 6 Respondents' facing difficulty in accessing food due to any other reason other than financial inability and unavailability of resources *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

Table 7 Respondents' source of food in crisis

Source	Frequency	Per cent (of 100%)
Government assistance	65	8.60
NGOs	44	5.82
Neighbours	254	33.60
Other public	228	30.16
We starve	165	21.83

Source the survey conducted by the autors in state of Gujarat during January to June 2021

Table 8 Whether respondent starve any day in the past 1 month due to unavailability of food at home and number of days in a month respondents' have survived without food

Yes/No	Frequency
Yes	297
No	103

Source the survey conducted by the autors in state of Gujarat during January to June 2021

As per the findings as depicted by Table 8 74.25% of the respondents agreed that they have starved at least one day during the month of data collection. 47% of the total respondents have starved at least for 2 days followed by 29% up to 3 days. Only 9% of them reported that they have starved for more than 4 days also (Table 9).

As per the data, 18.75% of the respondents or their children were having issues of malnutrition. 62.75% did not have any issues of malnutrition. 16.75% were diagnosed with stunting, 10.5% with wasting, and 23.25% underweight.

Table 10 demonstrates that 21.75% of the respondents or their family members were anaemic; 28% of the households reported to have experienced IMR and 5.75% MMR. IMR and MMR were very less reported by the respondents in their households (Table 11).

Table 9 Diagnosis of malnutrition/underweight/stunting/wasting in respondent/their children

Diagnosis of malnutrition/underweight/stunting/wasting in respondent/their children	Malnutrition	Stunting	Wasting	Under weight
Yes	75 (18.75%)	27 (6.75%)	42 (10.5%)	93 (23.25%)
No	251 (62.75%)	79 (19.75%)	65 (16.25%)	79 (19.75%)
Not applicable	74 (18.5%)	249 (62.25)	293 (73.25%)	228 (57%)

Source the survey conducted by the autors in state of Gujarat during January to June 2021

Table 10 Respondents or family member diagnosed with Anaemia

	Anaemia	Infant mortality	Maternal mortality
Yes	87	112	23
No	106	274	363
Don't know	196	14	14

Source the survey conducted by the autors in state of Gujarat during January to June 2021

Table 11 Hospital visit in case of illness

Visit	Frequency	Percentage (%)
Yes	110	27.5
No	290	72.5

Source the survey conducted by the autors in state of Gujarat during January to June 2021

Table 12 Respondents' availing/not availing different schemes on health care initiated to support BPL category by Gujarat Government/Central Government

Overall	Frequency	Percentage (%)
Yes	117	29.25
No	283	70.75

Source the survey conducted by the autors in state of Gujarat during January to June 2021

As per the study, only 27.5% of the participants prefer to visit hospitals in case of illness and majority 72.5% were not visiting and are not ready to visit hospitals in case of diseases (Table 12).

As per the response given by the respondent's majority of the respondents (70.75%) are not availing of the schemes on health care initiated by the government to support the poor. Only 29.25% of participants responded positively that they are availing benefits under the government schemes for health care (Fig. 7).

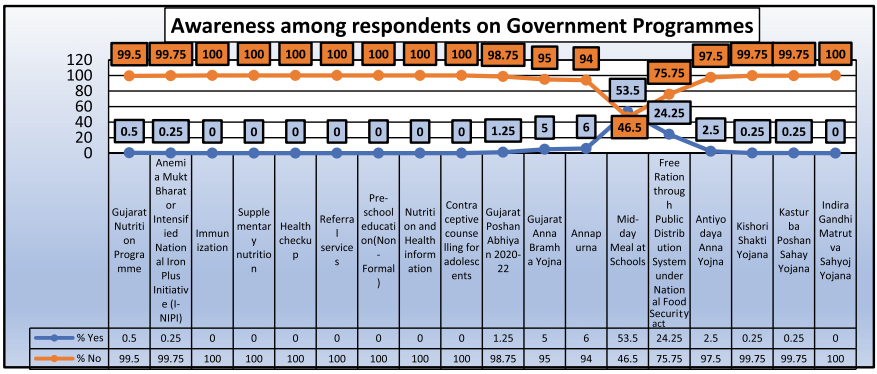


Fig. 7 Awareness among respondents regarding schemes aiming to alleviate hunger, food insecurity, and malnutrition initiated by the Government to support BPL category and the source of such awareness *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

Gujarat Nutrition Programme, Anemia Mukt Bharat or Intensified National Iron Plus Initiative (I-NIPI), Immunization programme, Supplementary nutrition, Health check-up, Referral services, Pre-school education (Non-Formal), Nutrition and Health information, Contraceptive counselling for adolescents, Gujarat Poshan Abhiyan 2020–22, Gujarat Anna Bramha Yojna, Annapurna, Mid-day Meal at Schools, Free Ration through Public Distribution System under National Food Security Act, Antiyodaya Anna Yojna, Kishori Shakti Yojana, Kasturba Poshan Sahay Yojana, Indira Gandhi Matrutva Sahyoj Yojana are some of the programmes implemented in Gujarat aiming to alleviate hunger, ensure health care and nutrition. The study found that a very negligible number of respondents are having awareness on these programmes. Some of the respondents know about mid-day meal (53.5%) programme and the free ration schemes rest of the schemes have not reached the urban poor yet (Fig. 8).

As there is less awareness, the respondents are not availing or a minority of the respondents are availing the government schemes. Majority 44.25% of the respondents are availing benefits under the mid-day meal scheme. Other than that 24.75% of the people are aware of the free ration schemes. Despite some big strides by the intervention of the Supreme Court of India through its interim orders that allowed these schemes to move forward in a crucial manner, the availing of these schemes in this survey was very dismal.

The biggest gain in respect of food insecurity has come from the mid-day meal scheme, which was also the most availed scheme when surveyed. The revision in guidelines in 2004 and 2006 has really reinforced this scheme and the impact it has on food insecurity in India. An extension of this scheme to cover children up to class X would be highly recommended. Given the fact that this scheme has already been well-received and is known to many. Apart from this, a substantial need was felt to improve the hygiene and sanitation needs, when surveyed this was the most required

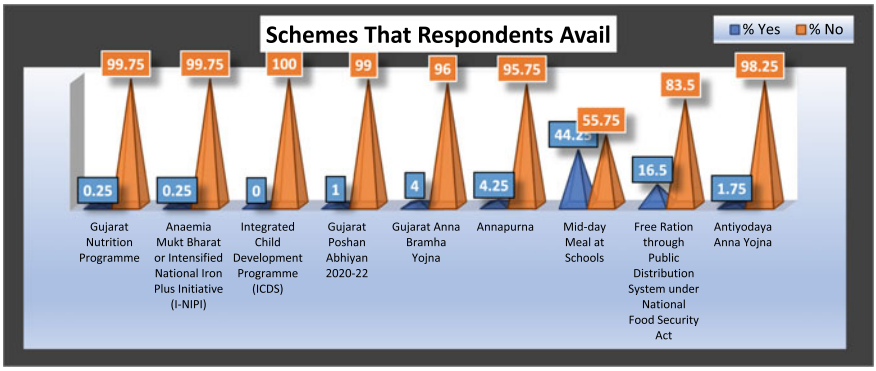


Fig. 8 Schemes that respondents' avail from the above mentioned *Source* the survey conducted by the autors in state of Gujarat during January to June 2021

need by the urban poor in terms of what they want the government to act on. Further, local bodies should encourage to go on drives to actively involve and inform the people about the existing schemes and procedures to avail them. Migrant workers make up a large chunk of the urban poor in these cities and language and literacy barriers in availing the schemes should also be addressed.

Table 13 demonstrates that 92.75% of the respondents were of the opinion that they are facing many barriers in getting access to and availing the benefits under government schemes. It has been observed from the ground that majority of the urban poor are illiterates and, for them, it is difficult to understand and apply for the schemes too. Only 22.75% of the respondents think that all the schemes put forward by the government are useful or capable of yielding benefit, whereas 76.25% are of the opinion that the schemes are not useful to them (Table 14).

Table 13 Barriers in availing the benefits under the above-mentioned schemes and perception of usefulness of the scheme

Opinions	Frequency	Percentage (%)
Yes	371	92.75
No	19	4.75

Source the survey conducted by the autors in state of Gujarat during January to June 2021

Table 14 Barriers in availing the benefits under the above-mentioned schemes and perception of usefulness of the scheme

Opinions	Frequency	Percentage
Yes	91	22.75
No	305	76.25

Source the survey conducted by the autors in state of Gujarat during January to June 2021

5 Conclusion and Suggestions

After the analysis, it has been found that what is being delivered by the government is just a comprehensive action which unfortunately has failed to take charge of issues faced by the urban poor because the entire focus is on the rural-based population. Systematic food distribution system is extensively regarded as the most fitting approach for the system to cope with the escalating challenges like food insecurity and hunger, poverty, illiteracy, unemployment, gender inequality, and shortage of apposite measuring tools. However, there is absolutely no solution that can be suitable for every circumstance but a reasonable interference can be attuned to the prevailing situation, including appropriate food accessibility and convenience, in addition to the prolonged development projections. The approach admitted must be suitable and deal with the elements of food insecurity, alongside the indispensable political adhesion to attain the required success.

The study recorded that majority of the urban poor are leading a miserable life and many have lost hope and they feel that it is a lost cause to expect anything from the government. As mentioned above very less schemes are accessible to these vulnerable sections. As the majority among the surveyed category of respondents were migrant workers, they were out of reach of access to free ration schemes as well. Even when it comes to distribution of food, due to several economic constraints and elevation in low-purchasing power, majority of urban poor can afford nothing but food of cheap quality and a mediocre lifestyle. In addition to the same they undergo other challenges like unavailability of clean drinking water, shelter, clothing, quality education, health care, and many other basic needs. They are not aware of the government schemes aiming to uplift them and hence are not availing the same. Another significant factor influencing food production and consumption pattern is socio-economic discrimination. The research team has observed certain practices of discrimination practised within the respondents' group.

The other pre-eminent feature responsible for food insecurity is the high frequency of force majeure. Majority areas in the state of Gujarat are prone to droughts, leaving them captivated under the trap of food insecurity and hunger. On the other hand, increase in population, enjoining increased demand for water supply and agricultural land, has left a coercive effect on the frail resource system in the majority parts of the state of Gujarat. Infrastructure is considered as the pivotal feature for the development of any economy, however progressive it is. The Government of Gujarat has made efforts towards implementing schemes that can provide direct access to food to the vulnerable section, still there is no proper promulgation of relief and support to people.

It is an alarming finding that majority of the respondents and their family members consume food only twice a day. Almost 90% of them agree that they consume less food than they should and are unable to feed their children enough food due to lack of money to buy the same. An overwhelming majority of the respondents (98%) live in constant worry about their food running out before they can afford more. They lack access to variety in food as they can only afford limited types of foods on which they

could rely on to feed their family. Due to financial constraints, the urban poor eat less than they should, and as a result, they are often hungry. In times of food crisis, especially during the lockdown due to the COVID pandemic, less than 10% of the respondents turn to the government for assistance. Almost half of the respondents (47%) have gone without food for 2 days. This is a matter of grave concern and reflects the high levels of food insecurity faced by the respondents.

Another matter of concern is that the data further shows that the majority of the schemes and initiatives set in place by the government go underutilized. Respondents felt that there are many barriers in availing the benefits under the above-mentioned schemes. This could range from red-tapism to corruption and needs to be addressed in order for these schemes and initiatives to actually make a difference. This is further supported by the fact that when facing problems in availing the benefits under the schemes the respondents usually have no one to contact.

A few measures which can be adopted to improve the condition of the urban poor in terms of guaranteeing food security can be;

1. **Steps to Improve the Current Welfare Programmes/Schemes**

The study found that among the 'urban poor' majority fall into interstate or intrastate migrants. The very first step the government needs to adopt is to take necessary steps to expand the coverage of existing welfare schemes to include migrant workers too. For the same, the state government should maintain a registry with the details of migrant population residing in their state. Universalization of schemes on basic rights also can be a solution. The implementation of 'One Nation One Ration Card Yojana' needs to be expedited, so that the current conditions and issues of non-access to ration schemes can be eliminated. Adequate number of awareness programmes on government schemes for urban poor needs to be initiated to spread awareness on the programmes and also educate the urban poor about the formalities to be furnished to avail such benefits. Adoption of right based approach to food and community participation in implementation of schemes might help in bridging the gap in the implementation of the welfare programmes.

2. **Administrative Measures**

More decentralized approach is required. The local authorities should be entrusted with more responsibilities in relation to the implementation of the welfare schemes on food, nutrition, and health care. The local self-governments should be supported with more financial assistance for the effective implementation of the schemes. Periodic monitoring of the schemes and revision of schemes as per the requirement can be done with the help of involvement of various agencies, academic/research institutes, and civil society. A nodal agency with representation of officers of the Department of Social Justice, the Department of Health and Family Welfare, the Department of Food, Civil Supplies and Consumer Affairs, the Department of Agriculture, and the Department of Women and Child Welfare is required to ensure the collaborative work. Regional offices should be set up to provide information and assistance to public in availing the benefits under the government schemes.

3. **Some Other Measures**

a. The slabs classified for the below-poverty line people should be re-modelled considering the present income earning capacities and include other indicators like housing and land ownership, especially for the migrated urban population.
b. As discussed in the chapter food security is a complex issue and it cannot be discussed in isolation with other rights. Education plays a vital role in improving the standard of living of the public. Educated people may effectively utilize the accessed food. Hence, schemes on literacy, compulsory education for children and adult education need to be implemented effectively.
c. Encouraging the practice of urban kitchen gardens for growing vegetables for self-sustenance by teaching the urban poor (those who are having their own land) to utilize their land for growing food, instituting social safety nets like the establishment of community kitchens, urban farmer's markets, urban food stores/banks, and self-help group co-operatives that help in the cementing of an urban agricultural programme while also involving beneficiaries in its functioning through the practice of social audits to foster a participatory approach.
d. PDS and be innovative in our supply chain and monitoring of supply chain. Since the studies are highlighting the deficiency of micro-nutrients, the Public Distribution System (PDS) should provide perishable micro-nutrient-rich food also as part of ration to the urban poor.
e. Adopting developed nations' model of giving food/grocery coupons instead of distributing ration through designated centres shall help in removing corruption and also the beneficiaries will get more varieties to choose.

References

Aayog, N. (2021). *National multidimensional poverty index baseline report*.
Barrett, C. B., & Lentz, E. C. (2021, February). Food insecurity. In *International Studies Compendium Project* (pp. 170–175). https://doi.org/10.5040/9781350080454.ch-009.
Chameli Singh and Others Etc. versus State of U.P. and Another. (1995). https://indiankanoon.org/doc/64823282/.
Committee on Economic, Social and Cultural Rights. (n.d.). *General comment No. 12: The right to adequate food (art. 11)*.
Committee on National Statistics. (2006). *Measurement of food insecurity and hunger and hunger in the United States*. http://www.nap.edu/catalog/11578.html.
Concern Worldwide; Welthungerhilfe. (2021). *Global hunger index 2021*. https://www.globalhungerindex.org/ranking.html.
Concern Worldwide and Welthungerhilfe. (2021). *India—Global Hunger Index (GHI)*. https://www.globalhungerindex.org/india.html.
Constitution of India. (1950). https://legislative.gov.in/constitution-of-india.
Drishti IAS. (2021). *Global food security index 2021*.
FAO. (2006). *Policy brief changing policy concepts of food security*. http://www.foodsecinfoaction.org/.

Food and Agriculture Organization of the United Nations. (1996, November). *World food summit—Final report—Part 1*. FAO. https://www.fao.org/3/w3548e/w3548e00.htm.
Food and Agriculture Organization of the United Nations. (2021). *The state of food security and nutrition in the world 2021*. https://doi.org/10.4060/CB4474EN.
Food and Agriculture Organization of United Nations. (2015). *Climate change and food security: risks and responses*.
Francis Coralie Mullin Versus Administrator, Union Territory of Delhi. (1981). https://www.scconline.com.
International Covenant on Economic, Social and Cultural Rights. (1966). https://www.ohchr.org/EN/ProfessionalInterest/Pages/CESCR.aspx.
Jain, M. P. (2018). *Indian constitutional law* (8th ed.). Lexis Nesis.
Ke, J., & Ford-Jones, E. L. (2015). Food insecurity and hunger: A review of the effects on children's health and behaviour. *Paediatrics & Child Health, 20*(2), 89. https://doi.org/10.1093/PCH/20.2.89.
Kishen Pattnayak & Anr versus State of Orissa. (1989). https://www.unhcr.org/publications/manuals/4d9352319/unhcr-protection-training-manual-european-border-entry-officials-2-legal.html?query=excom1989.
Koili Devi versus Union of India. (2019). https://indiankanoon.org/doc/91179340/.
Maneka Gandhi versus Union Of India. (1978).
Maxwell, S., & Frankernberger, T. R. (1992). Household food security: Concepts, indicators, measurements. *Techinical Review, 280*.
Ministry of Health and Family Welfare; Government of India. (n.d.). *National Family Health Survey (NFHS-5), 2019–2021*. Retrieved January 19, 2022, from http://rchiips.org/nfhs/factsheet_NFHS-5.shtml.
M/S. Shantistar Builders versus Narayan Khimalal Totame. (1990).
People'S Union of Civil Liberties ... versus Union of India (Uoi) and Anr., (1996). https://indiankanoon.org/doc/31276692/.
Saxena, N. C. (n.d.). *Hunger, under-nutrition and food security in India*. Retrieved February 2, 2022, from https://assets.publishing.service.gov.uk/media/57a08ac540f0b652dd0008cc/CPRC-IIPA44.pdf.
Sivakumar, B. (2011). *Census 2011: Tamil Nadu 3rd most urbanised state*. Times of India. https://timesofindia.indiatimes.com/city/chennai/census-2011-tamil-nadu-3rd-most-urbanised-state/articleshow/9292380.cms.
Tamura, T., Goldenberg, R. L., Hou, J., Johnston, K. E., Cliver, S. P., Ramey, S. L., & Nelson, K. G. (2002). Cord serum ferritin concentrations and mental and psychomotor development of children at five years of age. *The Journal of Pediatrics, 140*(2), 165–170. https://doi.org/10.1067/MPD.2002.120688.
The Food and Agriculture Organization of the United Nations. (2008). An introduction to the basic concepts of food security. In *EC-FAO Food Security Programme*. www.foodsec.org/docs/concepts_guide.pd.
The National Food Security Act. (2013). *The gazette of India 18*. http://indiacode.nic.in/acts-in-pdf/202013.pdf.
United Nations. (n.d.). *Nutrition and food security*. Retrieved January 20, 2022, from https://in.one.un.org/un-priority-areas-in-india/nutrition-and-food-security/.
United Nations. (2019). *Over 820 million people suffering from hunger; new UN report reveals stubborn realities of 'immense' global challenge*. UN News. https://news.un.org/en/story/2019/07/1042411.
UN Organisation, & UNDP. (1948). *Universal declaration on human rights 1948*. https://www.un.org/en/udhrbook/pdf/udhr_booklet_en_web.pdf.

Subjective Wellbeing of Women in the Marine Fisherfolk of Kerala: Anthropological Insights on Life Experience, Attitude, and Life Satisfaction

B. Bindu Ramachandran

1 Introduction

Human desire to attain the state of being well has existed since the beginning of man's social life. Within and across cultures people conceptualize wellbeing differently because of its multidimensional nature and the perspective towards that concept is totally relative. Though the notion of wellbeing is directly and/or indirectly connected with one's attitude towards quality of life, measuring subjective wellbeing is an essential component of measuring quality of life. Raibley stated that 'a person enjoys high levels of personal well-being or welfare when their life is going especially well for them' (2012: 7). That means, personal evaluation of one's life (which includes life satisfaction from attaining tangible and intangible assets) is very important to assess the extent of wellbeing experienced by a person. It is established (Diener et al., 1995; Steel et al., 2018; Krys et al., 2019) that evidences connecting the wellbeing of individual and society is based on averages of personal life satisfaction ratings from members of the society. Krys (2021) wrote that 'recent cross-cultural studies of well-being have introduced the concept of interdependent happiness (Hitokoto & Uchida, 2015) as a more relationship-oriented view of happiness—emphasizing harmony with others, quiescence, and ordinariness. All types of happiness probably share a common core, but emphasize different aspects of happiness: interdependent happiness is more relationship-oriented and life satisfaction tends to be more achievement-oriented'. According to Veenhoven, happiness is synonymous with subjective well-being and can be defined as how individuals rate their quality of life favourably (1984). In short, the subjective approach examines people's subjective evaluations of their own lives.

B. B. Ramachandran (✉)
Department of Anthropology, Kannur University, Kerala, India
e-mail: bindub@kannuruniv.ac.in

S. M. Dev et al. (eds.), *Achieving Zero Hunger in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-99-4413-2_12

Regarding the objective of anthropology in the study of happiness, Mathews and Izquierdo state, 'sociocultural contextualizing that can enable us to make sense of how people in different societies feel about their lives' (2009: 259). Anthropology offers that, happiness and wellbeing are abstract cultural constructs which one cannot observe, instead understand what is regarded by the research community as 'happiness' or 'being well' which can make them happy in their socio-cultural setting. To substantiate, Sarvimaki (2006) opined that wellbeing is most usefully thought of as the dynamic process that gives people a sense of how their lives are going through the interaction between their circumstances, activities, and psychological resources or 'mental capital'.

Anthropology also insists on the fundamental role that culture plays in providing a specific set of conceptions which directs an individual to achieve the state of feeling well. Suh in 'self as the hyphen between culture and subjective well-being' explains the importance of 'self' in maintaining the functioning of social institutions to achieve the state of wellbeing across cultures (2000, p. 63). Since social institutions are fundamental aspects of any society, the emotional support it provides to individuals is significant. This is especially true in societies where people are engaged in collective means of subsistence making which is very much challenging from the point of view of risk factors and uncertain in the availability of resources. In such societies where economic activities are collective and cooperative endeavours, subjective and collective well-being are complementary to each other.

Flanagan (1978) and Pullium (1989) considered wellbeing as a construct defined by the level of satisfaction of different factors of life such as health, family and couple relations, education of children, personality, friendships, social activities, work, recreational activities, personal expressions, and creativity among many factors. Anthropological perspectives strongly insist on the prevalence of needs[1] in human society and the way adopted for satisfying needs vary according to the socio-cultural background of the individual. The feeling of wellbeing experienced by the members of society also influence external factors such as religious commitments, political interventions, aspects of mechanization, ecological conditions, economic constraints in occupation, and social institutions. There are institutional structures and practices that allow the society to deal with conflicts if any, and these structures function well to treat every member of that group in a compassionate manner to help in developing individual perceptions. These individual perceptions substantiated with life experiences (hunger, poverty, and trauma) and personal qualities (such as interest, optimism, confidence, anxiety, anger, and level of autonomy) define the health status (both physical and mental) of people which is also a key factor of being well. In short, the different dimensions of well-being are independent, and to attain a comprehensive understanding of well-being, multiple dimensions are required to be measured.

While discussing subjective well-being, individual life experiences (hedonic) play a significant role as explained by psychologists. Ryff (1989) emphasized that factors (eudemonic) such as autonomy, personal growth, self-acceptance, life

[1] Malinowski suggested that individuals have physiological needs (reproduction, food, shelter) and that social institutions exist to meet these needs.

purpose, mastery, and positive relating, are responsible for psychological well-being in contrast to subjective well-being. However, anthropological interventions place individual life experiences and personal conceptualizations as significant factors from the perspective of culture and socio-ecological settings. So, it seems necessary to explore what people think about wellbeing as embedded in the world of meanings/values construed by a unique cultural tradition. This anthropological study is based on the understanding that subjective well-being is considered to be a multidimensional construct that denotes the satisfaction of many factors and subjects related to the diverse areas of people's lives. So, in this study, a combination of both objective and subjective factors is given emphasis from an anthropological perspective for explaining the state of wellbeing experienced by the women in marine fisherfolk of Kerala.

2 Significance of the Study

Even though the fishing villages in Kerala have different appearances in terms of layout, conveniences, and resource mobilization, there are many problems of similar nature which the fishermen experience for the last many years. First is the set of fundamental facilities and systems that support the sustainable functionality of households in specific and society in general. According to them, infrastructure provides facilities essential to enable, endure and empower societal living conditions and are objective factors towards community and individual life satisfaction.

Marine fishers are close-knit societies because of the nature of their traditional occupation. Since marine fishing is a group activity involving the participation of persons from different (mostly) families, a community/societal level wellbeing is expected by the members. Even though mechanization has created a certain level of competitions and progressions, the individual relationships materialized through social institutions and social dependence are found strong among them (Ramachandran, 2021). Attitude of fisherwomen towards factors influencing life satisfaction at individual/collective levels decides other sectors of their life and culture. So, attitudes are highly significant from the point of view of life satisfaction.

Among the marine fishers everywhere, 'uncertainty[2] of resources' is a major economic concern. Nowadays, the influence of social media, changing cultural traditions, political interventions, constraints in the availability of marine resources, climate change, occupational diversification, and dissatisfactory development interventions affect people's perceptions towards life. Individual experiences may vary which can act as catalyst in manifesting emotions to attain a state of mind with the feeling of wellbeing. In a society like the marine fishers, subjective wellbeing is considered as the by-product of several factors which has a strong thrive on social environment and culture.

[2] For the fishermen, the availability of resources from the sea is totally un-predictable because of the nature of marine environment and so economy based on such a resource system is uncertain.

In short, this anthropological research analyses the facilitating effect of life experiences, attitude, and life satisfaction on subjective wellbeing among women in the marine fisherfolk families. A structural equation model has been given to emphasize the influence of three main socio-cultural domains such as life experience, attitudes, and life satisfaction on subjective wellbeing of women with the support of thirteen sub-domains identified from the study. The model also reflects the signifiers relevant to the empowerment of women in a particular socio-economic, cultural, and geographic context where life experiences and attitude play a significant role in achieving life satisfaction. The findings of the study have ethical and applied implications, if subjective dimensions of wellbeing are considered in the preparation of public policies for women and thereby attaining a life circumstance where there is zero hunger and poverty.

3 Materials and Methods

3.1 Study Area

Kerala is one of the important maritime states in India, with more than 1,000,000 of its population engaged in the fishing industry (Govt. of Kerala, 2012). The coastal line spread over nine marine districts of Kerala such as Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Thrissur, Malappuram, Kozhikode, Kannur, and Kasaragod. Based on marine fish production in Kerala, the districts of Kozhikode and Alappuzha are among the leading coastal districts and marine fish consumption is also high in these districts. In the coastline of Kerala, the marine fishing population is found spread along the 590 km coastline in 222 densely populated marine fishing villages having clusters of settlements with no wider than half a kilometre from the seafront (Matsyafed Information Guide 2015). The vulnerability index developed based on demography, occupation, infrastructure, climate components, and fishery components for the coastal districts showed that Alappuzha District had the highest vulnerability followed by Kozhikode and Thiruvananthapuram (Shyam et al., 2014). Among the nine marine districts, Kozhikode district is the highest in number of fishing villages (Matsyafed Information Guide 2015). Based on these factors Kozhikode district was selected for the present study.

The coastal line of Kozhikode district has a length of 71 kms with 34 marine fishing villages. According to the Kerala Fishermen Welfare Fund Board, Directorate of Economic and Statistics, the fishermen population constitutes 97,987 in number among which 21,769 are active fishermen (2016).

Map of Kerala and the district map of Kozhikode

3.2 Selection of Respondents

The study was started in March 2020 but due to severe COVID situations in Kerala, continuous fieldwork was interrupted many times. In the initial phase, a household survey was conducted across 300 marine fishing families representing all the 34 fishing villages in Kozhikode district. Two different types of fishing families were identified in this study: (1) active fishermen families where one or more members of the family (e.g. father, husband, or son) are actively engaged in marine fishing; (2) families diversified from within the fishing industry with less dependence on fishing as a subsistence activity. Within these two groups, the selection of families was done based on parameters such as complete dependence on fishing activities, average family size, and socio-economic factors. The primary data from the above families were collected using a pre-structured interview schedule that included details on general particulars of families, educational status, assets, debts, marital status, occupation, and material possessions. Based on the family survey, a convenient sample of

310 women above 20 years comprised of housewives, fish vendors, women working in landing centres, and women employed in non-fishery sectors were identified for intensive study. These women were mainly from married, unmarried, and widow categories. It is significant to add that, not a single divorcee was identified in the sample as divorcee rate is negligible among them. A pilot study was conducted with a draft questionnaire to test its feasibility in the field and final draft was prepared with suggestions received from community members through focus group discussions.

The main research tool was questionnaire prepared in the local language with objective indicators of information on economic activities, education, enrolment in self-help groups, access to amenities and material assets along with subjective questions on self-evaluation of life satisfaction, attitudes, and life experiences category. A total of 65 closed-ended questions with both binary and multiple responses were given in the questionnaire. According to convenience, structured and unstructured open-ended questions were operated during focus group discussions and group interviews. Questionnaire was distributed through Kudumbasree (SHG) units in each fisheries village and all the 310 women identified during the survey responded to the questionnaire. Structural equation modelling (SEM) was used to examine a hypothesized model of causal relationships among socio-cultural, economic, ecological and emotional variables, individual life experiences, and subjective perception of well-being using AMOS graphics.

3.3 Data Collection and Limitations

This anthropological research is based on mixed methods focusing more on qualitative methods to derive quantitative model of subjective perspectives on wellbeing. In order to elicit information on the research problem, intensive fieldwork was conducted in the fisheries villages in Kozhikode district. Anthropological techniques such as observation (non-participant), interview, genealogical method, questionnaire, and case study were adopted for collecting information from the field. Using the genealogical method, the status of active fishermen and the number of persons (both male and female) involved in fisheries-related jobs was traced. Genealogy of all the women respondents was taken for clarification of qualitative data. Observation was made to understand the interactions of women in real-life situations such as at family level, during Kudumbasree meetings, and other situations where interpersonal interactions took place. Focus group discussions were made under strict COVID protocols. Since coastal areas of Kerala were exposed to speedy spread of the pandemic, data collection was interrupted many times. However, with the help of SHG officials (mainly Kudumbasree), women informants were contacted a number of times for clarification of responses submitted in the questionnaire. The informants extended strong support in filling the lengthy questionnaire because of their interest in responding to highly personal questions related to wellbeing which was never been asked by any officials from administrative or development departments. Telephonic probing was done in some of the areas where the informants were in containment

zones. Restrictions on COVID-19 curtailed the close observation of informants in their natural setting was one of the limitations of this study.

4 Empirical Realities

The infrastructural facilities availed by a population serve the function of basic amenities to overcome the inconveniences in many aspects of life. In this study, the lack of own house is a concern reported by the women. One fourth of the informants still live in rented houses or with their relatives. In most of the fishing villages in Kerala, fishermen's houses are agglomerated in nature and fishermen are not interested to shift their residence to a distant place away from their friends, relatives, and workspace. In some cases, the prevalence of joint households is one of the reasons for the absence of separate houses for individual families. It is also noticed that four families with independent ration cards are staying under one roof. However, all the houses are supplied with power supply and drinking water. The provision of toilets and power supply to 95% of households is reported as an attainment of government and NGOs in providing basic amenities in an effective manner. Fisherwomen opined that 'equal access to basic facilities to all families reduces the competition between families and also help to create a feeling of community wellbeing'. In a focus group discussion, the active[3] fishermen also admitted that community wellbeing is very much significant as they share the same social and geographical area as part of their subsistence activity for survival. Since marine fishing is a joint endeavour, group harmony is very much necessary to face challenges in the sea and also in the entire process of fishing starting from catch to distribution.

It has been observed (Ovstegard et al., 2010; Sumagaysay, 2011) that, impacts of societal and other fluctuations tend to be more severe on women. In India, marine fisheries sector was based on high degree of gender division of labour and women were subjected to differential access to marine resources, technology, decision-making process, and political participation. The objective of SHG like Kudumbasree to bring forward women to obtain empowerment is found gaining results considering the gender-specific contributions in livelihood securities in the families across Kerala. The women in fishing communities are also not an exception to this development. In this study, participation of women in post-fisheries activities is nominal and involvement in SHG activities provided them with income to support family expenditure. This has also created the feeling of economic independence which is highlighted as one of the factors leading to life satisfaction (Fig. 1).

The uncertain nature of marine resources never always substantiates the fishing families with sufficient income for an affluent living. So, the fisherwomen strongly suggest that right-time interventions from the part of government are mandatory for their minimum survival. In this study, 92% of the women respondents are formally literates and they admitted that accessibility to schools is one of the advantages that

[3] Those who still depend on seagoing as primary occupation.

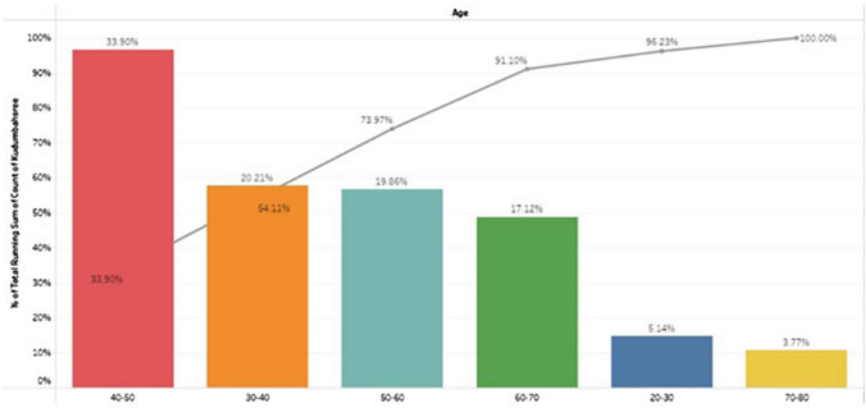


Fig. 1 Status of enrolment of women in Kudumbasree initiatives. Source: Field data

helped them to pursue education even in the middle of economic crises in families. Since membership in Self Help Groups like Kudumbasree does not require formal education, the illiterates could also avail opportunities under National Rural Employment Guarantee Programme (NREGP). Women admitted that it was an absolute support to their families during economic exigencies. 94% of women in this study are enrolled as Kudumbasree members which shows the successful attainment of a public policy initiative by the State government.

In fishing societies, the role of women is important from the livelihood and nutritional point of view at the household level. Besides this, the larger environmental, socio-cultural, and political framework within which they are embedded also has an impact on their contributions to family and society. Comfortable socio-cultural environments encourage to create positive emotions which help individuals to expand their social involvements in ways that create overall satisfaction with life. In the light of empowering fisherwomen, it is essential to bring into perspective their personal assessment of individual characteristics in developing an attitude towards the process of life satisfaction.

Chang and Sanna indicated that optimism had a direct link with life satisfaction, positive affectivity, depressive symptoms, and negative affectivity (2001). While asked about individual characteristics based on a personal assessment (Fig. 2), out of the total three hundred and ten women, 95% admitted that they are optimistic towards the present-day life situations. It is identified that the non-optimistic informants belong to a group of widows and unmarried women. The higher rate of confidence expressed by women highlights the empowerment they achieved through economic participation and self-dependence. Women admitted that, now they are capable of managing activities outside the family, and this achievement they dedicated to Kudumbasree initiatives. One fourth of the middle-aged women rated themselves ‘stress free’ and these women are found with better social and economic backgrounds. This response supports the understanding that stress is an emotional

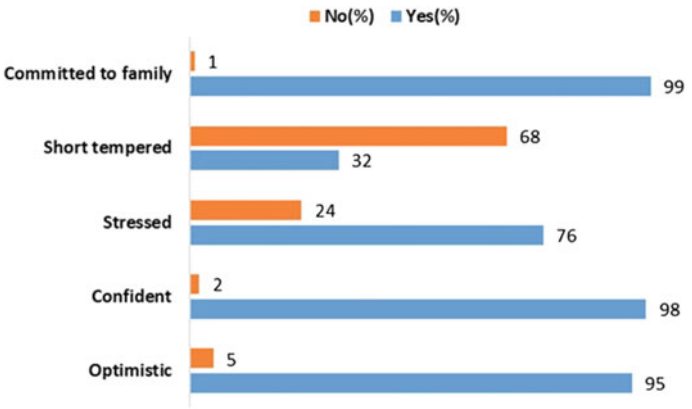


Fig. 2 Personal assessment of individual characteristics. Source: Field data

state resulting from a particular relationship between the individual and the social environment. The character of short temperedness was higher in the age group of 25–40 and they admitted that it is an undesirable emotion which is totally out of their control. It is significant to note that 99% of the respondents expressed their 'commitment in the day-to-day affairs of the family' which they consider as fundamental in sustaining both individual and family well-being. However, self-evaluation of life aspects plays a central role in providing an inclusive measure by which relative significance of the framework for better life can be compared.

Generally, in societies with similar subsistence patterns, people have relatively same requirements and the ways used to institutionalize these requirements vary according to their socio-cultural situation. The adaptive strategies which culture provide fluctuate through a process of individual-society interaction and changes in the attitude of the individual. This may happen at any level within cultures and the quality of life of persons should be based on their own evaluation of being well. In this study, the family of 95% of the informants depend on unreliable resources from marine fishing. So, the income is also unpredictable. With the advent of mechanization in marine fishery, the traditional social set up of the fishermen families underwent many structural and institutional changes and 45% of the women reported it as an unsatisfactory situation to them.

Before mechanization, fishing was a combined effort done by groups of people from the same household or neighbouring households and that unity gave individuals and families an emotional strength to overcome the obstacles in their life. Also, the occupation-based group life for extracting common property resources usually reduces the space of 'individual' when compared to 'group'. Group was significant in the path of survival and with this reason joint families survived for long among the marine fisherfolk. Their feeling of well-being was also retained with group living and activities, and the function of need was to pay more attention to the 'group' than to the self. Women admitted that, even though joint families have its own barriers in some of the life aspects, the overall function it sustains is comparatively higher.

Here, it is understood that the person is socially oriented and the pursuit of socially desirable and culturally delegated attainment is the supplementary approach of the socially oriented personhood.

In this study (Fig. 3), 75% of the respondents expressed that joint families were safer and provided them with all security and emotional strength. In joint families, participation of the kin group in fishing expeditions, professional socialization, and training within the kin group, provided them emotional support to face any kind of challenge. Even now elder women in fishermen families perceived well-being as a group feeling and stated that, in joint families, any external disturbance affecting family's welfare was handled unanimously with the involvement of all family members.

During focus group discussions women reported that integration of workplace, habitation, and occupation-based settlements with a large number of families are supportive factors for their safety and emotional comfort. It is significant to note that respondents (96%) from the age group of 50 years and above expressed concern about the safety and security of their children because of the disintegration of joint families. Older women in the study stated that the harmony and comfort they experienced in joined families provided them with the feeling of wellbeing and they never experienced it in nuclear families. Earlier, fishermen involved in deep sea operations were unable to predict the time of their return because of the uncertain nature of fishing. So, women undertook the entire responsibilities of children with the support of other family members. But, younger generation especially women below thirty years of age and all from nuclear families shared that they (64%) are not concerned about the structural changes in family environment. These two perspectives from two generations clearly show the shift of wellbeing paradigm from collective to a totally subjective one. Convenience of managing the income, personal freedom, decision-making role in family, and availability of more leisure time are the reasons they highlighted to substantiate their position. Young women shared that 'even though joint families provided safety and comfort, personal freedom for women was not there which led to low level of aspirations'.

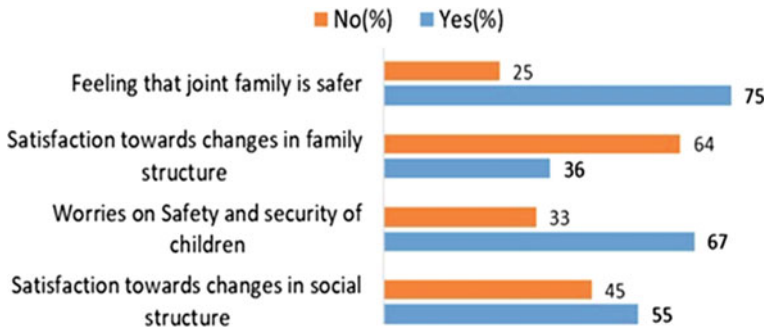


Fig. 3 Opinion of women towards present social situations. Source: Field data

Like any other global community, fisherfolk are also undergoing changes in the realm of society and culture.[4] It is a fact that all changes in the socio-cultural sector are not equally significant. Some changes turned mandatory as they are considered necessary for human existence. Some other changes are accepted in order to satisfy socially acquired needs that are not essential for survival. Changes in food culture and costumes are in the second category. The positive impact of food intake on well-being is not limited to the type of food people consume but extends to the way they consume, the environment, and the socio-economic factors related to eating. Since food is an important aspect of culture and women are closer to food-related activities, changes in this cultural trait are significant from the perspective of wellbeing. Here, 70% of women from all the age groups expressed less concern about the changes happened in food culture. Moreover, they shared a positive attitude towards such changes saying that a new fashion dress or a new food item would give them happiness. This notion of happiness substantiates the statement given by Sara Ahmed that 'happiness is always associated with some life choices' (2010: 2). It is also seen that more than 50% of women are not bothered about the changes in celebrations associated with life cycle rituals and practices. According to them, they try to attach wellbeing to new activities and involvements and the subjective experience they derive from these engagements is used for converting opportunities for individual and social wellbeing. In this study, the importance of social context as a determinant of well-being and quality of life is clear in the expressions of women.

In India, environmental disasters and subsequent degrading of ecosystems badly affect biodiversity and the availability of natural resources that support people's livelihoods. Marine environments are also not exempted from this phenomenon. From the study (Fig. 4), it is understood that the women are much aware of the decline of marine resources and the deterioration of the coastal environment. Ninety-eight per cent of the women expressed their anxieties about the fluctuating nature of economic conditions due to the decrease in marine resources. These women were from families solely depending on income from marine fishing and they strongly believe that life situations including wellbeing will be seriously affected by a decrease in marine resources. The remaining 2% comprised of women from families where marine fishing is not the primary subsistence activity. These families have men working in Gulf countries, employed in State government services, and also in local private jobs.

Faith was considered a significant part of life for the majority of the respondents. The focus group discussions conducted among the informants showed significant intergenerational differences in opinions regarding this aspect. The older generation (above 60 years) stated that the constraints in life will never affect their faith in God as the later they believe, gives emotional support in all critical situations. Even though many of the fishermen are affiliated with a political party which does not support faith in God, women consider these as two parallel lines. They also (72%) admitted that their attachment with the sea will never be affected by a decline in

[4] E. B. Tylor defined culture as 'that complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society' (1871).

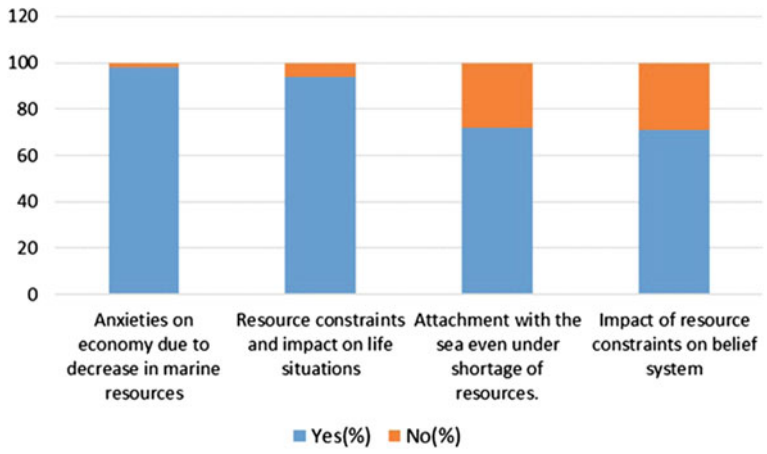


Fig. 4 Anxieties on constraints in marine resources. Source: Field data

marine resources because they trust the sea as 'mother goddess' who provides their subsistence and they prefix everything with this faith.

In a study across twelve countries, Krys et al. found that family-interdependent happiness refers to the collective happiness of one's family and the extent to which one's family is in harmony with other families and groups in one's community (2019). In this study, 76% of women opined that traditional work patterns in fishing operations had strengthened the social relationship among fishermen. The unity and cooperation within a fishing group gave them a comfortable working environment during unfavourable climate conditions in the sea. Women reported that earlier sea-going workforce comprised of kinsmen from the same family or neighbouring families and this has provided a strong social and familial bonding. This unity among men during and after fishing operations gave women emotional support and confidence to send their men to an occupation which is totally hazardous. They strongly believe that the kind of interfamilial support, social interactions, and the practice of sharing resources they experienced with clustered living, substantiate their feeling of well-being in the midst of economic crises and unsafe environment. It is significant to note that 60% of women supported (Fig. 5) the current trend of the younger generation to shift from traditional occupation to other job sectors. This opinion is validated by the percentage of women (56%) who expressed dissatisfaction towards low income from fishing. They (92%) are of the opinion that a decrease in income from fishing will definitely affect their family life. However, 85% of younger women respondents in the study strongly opined that, they are not at all satisfied with the income from fishing.

Elderly women (above 60 years) in the study expressed the economic freedom they experienced while managing the entire household expenditures. Earlier, sea-going fishermen handed over the entire earnings to their women who controlled the family expenditures. Women claimed that they could manage the family in a

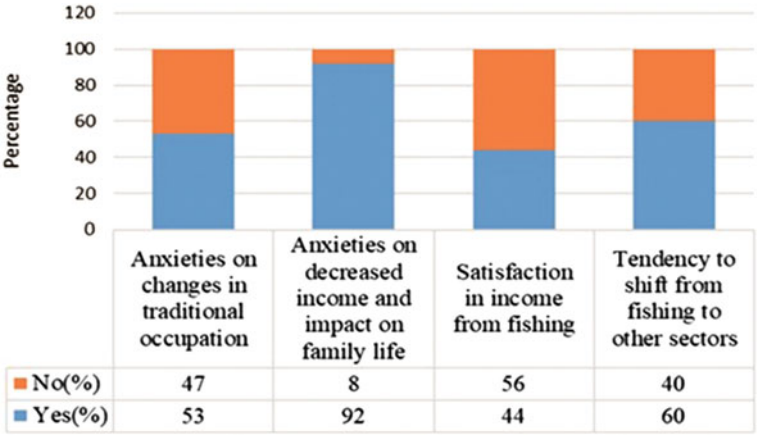


Fig. 5 Traditional occupational sector and apprehensions. Source: Field data

balanced way without much debt. But, with the advent of mechanization, the situation has changed and the active[5] fishermen in the younger generation are found reluctant to give their earnings to women. Instead, they started to manage family expenditures and spent large share of their income for habits such as drinking alcohol and smoking. During the study, this tension was shared by women of all age groups and 53% of women (especially above 60 years) expressed their worries about family management mainly due to the changes in traditional occupational sector. Beyond generational differences, women expressed that the excess alcohol consumption of men creates problems in most of the families which lead to a state of decreased wellbeing, especially for women and children.

It is a fact that income from fishing has decreased nowadays and the new generation of fisherman families started to choose other diversified job sectors for subsistence. The genealogical chart (Fig. 6) of a joint family shows the decreasing involvement of men and women in active fishing and post-fishing works. The women who engaged in fishing from two generations were unmarried and in the third descending generation no women are found doing fisheries-related works. The number of active fishermen is also found reduced in the descending generations. With the increase in household expenditure, it is difficult to manage the family with a single source of income and they used to avail microcredits from government and private sources. 70% of women expressed that the decision to take microcredit was a joint decision by the family and their involvement in familial income generation helped them to elevate the decision-making power in family.

In the marine fishery sector of Kerala, participation of women is absent in the production process and it is completely handled by men. Even though technological aspects are highly developed to extract maximum marine resources, women are

[5] Active fishermen are those still engaged in sea going and other fishing operations.

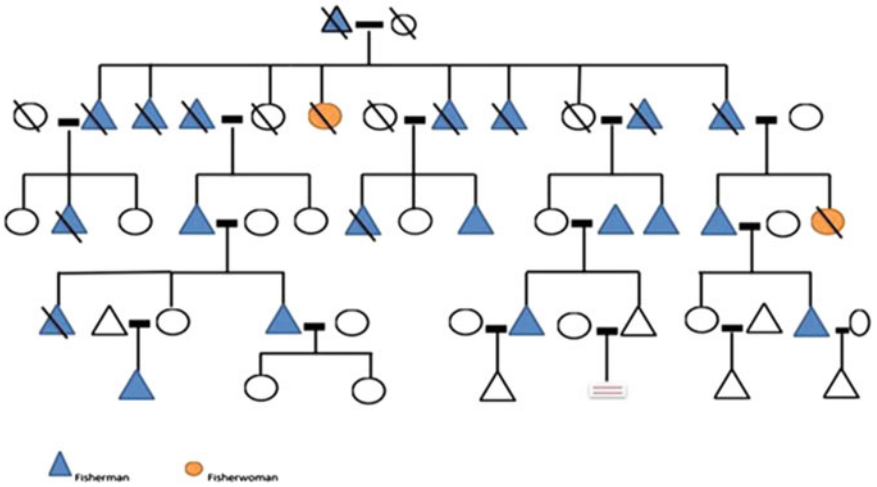


Fig. 6 Genealogical chart showing the inheritance of occupation. Source: Field data

normally discouraged to do fishing operations in sea waters because of the high-risk factors involved. However, they were involved in post-harvest activities as part of division of labour. Fisherwomen opined that those technological changes due to mechanization and resultant labour concerns have made changes in the marine fisheries economy unfavourable to women. They were much aware of the situation and 64% addressed the issue with great concern. But the rest of the women opined that mechanization was beneficial to the fishermen society from an economic point of view. They also highlighted the comparatively less risk factor involved in fishing with improved fishing technologies. It is found that most of the fish landing centres in the study area, participation of women in the post-harvest activities was replaced by the service of migrant male labourers appointed by the local fish merchants.

Earlier there was no mechanism to know the welfare of fishermen while they engaged in deep sea fishing. But the efficient Information and Communication facilities now provide easy access to fishermen at sea to communicate the warnings from official centres. One of the younger informants said; 'When technologies become efficient, we rely more on technology instead of relying on God. This gives us more confidence and optimism for sending our men to fishing jobs. During the time when technology was not that much efficient, faith in God and human relations were strong and ardent'. Elderly women (27%) admitted that the present situation is not at all supportive to their state of wellbeing because of the changes in earlier social realm which they found more comfortable. Dissatisfaction was shared by the respondents (45%) towards the loss of personal relationships due to changes in local distribution of fish. Their personal relationships with women from other Castes and Communities outside the jurisdiction of beach helped them to avail financial support whenever required. But the change in distribution system after mechanization has reduced

their involvement in local marketing and their space is limited to a corner of the fish markets. Distribution of fish by taking as head loads has totally stopped in the area.

Religious believes and practices play a central role in the life and culture of people, especially among those living in unfavourable environments such as coastal ecosystems. The challenging nature of environment will bring people closer to faith and it is established that (Hackney & Sanders, 2003; Oishi & Diener, 2014) the worldviews, beliefs, and thoughts along with actions, rituals, and practices provide an effective wellbeing to people in different cultures. Among the marine fishers, faith in God and belief system are strong components that support the emotional wellbeing of people, especially women. It is found that like any other traits of culture, believes and practices are also undergoing structural changes along with the transformation of society. In this study, 67% of women opined that they never felt unhappy with the changes in traditional rituals and practices. Women (54%) of all age groups opined that they are more comfortable with the new system of practices in belief system as the old ones are more rigid and gender biased. During menstrual periods, they were totally isolated from all the household activities with the cause of touch pollution and the elder women imposed strict restrictions on them. During focus group discussions, women admitted that they were emotionally disturbed with these restrictions. But now, these practices were found almost vanished and the younger generation is not willing to follow the old customary practices associated with life cycle rituals. 93% of women (Fig. 7) expressed interest in sharing their experiences with younger generation even though the later are not interested to listen them. According to elderly women, they (67%) are trying to adjust with the new world view of younger generation to maintain harmony in the family. They used to engage in prayer, reading religious texts, or listening to devotional songs so as to attain emotional wellbeing.

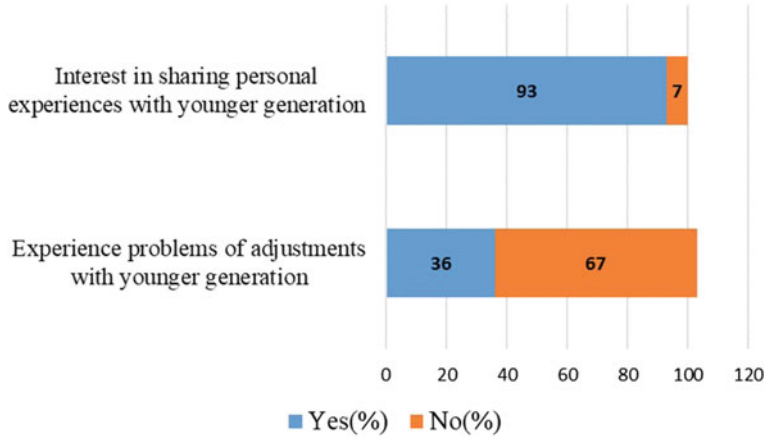


Fig. 7 Attitude towards younger generation. Source: Field data

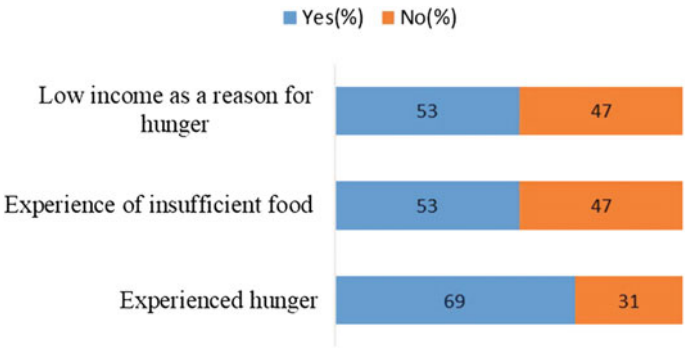


Fig. 8 Experience of hunger and insufficient food. Source: Field data

The health and wellbeing of people at all ages is one of the significant goals of sustainable development. At present the evaluation of individuals' health status and well-being extends beyond traditional indicators of disease, infirmity, concept of health, and health care approaches. The Committee on Economic, Social and Cultural Rights,[6] suggested a range of factors as 'underlying determinants of health' for helping individuals to lead a healthy life. Safe drinking water, adequate sanitation, clean food, healthy working space, and environmental conditions are also added to the list of factors identified as determinants of health. It is a fact that the health outcomes and disparities are driven by socio-cultural and economic determinants and this is especially true in the case of societies such as the marine fishermen.

Information (Fig. 8) on the experience of hunger shows that women experienced hunger during childhood and they had times when there was insufficient food. A cross-examination on economic status and experience of hunger highlights the role of occupation, increased number of persons in a family, and the status of food consumption. Earlier, in fishing families, the number of children was more and the income to afford a large family was insufficient. As persons engaged in a hardship job, men were provided with good food in sufficient quantity which always resulted in insufficiency for women. One of the women (70 years) informants said, 'Mothers provided quality food to sons. We experienced hunger after procuring, cooking and serving the food. Some of the days we didn't go to school because of hunger. For our complaints mothers used to say that boys are earning members of the family and they are doing a tiresome job to safeguard family members. So, we were inculcated with the notion that women have to tolerate hunger and no concern was given to our health issues'. Women admitted that, now the situation has changed and food is not a matter of concern to the present generation provided one must have money to buy it.

Health issues such as intestinal ulcer and problems of digestion while taking certain food are reported by the women. Elderly women strongly believe that acute

[6] The committee responsible for monitoring the international treaty on Economic, Social and Cultural Rights which was adopted by the United Nations General Assembly in its resolution 2200A (XXI) of 16 December 1966.

Table 1 Relationship between economy and decision making. Source: Field data

Age	Membership in SHG	Economic independence	Role in decision making
20–30	15	8	12
30–40	59	44	42
40–50	99	56	87
50–60	58	27	47
60–70	50	19	43
70–80	11	3	13
Total	292	157	244

poverty experienced during childhood was one of the reasons for present intestinal problems. The women who experienced hunger substantiate that low income was the main reason for hunger. Older women (comprised of widows and unmarried) with some sort of physical discomforts and ailments expressed dissatisfaction[7] on the irresponsible attitude of family towards their health issues. Contrary to this, younger women (84%) supported the concerns of family towards them after a shift in the position of women from consumer to producer of income. This intergenerational difference in opinion made it clear that contribution to family income and subsequent role in family's decision-making process supported younger females with all attention from the family members. From this study, it is understood that income generation by the females and their contribution to family economy are indispensable factors for reducing poverty at family level and helping them to reach a situation where there is zero hunger. 65% of younger women admitted that they have no difficulty in availing any job outside the jurisdiction of beach. However, they prefer to reach family every day to look after the family affairs.

It is significant to note that, in the sample of study, 94% of women (n = 310) enrolled in Kudumbasree and they agreed that this involvement has increased their economic independence at household level. However, 43% shared that, due to the increased burden of managing family, their earnings are not sufficient for meeting very personal needs. 61% strongly admitted that they acquired an economically independent status in the family and 79% of Kudumbasree members unanimously admitted that their role in decision-making at family level increased because of this initiative by the government (Table 1).

In the social gerontological literature, happiness, life satisfaction, and morale are the main indicators of Subjective Wellbeing (George, 1979). The positive and negative emotions on over all life domains associated with expectations about the future constitute the level of wellbeing experienced by an individual. Social comparisons, life reviews, and state of happiness are the explanatory tools used to filter information from individuals to define the quality of life. During focus group interviews to discuss personal life experiences, women clearly articulated their attitude towards accepting

[7] A recent study on elderly individuals in China emphasized the importance of health as a primary determining factor of life satisfaction for older adults (Ng et al., 2017).

transformations in society. Without intergenerational difference, 50% of the women expressed their mindset to accept any kind of socio-cultural change. However, the older generation highlighted worries on changes that are harmful to younger generation. In their opinion, 'the values, ethics and morale showed by ancestral generation gave strength to the society to face any kind of challenges. But the good elements of society are now found vanishing and younger generation has no commitment in fulfilling social responsibilities'. Older women also revealed that they are constantly trying to focus on their weaknesses and possibilities as part of adjustment which is considerate to other's needs and social mandates (Fig. 9).

Lawton, Morris, and Sherwood considered attitude towards own ageing as a factor in apprehending the individuals' perceptions of changes taking place in their lives, and their evaluation of those changes (1975). Here, 13% of the women (all of them above 70 years of age) were found emotionally disturbed while explaining their experiences with the younger generation. They admitted an absence of happiness and satisfaction in the present socio-cultural set up of the society. However, most of them are under the impression that people of their ages have good relationship with each other which gave them moral support to overcome obstacles in life situations. It is understood that older adults do not place much importance on individual status and money as that of younger generation, but they tend to place more value on family relationships and long-term fulfilment from one's life. In short, 75% of women under study expressed that they are satisfied with the present-day life situations only to a certain extend.

Emotional well-being can be conceptualized as the balance of positive and negative feelings experienced in life and the perceived feelings such as happiness and life satisfaction. It is a general attitude among the people that, involvement in day-to-day affairs of the family and healthy interaction with other members of the society help to develop a satisfactory attitude towards life. In the present study, 86% of the women stated that they feel happy while mingling with others, especially relatives and friends.

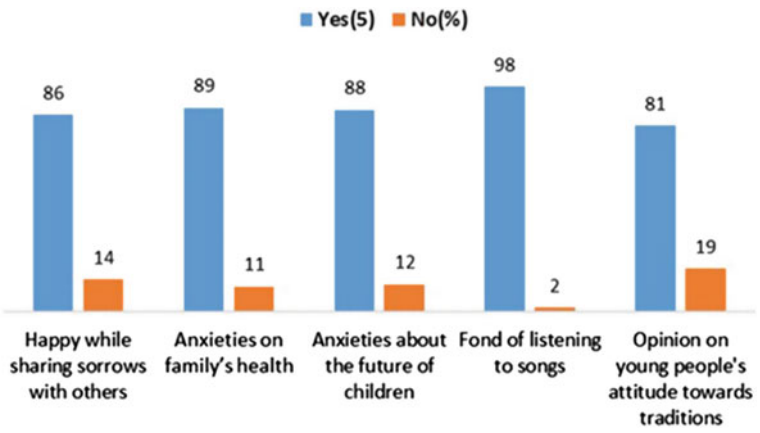


Fig. 9 Opinion on personal anxieties and attitudes. Source: Field data

They added that they have no hesitation to interact with others because of the involvement in Kudumbasree activities. One of them added, 'internally we had differences in opinion but, the overall group activities provided us with emotional support to move forward'. Majority of women (88%) expressed that the engagements in Kudumbasree activities made them positive towards life. Those who hesitated to express their opinion or took a neutral position during discussions comprised of women above 70 years, unmarried women, and women with chronic diseases. However, it is significant to note that only 71% of women expressed satisfaction towards governmental interventions in the overall development of fishing community. Remaining (29%) women could support their arguments by highlighting the loopholes in development interventions. Differences in political affiliations and preconceived notions on ruling parties are identified as some of the reasons for these comments. The ability achieved by women to express their opinion for and against any issue is a positive indication of their empowerment and beyond political affiliation all of them dedicated this achievement to Kudumbasree initiatives.

Even though they are busy with everyday life, 88% of women revealed that the health aspects of family and anxieties on the future of children continue to disturb their emotional wellbeing. It is significant to note that none of the respondents was interested to send their children to traditional occupation of fishing. They agreed that high-risk factors involved in deep sea fishing along with low income restricted to take such a deviant thought in opting fishing as a subsistence activity. At the same time, women (64%) expressed optimism towards the changes happening in traditional occupational sector. They opined that the new fishing technologies, marketing strategies and resource management system are giving an elevated status to fishing even though there are many challenges in the fisheries sector.

It is an established fact that listening to music has the characteristic ability to decrease the psychological stress response. Research (Kallinen & Ravaja, 2004) claimed that listening to music is mainly for getting relax and improving people's mood and also for decreasing negative emotional states such as anxiety and stress. In this study, women (98%) of all age groups expressed that they are very fond of listening to old songs. Elderly women said that listening to music reduces their tension and younger women opined that music make them happy. Nowadays, they create small groups of 1–10 members and used to recite religious texts such as Ramayana and Bhagavata in temples. They complained that younger generation (below 20 years) is not interested in such activities and over-emphasis on social media and other entertainments withdraw them from traditional cultural practices and faith. Elder women strongly believe that the present-day problems in the society are mainly due to the deviance from traditional norms and practices shown by the younger generation.

Participation in local political parties is one of the reasons expressed by women regarding the deviance of young men from family responsibilities. It was reported that women had no representation in mainstream politics and they (71%) expressed annoyance towards the interventions of politics in community affairs. The present political scenario of the study area is not favourable for a healthy political work and 82% of women in the study expressed strong disagreement withn the participation

of their men in local politics. However, 18% still believed that political interventions will definitely stand for societal development. This section of women admitted that they received governmental aid with the help of political parties. Women supported the role that fishermen organizations play in helping the fishermen to avail benefits from the government and NGOs. But they are least interested in affiliating these organizations with ruling or opposition parties.

Life evaluations have been considered a central role in the assessment of well-being because these provide an umbrella measure by which the relative role and significance of the supporting pillars of quality life can be compared. Ruut Veenhoven defined life satisfaction as 'the degree to which a person positively evaluates the overall quality of his/her life as a whole. In other words, how much the person likes the life he/she leads' (1996). In this study, an evaluation of life satisfaction shows that 45% of women expressed dissatisfaction in the present life situations. Major reasons reported by women include personal health issues and health issues of family members, financial issues, absence of a safe shelter, lack of pure drinking water, lack of employment for children, declining marine resources, weakened social control mechanism and decreasing strength of kin relations. External factors such as unsatisfactory development interventions, lack of sufficient employment opportunities for men, political interferences in community and family affairs, lack of proper infrastructural facilities are the major external factors reported as influencing their life satisfaction. Basic insufficiencies in families are also reported as factors for unhappiness. When asked about the attitude towards complete happiness, 81% women reported that they never experienced such a state of mind. This is because of the reason that they value happiness of the whole family over personal happiness. From this study it is understood that, the conceptual relations regarding the extent to which societal wellbeing is a fundamental component of individual wellbeing is stronger in collective societies like the fishermen.

Among the 310 women selected for the study (Fig. 10), the frequency of respondents shared unhappy state of mind were almost same in the age group of 30–40 and 50–60. However, the frequency of women who agreed that they are 'happy to a limited level' shows an increasing trend from 20–30 age group and then found decreasing to 70–80 age groups. The number of women in this category are more from the age group of 40–50 and it is important to note that all of them are members of the Employment Guarantee Programme (MGNREGA) of the Central government. The involvement in this Programme ensures them economic security which has been addressed by them as one of the important factors towards happiness. When examined the status of women who expressed as 'happy', it was seen that they (19%) are one of the earning members of their families. Even if some of them have no involvements economic activities, family's welfare is safe with other members, especially husband or son. Moreover, they agreed that their family environment and kinship networks are strong to face any external challenges. Dependence on active fishing is nominal in their families and at least one member of the family is engaged in jobs other than fishing or post-fishing activities. In the age group of 20–30, only one woman has stated unhappy and she belongs to a family where three persons died from the sea during fishing operations. It is significant to note that all the three levels of happiness

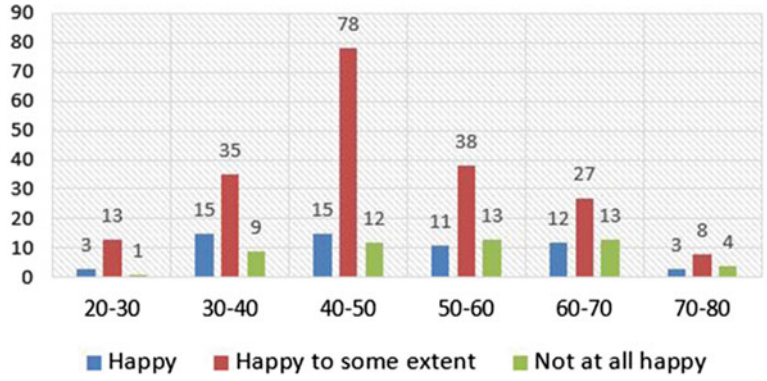


Fig. 10 Response towards the state of happiness. Source: Field data

are found decreasing in the age group of 70–80. It is understood that every unhappy woman in this study has her own justifications and reasons for that state of mind.

5 Analysis and Interpretations

In a community like the marine fishermen where 'common property resources' are used for subsistence; it is important to understand that socially oriented conceptions of wellbeing are composed of role obligations in family and society. In the middle of her kinship obligations as daughter, wife, mother, and grandmother, a woman always strives for familial wellbeing and her individual state of wellbeing and happiness are centre around personal accountability. This obligation was ardent in joint families. Here, in addition to her husband, children and parent in-laws, she has to consider the welfare of other members also. In Kerala, most of the joint families of the fishermen are horizontally extended with brothers (both married and unmarried) live together in one house along with the parents. So, as daughter-in-law and sister-in-law a woman has to bear many responsibilities in addition to the commitments towards her husband and children. Earlier in joint families, in addition to the kinship obligations she was entitled to manage the cultural traditions through organizing celebrations at family level and managed the function with her overall supervision. In short, a woman is placed in a nexus of responsibilities (Fig. 11) to maintain joint wellbeing in families. Nowadays, it is seen that those who are economically stable and capable to live independently leave the joint family and establish separately.

From an anthropological perspective, the notion of wellbeing is culturally conceptualized and so culture is the central force for the construction of happiness and wellbeing with the support of subjective experiences. Here, societal interactions help individuals to maintain cultural traditions with the support of social institutions and this provides a state of 'social comfort' as stated by the fisherwomen. Luo LU states

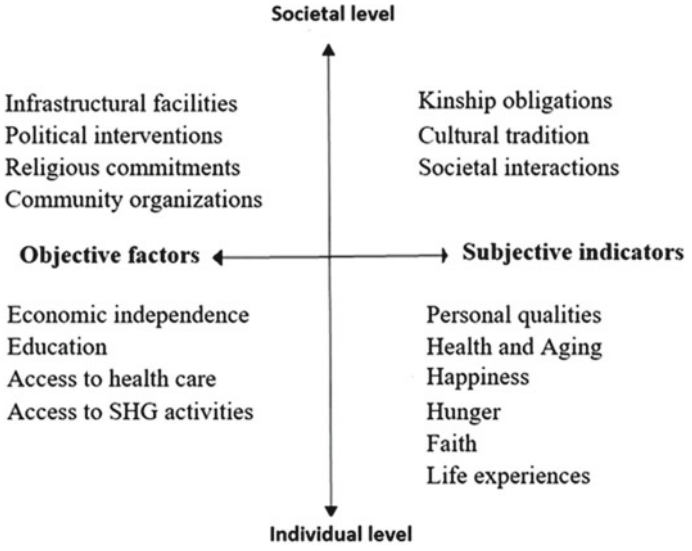


Fig. 11 Anthropological dimensions on subjective wellbeing. Source: Field data

that culture influences SWB (subjective wellbeing) through multiple mediators and complex mechanisms that encourage and/or reflect the person as an individually oriented or a socially oriented entity (2008). During focus group discussions elderly women in the study emphasized the importance of this nexus of relationships in providing emotional strength to a woman in the middle of economic constraints and also in handling health issues. The ultimate goal of a woman in a family focused on familial wellbeing rather than individual. The folksongs and stories among women clearly depict these responsibilities, moralities and obligations. It is also understood from the study that, these attitudes are found changing in younger women and their likes and dislikes are limited to individual families. The new ways of identity formation supported through governmental initiatives and education provided them with confidence to manage activities without the support of a joint family.

When examined the status of women who expressed happiness but not satisfied with life situations, it was seen that all of them were married and belong to families fully depending on fishing. They admitted that, 'there is no absence of food, experience of hunger and other conflicts in the family which make us unhappy. The absence of material possessions including land and own house are lacking which affect our life satisfaction'. Women (17%) who expressed 'unhappy' comprised of widows, those having chronic physical sufferings, those with traumatic experiences such as loss of beloved ones, unmarried ones depending on siblings and also elderly women who are helpless to manage one's basic needs. During discussions at various levels these women expressed grief for depending others for all their daily requirements. Wellbeing among these women relates not only to their health but also to whether

their needs are met such that one can enjoy a satisfactory quality of life. Dissatisfaction and unhappiness impact health, both physical and psychological and may affect relationships between kins and social institutions.

Here, the self-reported state of happiness and/or life satisfaction is subjective and it does not mean that it has no relation or connection to relatively more objective factors. In this study (Fig. 12), for a question on the state of happiness, 64% of women responded that they are happy to only a certain extent. But, 61% of them shared that they are satisfied with the life situations highlighting the fact that the state of happiness and life satisfaction are two states of mind. According to Amartya Sen, 'If a starving wreck, ravished by famine, buffeted by disease, is made happy through some mental conditioning…the person will be seen as doing well on this mental-state perspective, but that would be quite scandalous…It is hard to avoid the conclusion that although happiness is of obvious and direct relevance to well-being, it is inadequate as a representation of well-being' (1985: 188). Happiness is a saturated and elevated state of mind which has nothing to do with material possessions and other assets. However, it is understood from this study that the role played by material assets is comparatively high in achieving life satisfaction. An anthropological model is given here to show the influence of various domains helping to create a state of wellbeing among the women in marine fisherfolk families.

The analysis of the model shows that it has a CMIN/DF value of 1.709. This value is less than 3 and it indicates an acceptable fit between hypothetical model and sample data. Also, the model has a GFI of 0.95, CFI of 0.94, RMSEA of 0.04, AIC value of 164.8, ECVI value of 0.53, and TLI value of 0.92 as the fitness indexes. Here, the high CFI value shows that there is only less discrepancy between the data and the hypothesized model. The high CFI value shows that there is less misfit in the model compared to the baseline model. The low RMSEA value shows that the hypothesized model is less far from the perfect model. A smaller ECVI value indicates a better fit.

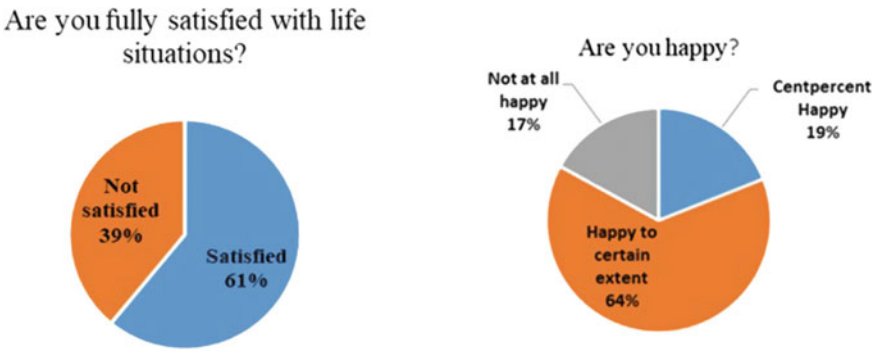


Fig. 12 Comparative assessment of happiness and life satisfaction. Source: Field data

6 Model Discussion

In the present study, the three main components identified for understanding subjective perspectives on wellbeing are life satisfaction, personal experiences, and attitude (Satisfaction, Experience and Attitude)—the SEA abbreviation. The proposed **SEA model** (Fig. 13) integrates both objective[8] and subjective components of wellbeing from a cultural perspective. The three components satisfaction, experience, and attitude are associated and influenced by other components which are essentially involved in acquiring a state of wellbeing. Among the three, life satisfaction[9] is assessed by an individual through comparisons of overall life realms mainly associated with the past and it is an activity with optimal cognitive functioning involving comparison of one's life with others, comparison of life over a certain period of time and a total review of one's entire life. Temperament variables such as *Hope*[10] (EA-h) and *Self-esteem*[11] (EA-i) are found contributing to achieve life satisfaction among women in addition to the variables such as *Economic independence* (ECON-e) and *social capital*[12] (IPLE-c). A person's life satisfaction will not be determined based on factors that he/she don't actually find personally meaningful. It is evident that life satisfaction is associated with physical health, less unemployment and financial strains, a better ability to meet personal needs, hope, self-efficacy, more social support, and higher interpersonal and cognitive functioning. So, the measures of life satisfaction are generally subjective and personal experiences also play a significant role in substantiating wellbeing directly and/or through making life satisfaction effectively.

Well-being is regarded as a multifaceted construct. The common theme developed from various discussions on wellbeing centres around a state of 'feeling good and effective functioning' which involves an individual's own life experiences and comparative assessment of life circumstances. However, anthropological perspectives insist on the importance of socio-cultural background of individuals in perceiving wellbeing from a subjective point of view. Here, women in fishing families highlighted their life experiences mainly in connection with health, hunger, and poverty due to low income from their occupation. It is found that *Hunger* (H-c),

[8] Objective wellbeing is a measure based on expectations about basic human requirements and rights, including aspects such as own house, clean drinking water, adequate food, physical health, stable income, education, and safety.

[9] Life satisfaction may be measured either through a 'global satisfaction' measure, in which people evaluate their lives as a whole, or through a set of domain specific measures, in which people state their degree of satisfaction with different aspects of their lives (Diener, 1984).

[10] The concept of hope denotes a 'positive motivational state that is based on an interactively derived sense of successful agency (goal-directed energy), and pathways (planning to meet goals)' (Snyder, 2002, p. 250).

[11] Self-esteem may be defined as a person's overall subjective sense of personal worth or how much one appreciates and like oneself regardless of the circumstances.

[12] Social capital is defined as the 'ability of actors to secure benefits by virtue of their membership in social networks or other social structures' (Portes, 1998).

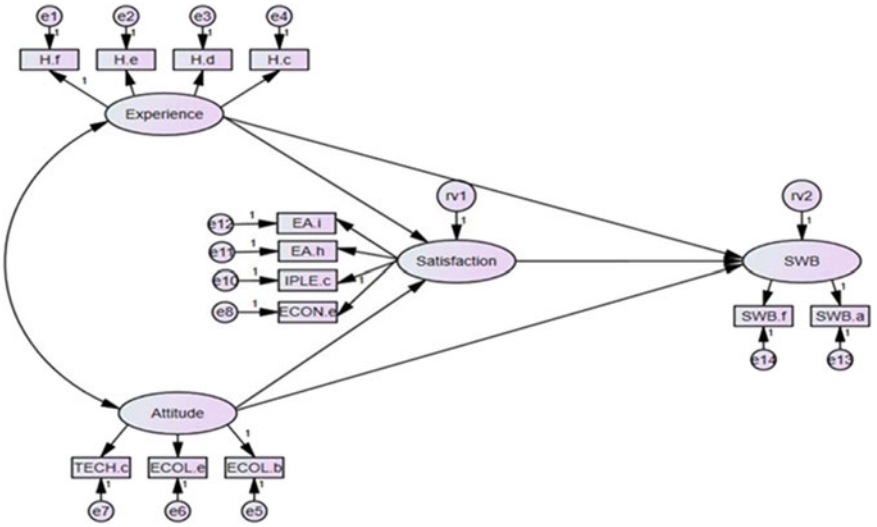


Fig. 13 Anthropological model of subjective wellbeing. N = 310, ECON-Economy, EA-Emotional aspects, H-Health and Hunger, TECH-Technology, ECOL-Ecology, IPLE-Personal life experiences, SWB-Subjective wellbeing. Source: Field data

Health issues (H-e) *Absence of health care* (H–d), and *Poverty* (H-f) are the significant factors identified by them as painful life experiences which directly affect their *attitude* towards life and resultant life satisfaction. During focus group discussions more than 50% of women in the study shared their experiences in connection with hunger and poverty. One of the women said, 'hunger is the most painful experience for a woman because she is entitled to feed others with whatever is left in a pot with an empty stomach'. When asked to make an overall assessment on life, these experiences influence them in developing an attitude which is different from their neighbourhood women.

Attitude[13] is a mental construct influenced by a number of factors and life experience is one among them influencing a person's overall life. In this study, it is found that *occupational diversification* (ECOL-e), *impact of decrease in marine resources on life situations* (ECOL-b), and *mechanization* (TECH-c) are the key factors identified as significant ones influencing their attitude. Women strongly expressed anxieties on the decreasing marine resources and they emphasized that mechanization and over fishing have reduced the availability of marine resources which in turn started to change their attitude towards fishing as a primary source of income. They also fear that, occupational diversification due to a decrease in marine resources will change the traditional socio-cultural set up of the community which has been providing them with emotional wellbeing during joint living. Attitude towards life and life experiences have positive correlations and both influence life satisfaction which is

[13] 'Behavior based on conscious or unconscious mental views developed through cumulative experience' (Venes, 2001, p. 189).

identified as the foundation of subjective wellbeing. Moreover, *Age* (SWB-a) and *circumstances*[14] (SWB-f) also contribute a major share in developing the potential of wellbeing that people adapt more rapidly to new circumstances and life events.

7 Conclusion

In fishing societies, the attitude towards collective wellbeing is underlined as a cultural approach because it is believed to construct particular pathways for achieving individual wellbeing which fluctuates over time. In my previous research among the Hindu marine fishers, women emphasized the invisible role that they play in maintaining family-level wellbeing through the maintenance of community networks and kinship ties. In societies like marine fishers where subsistence is based on unpredictable resources, women are very much flexible in adjusting to their life situations, so that what was originally a source of wellbeing (or not being well) becomes part of the unnoticed circumstances, losing its power to influence them. The effects of life circumstances tend to be of short period because of their static adaptation to social and cultural setting manifested through social institutions. However, the infrastructural facilities, supportive environment, certainty in economy, access to non-economic resources, and life experiences are reported as some of the factors substantiating life satisfaction and well-being to both individual and at community levels. These factors influence an individual to manifest their attitude towards better health and emotional aspects which are materialized through culture and social institutions. Wellbeing in fishing communities relates not only to a single factor but also to whether their needs are met such that one can enjoy satisfactory life situations. Individual life experiences also play a significant role in the formation of attitudes towards wellbeing.

It is understood from the study that, a state of wellbeing for an individual is influenced by support from family along with the intervention of government and other agencies which can provide sustenance in the spheres of education, employment, health, and other infrastructural facilities. This is very much helpful in developing individual perceptions towards constructive action and attitude for development. The creation of a positive attitude is vital in sustaining aspirations towards one's own wellbeing and the subsequent involvement in sustaining livelihood activities with anthropogenic management of resources. The results of the present study have implications for policy decisions and application-level research in the future for marginalized societies. Anthropological model and the analysis discussed here have significantly revealed the association between life satisfaction, personal experiences, and attitude of people which are key factors in the context of development of a community.

[14] Circumstances include own family, friendship circle, work space, and kinship networks. Circumstantial factors also include life status variables such as marital status, religious and political affiliations, and involvement in new initiatives.

References

Ahmed, S. (2010). *The Promise of Happiness*. Duke University Press.

Chang, E. C., & Sanna, L. J. (2001). Optimism, pessimism, and positive and negative affectivity in middle-aged adults: A test of a cognitive-affective model of psychological adjustment. *Psychology and Aging, 16*(3), 524–531.

Diener, E. (1984). Subjective well-being. *Psychological Bulletin, 95*, 542–575.

Diener, E., Diener, M., & Diener, C. (1995). Factors predicting the subjective well-being of nations. *Journal of Personality and Social Psychology, 69*, 851–864. https://doi.org/10.1037/0022-514.69.5.851

Flanagan, J. (1978). A research approach to improving our quality of life. *American Psychologist, 33*(2), 138–147.

George, L. K. (1979). The happiness syndrome: Methodological and substantive issues in the study of social-psychological well-being in adulthood. *The Gerontologist, 19*, 210–216.

Hackney, C. H., & Sanders, G. S. (2003). Religiosity and mental health: A meta-analysis of recent studies. *Journal for the Scientific Study of Religion, 42*, 43–55.

Hitokoto, H., & Uchida, Y. (2015). Interdependent happiness: Theoretical importance and measurement validity. *Journal of Happiness Studies, 16*, 211–239.

Kallinen, K., & Ravaja, N. (2004). The role of personality in emotional response to music: Verbal, electrocortical and cardiovascular measures. *Journal of New Music Research, 33*(4), 399–409.

Krys, K., Uchida, Y., Oishi, S., & Diener, E. (2019). Open society fosters satisfaction: Explanation to why individualism associates with country level measures of satisfaction. *The Journal of Positive Psychology, 14*, 768–778.

Krys, K., Park, J., & Adamovic, M. (2021). Personal life satisfaction as a measure of societal happiness is an individualistic presumption: Evidence from fifty countries. *Journal of Happiness Studies, 22*, 2197–2214.

Lawton, M. P. (1975). The Philadelphia Geriatric Center moral scale: A revision. *Journal of Gerontology, 30*, 85–89.

Luo, L. (2008). Culture, self and subjective wellbeing: Cultural, psychological and social change perspectives. *Psychologia, 51*, 290–303.

Mathews, G., & Izquierdo, C. (2009b). Conclusion: Toward an anthropology of well-being. In G. Mathews & C. Izquierdo (Eds.), *Pursuits of Happiness: Well-Being in Anthropological Perspective*. Berghahn Books.

Matsyafed Information Guide. (2015). Government of Kerala.

Matsyafed Information Guide. (2012). Government of Kerala.

Ng, S. T., Tey, N. P., & Asadullah, M. N. (2017). What matters for life satisfaction among the oldest old? Evidence from China. *PLoS ONE, 12*(2), e0171799. https://doi.org/10.1371/journal.pone.0171799

Oishi, S., & Diener, E. (2014). Residents of poor nations have a greater sense of meaning in life than residents of wealthy nations. *Psychological Science, 25*, 422–430.

Ovstegard, R., Kakumanu, K. R., Lakshmanan, A., & Ponnu Swamy, J. (2010). Gender and climate change adaptation in Tamil Nadu and Andhra Pradesh: A preliminary analysis. [Electronic resource] Tamil Nadu Agricultural University; International Pacific Research Centre, Hawaii (IPRC), [s.l.] ClimaRice.

Portes, A. (1998). Social capital: Its origins and applications in modern sociology. *Annual Review of Sociology, 24*, 1–24. https://doi.org/10.1146/annurev.soc.24.1.1

Pullium, R. M. (1989). What makes good families: Predictors of family welfare in the Philippines. *Journal of Comparative Family Studies, 20*, 47–66.

Raibley, J. R. (2012). Happiness is not well-being. *Journal of Happiness Studies, 13*(6), 1105–1129.

Ramachandran, B. B. (2021). *An Anthropological Study of Marine Fishermen in Kerala: Anxieties*. Cambridge Scholars Publishing.

Sen, A. (1985). Well-being, agency and freedom: The dewey lectures 1984. *The Journal of Philosophy, 82*(4), 169–221.

Shyam, S. S., Kripa, V., Zachariah, P. U., Mohan, A., Ambrose, T. V., & Rani, M. (2014). Vulnerability assessment of coastal fisher households in Kerala: A climate change perspective. *Indian Journal of Fisheries, 61*(4), 99–104.

Steel, P., Taras, V., Uggerslev, K., & Bosco, F. (2018). The happy culture: A theoretical, meta-analytic, and empirical review of the relationship between culture and wealth and subjective well-being. *Personality and Social Psychology Review, 22*, 128–169.

Snyder, C. R. (2002). Hope theory: Rainbows in the mind. *Psychological Inquiry, 13*, 249–275.

Suh, E. M. (2000). Self, the hyphen between culture and subjective well-being. In E. Diener & E. M. Suh (Eds.), *Culture and Subjective Well-Being* (pp. 63–86). The MIT Press.

Sumagaysay. (2011, April 21–23). Adapting to climate change: The case study of woman fish driers of Tanuan, Leyte, Philippines. In *Paper Presented at the 3rd Global Symposium on Gender and Fisheries, 9th Asian Fisheries and Aquaculture Forum*, Shanghai, China.

Veenhoven, R. (1984). The concept of happiness. In *Conditions of Happiness* (pp. 12–38). Springer.

Veenhoven, R. (1996). The study of life satisfaction. In W. E. Saris, R. Veenhoven, A. C. Scherpenzeel, & B. Bunting (Eds.), *A comparative study of Satisfaction with Life in Europe* (pp. 11–48). Eotvos University Press.

Venes, D. (Ed.). (2001). *Taber's Cyclopedic Medical Dictionary* (19th ed.). F. A. Davis.

Sarvimaki, A. (2006). Well-being as being well—A Heideggerian look at well-being. *International Journal of Qualitative Studies in Health and Well-being* 1(1). https://doi.org/10.3402/qhw.v1i1.4903.