From Farm to Nutrition: Connecting the Dots between Dimensions of Food Security and Child's Nutritional Wellbeing in India using Panel Data Analysis

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Abstract

Sustainable Development Goal 2 aims to eliminate hunger by 2030, but this cannot be achieved without addressing undernutrition in the early years of life. Therefore, this study examines the linkage between each dimension of food security and nutritional well-being among children in India. Using panel data from the Young Lives Survey (2006–2016), conducted in Andhra Pradesh and Telangana, India, this study introduces a novel method to construct the dimensions of food security and applied fixed-effects panel regression, dynamic structural equation model, regression-based and KHB decomposition models. Food availability is composed by integrating the data on district level crops and ICMR recommended dietary allowances as well as NSDP by agriculture and allied activities. Food accessibility is created using self-rated food accessibility and purchasing power. Food utilisation is composed of WASH and Dietary diversity score. Appropriate weights were given. Results show that a one-unit increase in availability and accessibility is significantly associated with a 0.81 kg/m^2 rise in BMI, while utilisation contributes 0.17 kg/m^2. Decomposition reveals accessibility (46%) as the largest driver of BMI change, followed by availability (38%) and utilisation (17%) between 2006 and 2016, with the latter's contribution increasing. This study underscores the need for integrated policy frameworks that target all dimensions of food security as interconnected drivers of child's nutritional wellbeing.

Key Words: Food Security, Child's nutrition, Health Policy, Panel Data Analysis, India

Extended Abstract

Introduction

Globally, while the proportion of the undernourished population has declined to around 685 million in 2022-24, the prevalence of the food-insecure population is on the rise from 21.7% to 28.3% between 2014-16 and 2022-24 (FAO et al., 2025). The prevalence of the food-insecure population in South Asia has increased by 12 percentage points in the same time period. This paradox highlights the need to understand the connection between food security and nutrition security, which goes beyond ensuring calorie sufficiency and includes broader dimensions of access, quality, and stability (Pritchard, 2016). Despite India's remarkable boost to agriculture by the Green Revolution, undernutrition persists alongside increased food availability and per capita income (Gillespie and Kadiyala, 2012; Pingali, 2015). This is a matter of concern, particularly for children, as undernutrition during the early years of life has long-term effects on their physical growth, cognitive development, and overall health, emphasising the importance of early interventions to break the intergenerational cycle of undernutrition

(Georgiadis and Penny, 2017; Rahman and Pingali, 2024). This highlights a critical gap in achieving Sustainable Development Goal 2 of Zero Hunger.

Although the relationship between food security and nutrition is well-recognised (Simelane and Worth, 2020), much of the existing research remains limited to cross-sectional analyses or individual aspects of food systems, failing to capture their dynamic and cumulative impact on child health and nutrition. This study is motivated by the need to adopt a more holistic and temporal perspective which focuses on how different dimensions of food security interact and contribute to children's nutritional outcomes over time. By using panel data and robust analytical methods, the present study attempts to empirically understand the linkages between dimensions of food security and child nutritional well-being in India. We hypothesise that the dimensions of food security have a sequential positive influence on children's nutritional outcomes, consistent over time. By testing this hypothesis and quantifying the relative contribution of each dimension of food security, this study contributes to the existing literature by providing a strong integrated approach to study nutritional security in early years of life and simultaneously guiding policymakers in adopting interventions through a multi-dimensional approach, focusing on these proximate determinants of child undernutrition.

Data and Methods

The major data source is Young Lives Survey, which is part of a multinational longitudinal study following the lives of 3000 children in the States of Andhra Pradesh and Telangana in India since 2001. We have integrated data at district level from other sources like ICRISAT-District Level Database and government reports for the same time period i.e. 2006-2016. The major dependent variable is Body Mass Index (BMI), an indicator of nutritional status of children (up to 15 years of age). The major predictors are food availability, food accessibility and food utilisation. Food availability score is developed by integrating the data on district level crops and ICMR recommended dietary allowances norms as well as Net State Domestic Product (NSDP) by agriculture and allied activities. Food accessibility scores are created using self-rated food accessibility of households and their purchasing power. Food utilisation is composed of Water, Sanitation and Hygiene (WASH) and Dietary Diversity score. Appropriate weights were given. Using this panel data, the following major empirical strategy is undertaken:

Fixed effect panel regression model

This model is employed for causal analysis to understand the effect of different dimensions of food security on nutrition. Three separate models were developed for each of these dimensions, as they are correlated with each other. The Hausman test suggested the fixed effect model, which controls for unobserved time-invariant characteristics.

$$Child\ BMI_{ikt} = \alpha_i + Time_t + \beta_1 Dimension\ of\ food\ security_{ikt} + \beta_2 Control\ Variables_{ikt} + \varepsilon_{ikt}$$

Regression-based decomposition

This model tells the relative contribution of each of the dimensions of food security in determining the change in child's BMI between the year 2006 (time 1) to 2016 (time 2).

$$\begin{aligned}\Delta\, Mean\ of\ Child\ BMI_{it} &= \beta_1(\Delta\, Mean\ of\ Food\ Availability)_{it} + \beta_2(\Delta\, Mean\ of\ Food\ Accessibility)_{it} \\ &+ \beta_3(\Delta\, Mean\ of\ Food\ Utilisation)_{it} + Unexplained\ Component + Residuals\end{aligned}$$

KHB decomposition model

KHB Model decomposes the degree to which a control variable, Z, mediates or explains the relationship between X and a latent outcome variable, Y, underlying the nonlinear probability model (Kohler et al., 2011). This model tells the total effect of each of the dimensions of food security and specifies their direct and indirect effect in determining a child's BMI.

Dynamic structural equation model (SEM)

Lastly, to understand the entire mechanism of the relationship between different dimensions of food security and socio-economic demographic variables on child BMI, a dynamic structural equation model is used, which considers the changes that have taken place over time. It follows the linear regression model and provides a marginal coefficient for each set of predictors following a particular path, controlling the lagged variable.

Results

The findings reveal that the food availability, accessibility and utilisation have increased in the study period with slight decline in food availability score in 2016 (Figure 1). In the year 2013, food accessibility score increased faster, and food utilisation score increased highest in the year 2016. The results presented in Table 1 reflect estimates from fixed effects panel regression models assessing the relationship between key dimensions of food security and Body Mass Index (BMI). In Model 1, the Food Availability Index has a statistically significant and positive association with BMI, with a coefficient of 0.808 and a standard error of 0.069. This suggests that, holding other factors constant, a one-unit increase in food availability is associated with a 0.80 kg/m^2 increase in BMI. Similarly, Model 2 shows that the Food Accessibility Index is also significantly and positively associated with BMI, with a coefficient of 0.807 and a smaller standard error of 0.042, indicating a strong and precise effect. In contrast, Model 3 finds a positive but smaller effect size of Food Utilisation Index on BMI with coefficient 0.169, and a standard error of 0.045. These results underscore the importance of multidimensional food security in influencing nutritional outcomes over time. Findings from regression-based decomposition model show that among the dimensions of food security, food availability accounts 38% of change in Body Mass Index. However, KHB decomposition model reveals that 54% of the effect of food availability on BMI is mediated by food accessibility and food utilisation, even after controlling for control variables. Further, the dynamic SEM illustrates a pathway of influence from broader food system factors (availability and accessibility), moderated by socio-demographic controls, leading to food utilisation, which directly influence BMI (Figure 2). Overall, the findings suggest that improvements in food availability, accessibility, and utilisation are all associated with higher BMI, with availability and accessibility demonstrating particularly strong effects, but the effect is mediated by food utilisation.

Conclusion

This is one of the initial efforts in Indian context, where child nutritional wellbeing is studied beyond the demand side socio-demographic and economic factors. This study provides an empirical understanding on how the entire food system is linked while determining the child's nutritional wellbeing using panel data, where the growth of each child is traced over 10 years. Such an approach is limited in existing research. Findings of this study emphasise the importance of addressing the concerns of entire food system for achieving child wellbeing. This study underscores the need for integrated social policy frameworks that target all dimensions of food security as interconnected drivers of child's nutritional wellbeing.

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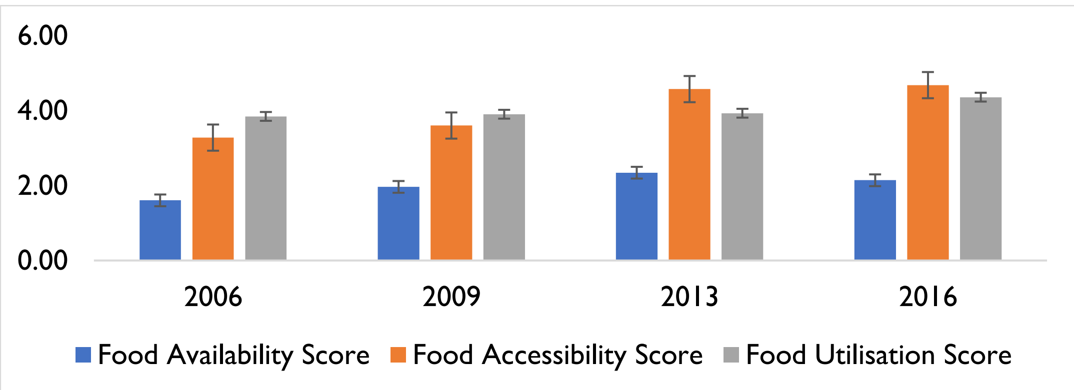
Figure 1. Trends in score in different dimensions of food security (ranges from 0 to 5), 2006-16



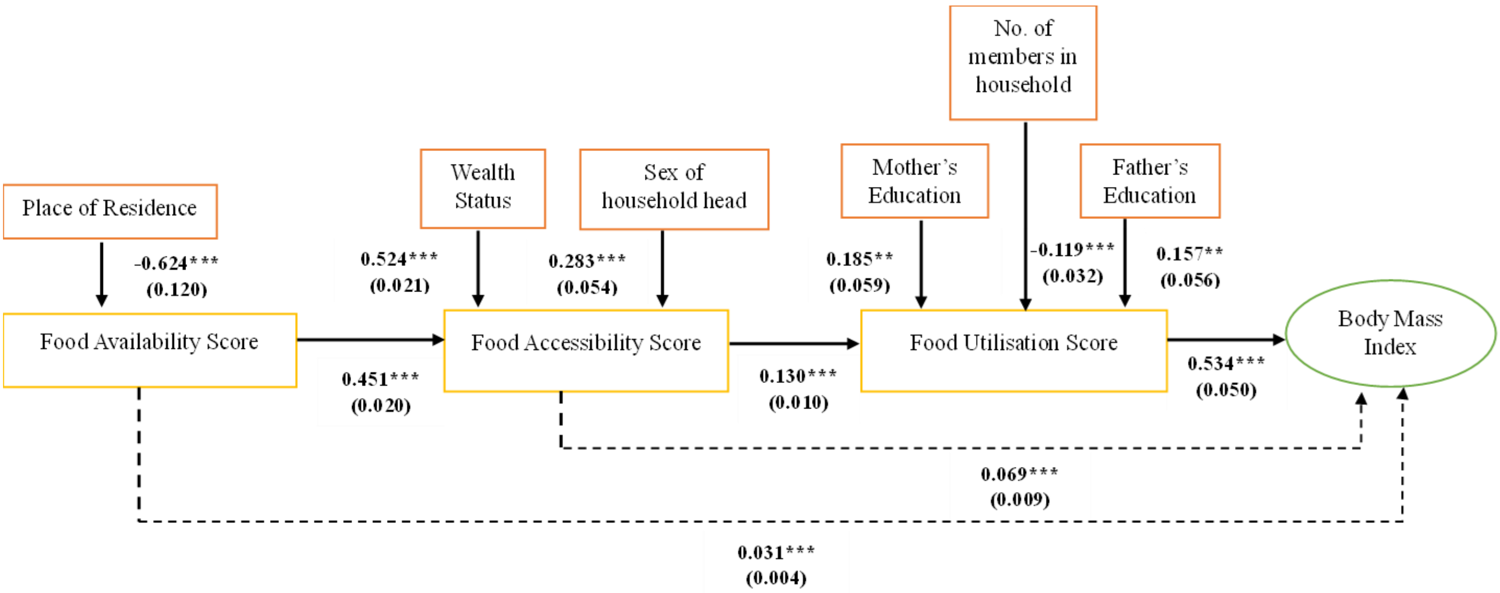
Chi square test: p-value<0.005

Table 1: Panel Regression Model of Body Mass Index with key predictors - Fixed Effect Model

	Model 1 Coefficient (S.E at 95% CI)	Model 2 Coefficient (S.E at 95% CI)	Model 3 Coefficient (S.E at 95% CI)
Food Availability Index	0.808*** (0.069)		
Food Accessibility Index		0.807*** (0.042)	
Food Utilisation Index			0.169*** (0.045)
Constant	12.349*** (0.434)	11.526*** (0.394)	13.163*** (0.459)

Note: *<0.05, **<0.01, ***<0.001; Standard Error (S.E) at 95% confidence interval are in parentheses ( ).
Fixed effects specification has been chosen based on Hausman test.
Model 1-3 is adjusted for parental controls (father's education and mother's education), Household controls (household size, sex of head of households, wealth status), locational controls (place of residence).

Figure 2. Path Diagram of Direct and Indirect Effect on Body Mass Index using Dynamic Structural Regression Model



Note: *<0.05, **<0.01, ***<0.001; Standard Error (S.E) at 95% confidence interval are in parentheses ( ).