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Urbanization, economic access to food and child stunting prevalence: Empirical evidence from urban children of 220 districts in India

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Abstract

India has a higher child stunting prevalence than many South Asian and African nations. Child stunting is a multi-dimensional concept. The impact of most dimensions of child stunting has been studied in the last two decades, but the impact of urbanization using satellite data at cluster level and economic access to food at district level using food expenditure data has not been studied in context of India. There is negative linkage between urbanization and stunting in urban children of 220 districts in India. The Engel ratio is positively linked with child stunting, it means economic access to food is negatively associated with child stunting prevalence in India. Child diet diversity is negatively linked with child stunting. Animal source food and iron rich food consumption are also negatively associated with child stunting in urban children. India is experiencing very slow decline in child stunting prevalence in urban India. Therefore, economic access to food must be increased through economic policies by increasing income level of urban households and controlling food prices in urban India. Polices for inclusive urbanization should be used to catalyse negative association between urbanization and child stunting prevalence.

Keywords: Food Security, Child Stunting, Engel Ratio, Food Consumption Expenditure

Introduction

India is urbanizing rapidly. As of recent estimates, approximately 34% of India's population resides in urban areas. This represents over 470 million people living in cities and towns. By 2031, it is estimated that forty percent of Indians will reside in cities. By 2040, this

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percentage is predicted to increase to more than fifty percent. The growth rate of urban populations is among the highest globally. Urban areas are expanding at a rapid pace. In India, there are now 7,933 cities and towns as opposed to 5,161 in 2001. Urbanization, characterized by the growth of town, cities, and metropolitan areas, affects various aspects of life, including human health (child health). Child stunting is one of important indicator of child health. Child stunting, a form of malnutrition defined by low height-for-age, is a significant concern in both rural and urban contexts. Stunting is a major public health problem in India, with an estimated 35.5% of children under the age of five being affected by the condition (National Family Health Survey, 2019-21). India has shown some progress towards stunting as 35.5% (2019-21) of children from 38.4% in 2015-16. It is higher than the average for the Asia region (21.8%). Children from rural India witnessed 13.4 percent reduction in stunting since 2005-06 and 3.9 percent since 2015-16. Children from urban India witnessed 5.9 percent reduction since 2005-06 and 0.9 percent since 2015-16. Children from urban India are witnessing slower reduction in stunting prevalence than children from rural India. On one hand urban population is increasing rapidly and on the other hand child stunting prevalence is declining slowly, even in last four years, decline in child stunting was mere 0.9 percent. This high prevalence of stunting in urban India has important implications for the health, cognitive development, and economic productivity of affected children. Child stunting affects cognitive development of children, which can lead to poorer academic performance (McGregor et al., 2007). Longitudinal study (Alderman et al.,2014) finds that child stunting leads to low educational attainment and low numeracy skills. Child stunting leads to poor physical health and prevalence of chronic health problems in later years (Bhutta et al., 2013). Poor physical health and lower educational attainment reduce productivity in adulthood (Hoddinott et al., 2013). Lower overall productivity and high healthcare costs due to child stunting prevalence leads to low economic growth (Victora et al., 2008). Impact of most dimensions on child stunting have been studied in Indian context extensively except urbanization level and economic access to food. The percentage of a household's consumption budget that goes towards food determines its economic access to food (Marchetti, 2022). The Engel ratio is another name for it (Moltedo et al., 2014).

It is important to research how urbanisation and food access affect stunting in urban children across India's 220 districts. Moreover, this study is first attempt to examine the impact of accessibility dimension of food security on child stunting prevalence in urban regions at large scale (220 urban regions from 19 states) in India. The remaining sections of the paper are arranged as follows: This paper's second section reviews the existing literature. Research methodology and data are presented in Section 3. Results of parametric regressions are presented in Section 4. Section 5 contains discussion of the study along with recommendations for policy.

Literature Review:

Most of studies have examined association of child stunting with economic development (Ramalingaswami, Jonson and Rohde, 1997), open defecation (Spears, 2013), poor sanitation, feeding practices of children (Menon et al, 2015), deficiency in diet (Deaton and Dreze, 2009), women's education (Pillai and Maleku, 2019, Kim et al., 2017), maternal autonomy (Shroff, 2009) and diverse diets (Headey et al., 2018; Ruel et al., 2017; Hirvonen et al., 2017; Black et al., 2013; Bhutta et al., 2013;Onyango et al., 2008; Arimond and Ruel, 2002; Hatloy et al.,2000).

Impact of economic access to food and urbanization level on child stunting prevalence has been studied less in Indian context. Food consumption has been used as a good proxy for living standards from the time (mid-nineteenth century) of Ernst Engel. Few studies use Engel ratio as indicator of food security (economic access to food) at household level (Amrullah et al., 2019 and Kaicker et al. 2022). Marchetti and Secondi, 2022 use share of food in total expenditure as indicator of economic access of food (food security) in context of Italy. In Indian context, Kaicker et al. (2022) finds households with a higher percentage of children had higher food consumption shares in total expenditure than households with a higher percentage of adults. With the constraints of income, children require more diverse diets that include dairy, fruits, and vegetables.

Arimond and Ruel (2004) finds an association between dietary diversity of children and child stunting after controlling for other socioeconomic factors. Menon et al. (2015) analyzes the National Family Health Survey 2004–2005 in India and finds a statistically significant correlation between the three parameters of child anthropometry and the diversity of children's diet.

In last two decades, research and development in nutritional science made multifactorial nature of child stunting more exploratory and interesting capturing positive linkage between low Animal Source Foods (ASF's) and prevalence of child stunting. Study of Krasevec et.al. (2016) found positive linkage between ASF consumption and child stunting for upper and lower-middle in comparison of low 6 income countries. Study of Heady, Hirvonen and Hoddinot (2018) use Demographic Health Surveys (DHS) data of many countries in phase 5 (year 2006) and 6 (year 2014). In this study sample had better representation of children from South Asia (with Bangladesh, India, Pakistan and Nepal) and sub-Saharan Africa. Results of parametric regression indicates that consumption of ASF lessened stunting by 3.7 percentage points. Experimental studies also suggested that increasing consumption of ASF improves growth (of height, mass of muscle and cognitive function) in school children (Allen, 2013).

There are only two studies that examine the relationship between the degree of urbanization (measured by satellite data) and the prevalence of stunting in children (Amare et al., 2018; Ameye and De Weerdt, 2022). These studies are based on Africa. Amare et al., 2018 finds strong associations between child stunting and urbanization at early stages of urbanization, while such relationships weaken in more advanced stages. Second study (Ameye and De Weerdt, 2022) finds child stunting improves rapidly at low levels of urbanization in all ten countries of sub- Saharan Africa. Both studies finds negative association at initial level of urbanization and use nighttime lights data from satellite as continuous variable for urbanization.

Understanding of degree of urbanization and its effects on wellbeing through continuous measurement (satellite data) is limited to nations in Africa. Thus, in order to investigate the effects of urbanization on child stunting, it is necessary to replicate similar research in other contexts. This paper represents an attempt to assess impact of economic aces to food and urbanization level of child stunting prevalence empirically.

3. Methodology and Data:

3.1 Methodology:

This study estimates the relationship between child stunting, economic access to food, and the degree of urbanization using linear probability analysis. Child stunting is outcome variable in this study. The key explanatory variables of child stunting in India are selected following conceptual framework of the Amey and De Weerdt (2020). Basic control variables are household characteristics. The number of people living in the house and the head of the family's sex are these characteristics of household. Then, explanatory variables for practices related to child feeding (averages for dietary diversity, consumption of foods rich in iron, consumption of foods derived from animals, total food expenditure and share of food in total expenditure), healthcare access (distance problem), and characteristics of mothers and children (dummies for a mother who has completed secondary education, and dummies for an anemic mother and an anemic child). Urbanization level of cluster that child belongs is also added as explanatory variable. In this study, independent determinants are at child level, household level, cluster level and district level.

Following Ameye and De Weerdt (2020) the linear probability regression equation is defined as follows:

$$Stunted_i = \alpha + \beta H_i + \Upsilon F_i + \lambda HA_i + \delta MC_i + \Upsilon U_i + \varepsilon_i \text{-------------- (2)}$$

H_i: It represents a vector of variables relating to household characteristics.

Fi :It is a vector of factors relating to feeding characteristics.

HA_i : It is a vector of factors relating to healthcare access.

MC_i : It represents a vector of factors relating to mother and child.

U_i : It represents urbanization level of cluster that child belongs.

3.2 Data

In this paper, unit-level data of 26,115 children from the Demographic Health Survey (DHS), 2015-16, India, is used for stunting (an outcome variable) of urban child in 220 districts. Our outcome variable is child stunting. The height-for-age (HAZ) z-scores of children are used to define stunting in children. If a child's height-for-age (HAZ) measurement is less than two standard deviations from the medium value of the WHO reference group, the child is considered stunted. 220 districts are selected because data for only these districts are available on variables of food expenditures for urban households are available in CPHS. These 220 districts comprise data on food expenditure from urban 83,288 households. The DHS, 2015 also contains information on the following determinants: anemic mother; anemic child, sex of the household head, number of persons in household, mother who has completed secondary education, wealth level of household, money problem and distance problem.

Children's diet diversity score is determined by counting the number of food groups (FG) they eat from each of the following seven food groups: eggs (FG3), meat foods (FG4), grains, roots, and tubers (FG1), legumes and nuts (FG2), eggs (FG3), milk and milk-based products (FG5), vitamin A-rich fruits and vegetables (FG6), other fruits and vegetables (FG7), and milk and milk-based products (FG5) (WHO, 2008).The iron rich consumption by child is determined by whether or not they ate them the day before. The animal-based food consumption is determined by whether or not they ate foods animal source food the day before. DHS provide food consumption data of mother's youngest child. As a result, it omits crucial information about the variety of diets consumed by other children aged 0-59 months. In order to get around this, we average the dietary diversity of children at the cluster level, which stands for children' typical eating patterns at the level of urban areas.

Data on variables of total consumption expenditure and share of total food expenditure in total expenditure are used from the Consumer Pyramid Household Survey (CPHS) of CMIE for the months of January–March 2016 for urban households of 220 districts. Data of only three months (January-March) are taken to represent consumption expenditure of year 2015-16, following a World Bank study (Sinha Roy and Van Der Weide, 2022), which also use three months consumption expenditure data to estimate consumption-based poverty. Data from the CPHS are used in this study after being reweighted and converted into a national representative (DHS compatible) survey. For reweighting CPHS data, new weights are used which are created in study (Roy and Van Der Weide, 2022) applying max entropy approach which was endorsed by Jaynes (1957) and is also used by many studies (Zhang and Yoshida, 2022). Mechanism of max entropy strategy is to minimize distance between the weighted means in the CPHS and the DHS and to make CPHS DHS compatible.

Now, reweighted household food expenditure data is deflated using monthly data of consumer price index value provided by Reserve Bank of India (RBI) for urban India (base year 2012) for the month January to March 2016 to get a real, or inflation adjusted household food expenditure. Then, we take average of three months inflation adjusted household expenditure data to construct variables of consumption and food consumption expenditure at urban regions level. We construct inflation adjusted data of total consumption expenditure, total food consumption expenditure, expenditure on eggs, expenditure on milk and milk products, expenditure on meat and fish separately at urban region level from household level data. We construct share of different food group dividing expenditure on food group by total real food consumption expenditure. We calculate Engel Ratio dividing real food consumption expenditure by real total food consumption expenditure at household level. Then average of Engel ratio is taken for urban households at district level which is further multiplied by hundred and used as explanatory variable (economic access to food) of child stunting.

Urbanization level is measured through gridded population density data. Gridded population density is measured as average at 1x1 kilometre area in urban. Unit of population density is number of people per square kilometer. The human population density (number of people per square kilometer) in Gridded Population of the World, Version 4 (GPWv4) is estimated at high resolution using counts that are in line with national censuses and population records. The Center for International Earth Science Information Network of Columbia University developed it.

4. Results:

This section deals with empirical linkages between economic access to food, dietary diversity, consumption of animal source food, iron rich food, urbanization level of settlements, and probability of child stunting. We run four different regressions with these explanatory variables.

Table 1: Regression analysis of child stunting probability with total food expenditure, economic access to food and diet diversity as predictors.

Variable	Value
Dietary Diversity	-0.00486 (0.002)
Anemic Child	0.01152*** (0.006)
Anemic Mother	0.02182*** (0.006)
Sex of Household Head	0.00283 (0.009)
No of Persons in Household	0.001958 (0.002)
Secondary Education	0.0174· (0.009)
Wealth Level of Household	-0.07077*** (0.002)
Money Problem	-0.000971 (0.009)
Distance Problem	0.00304 (0.008)
Total Food Consumption Expenditure	-0.000001 (0.00005)
Economic Access to Food (Engel Ratio)	0.000869 (0.0004)
Intercept	0.4872*** (0.02)
Multiple R-squared	0.05263
Adjusted R-squared	0.05211
F-statistic	100.1
p-value	<2.2e-16

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, *p<0.1

First, we run regression with total food expenditure, economic access to food and diet diversity as independent variables. Table 1 shows the coefficients of total food consumption expenditure, money problem, distance problem and sex of household head are not significant.

Coefficients of economic access to food (Engel Ratio), dietary diversity, anemic child, anemic mother, no of persons in household are significant but all impact child stunting in different ways. The coefficient of dietary diversity is significant and it influences child stunting negatively. The coefficient of anemic child is positive and significant. Anemic children have a 0.01 (1 percent) higher probability than children who are not anaemic. Anaemic mother has a positive and significant coefficient. Children of anaemic mothers have a 0.02 (2 percent) higher probability than children of mothers who are not anaemic. The coefficient of economic access to food is positive and significant. Coefficient of wealth level

is significant and negative. One unit increase in wealth level decreases probability of child stunting by 0.07 (7 percent).
Secondly, we run regression with total food expenditure, economic access to food and consumption of animal source food as independent variables.

Table 2: Regression analysis of child stunting prevalence with total food expenditure, economic access to food, consumption of animal source food as predictors.

Variable	Value
Animal Source Food Consumption	-0.009846* (0.004)
Anemic Child	0.1157*** (0.006)
Anemic Mother	0.02202*** (0.006)
Sex of Household Head	0.00243 (0.009)
No of Persons in Household	0.002326* (0.002)
Secondary Education	0.018430· (0.009)
Wealth Level of Household	0.070380*** (0.002)
Money Problem	0.003889 (0.009)
Distance Problem	0.003477 (0.008)
Total Food Consumption Expenditure	0.000001 (0.00003)
Economic Access to Food (Engel Ratio)	0.000886* (0.0004)
Intercept	0.048111 (0.02)
Multiple R-squared	0.052000
Adjusted R-squared	0.051520
F-statistic	108.5
p-value	2.2e-16

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, *p<0.1

Table 2 shows the coefficients of total food consumption expenditure, money problem, distance problem and sex of household head are not significant. Coefficients of economic access to food (Engel Ratio), consumption of animal source food, anemic child, anemic mother, no of persons in household are significant but impact child stunting in different ways.

The coefficient of animal source food consumption by child is significant and it influences child stunting negatively. The coefficient of anaemic child is positive and significant. Anemic children have a 0.01 (1 percent) higher probability than children who are not anaemic. The coefficient of anaemic mother is positive and significant. Children of anaemic mothers have a 0.02 (2 percent) higher probability than children of mothers who are not anaemic. The coefficient of economic access to food is positive and significant. Coefficient of wealth level is significant and negative. One unit increase in wealth level decreases probability of child stunting by 0.07 (7 percent).

Thirdly, we run regression with total food expenditure, economic access to food and consumption of iron rich food as independent variables.

Table 3: Regression analysis of child stunting prevalence with total food expenditure, economic access to food and iron rich food consumption as predictors.

Variable	**Value**
Iron Rich Food Consumption	-0.02267* (0.009)
Anemic Child	0.11149*** (0.006)
Anemic Mother	0.00219*** (0.002)
Sex of Household Head	0.00216 (0.009)
No of Persons in Household	0.002174* (0.001)
Secondary Education	-0.01779* (0.009)
Wealth Level of Household	-0.07079*** (0.002)
Money Problem	-0.00031 (0.009)
Distance Problem	0.00369 (0.008)
Total Food Consumption Expenditure	-0.000001 (0.000003)
Economic Access to Food (Engel Ratio)	-0.000848* (0.0004)
Intercept	0.04881 (0.02)
Multiple R-squared	0.05206
Adjusted R-squared	0.05158
F-statistic	108.6
p-value	<2.2e-16

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, *p<0.1

Table 3 shows the coefficients of total food consumption expenditure, money problem, distance problem and sex of household head are not significant. Coefficients of economic access to food (Engel Ratio), consumption of iron rich food, anemic child, anemic

mother, number of persons in household and completed of secondary education by mothers are significant but all influence child stunting in different directions.
The coefficient of iron rich food consumption by child is significant and it influences child stunting negatively. The coefficient of anaemic child is positive and significant. Anemic children have a 0.01 (1 percent) higher probability than children who are not anaemic. The coefficient of anaemic mother is positive and significant. Children of anaemic mothers have a 0.02 (2 percent) higher probability than children of mothers who are not anaemic. The coefficient of economic access to food is positive and significant. Coefficient of wealth level is significant and negative. One unit increase in wealth level decreases probability of child stunting by 0.07 (7 percent). Finally, we run regression with total food expenditure, economic access to food and consumption of iron rich food as independent variables.

Table 4: Regression analysis of child stunting prevalence with total food expenditure, economic access to food, dietary diversity, and urbanization level as predictors.

Variable	**Value**
Dietary Diversity	-0.00442· (0.002)
Anemic Child	0.1142^{***} (0.003)
Anemic Mother	0.07055^{***} (0.006)
Sex of Household Head	0.00280 (0.01)
No of Persons in Household	0.00203 (0.001)
Secondary Education	-0.01784· (0.009)
Wealth Level of Household	-0.07066^{***} (0.002)
Money Problem	-0.00109 (0.009)
Distance Problem	0.00294 (0.008)
Total Food Consumption Expenditure	0.00000 (0.000003)
Economic Access to Food (Engel Ratio)	-0.00049 (0.0004)
Population Density (Urbanization Level)	-0.000002^{***} (0.0000007)
Intercept	0.0499^{***}
Multiple R-squared	0.052
Adjusted R-squared	0.052
F-statistic	100
p-value	<2.2e-16

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, *p<0.1

Table 4 shows the coefficients of total food consumption expenditure, economic access to food (Engel ratio), money problem, distance problem and sex of household head, number of persons in household are not significant. Coefficients of anemic child, anemic mother, wealth level and population density (urbanization) are significant but all influence child stunting in different directions. Coefficient of wealth level is significant and negative. One unit increases in wealth level decreases the probability of child stunting by 0.07 (7 percent). The coefficient of population density is both significant and negative. A thousand-unit increase in population density decreases the probability of child stunting by 0.02 (2 percent).

5. Discussion

This study examined the link between urbanization, economic access to food and child stunting prevalence in urban population of 220 districts of India. There is a significant and negative association between the likelihood of childhood stunting and urbanization.

It is in line with the results of Amare et al., 2018 and Ameye and De Weerdt, 2020. Engel ratio (the share of food in total expenditure) is positively associated with child stunting, it means economic access to food is negatively and significantly associated with child stunting. Children-dominated households spend the highest percentages on food expenditure compared to grown-up-dominated households and balanced households. Given the financial constraints, children's diets should be more varied and include dairy, fruits, and vegetables (Kaicker et al., 2022). This study also finds that diet diversity of child is negatively associated with child stunting. Many research' findings are in line with it (Chandrasekhar et al., 2017; Saha et al., 2022; and Darapheak et al., 2013).

Empirical analysis reveals that consumption of animal source food is negatively associated with child stunting prevalence. Result is consistent with findings of other studies (Heady, Hirvonen & Hoddinot, 2018; Haile & Heady, 2023 and Darapheak et al., 2013). Consumption of animal source food is important because of its intrinsic micronutrient content and protein, which may catalyze the speed of information processing, which is important for the problem-solving capacity and cognitive development of children (Neumann et al., 2007). Iron-rich food consumption is also negatively associated with probability of child stunting.

The study also finds non-anemic children have less stunting prevalence than anemic children. The study reveals that children from anemic mothers have high stunting prevalence than children from non anemic mother. The empirical analysis reveals that wealth level of household is negatively associated with child stunting prevalence. Secondary education completion by mother is also negatively associated with child stunting. Number of persons in household is positively associated child stunting in India.

Child-dominated households are already most food insecure. Therefore, economic access to food (low Engel ratio) is important pathway to improve dietary diversity of child’s food. Improving economic access food is important to increase consumption of animal resource food (expensive calories) and iron-rich food in child’s diet. Economic access to food can be increased by increasing income level of urban households and controlling food prices in urban India. Overall, urbanization influences child stunting prevalence negatively but it requires a further investigation to examine the effect of different level of urbanization (low, medium, and highest level) on child stunting prevalence.

Declarations

Conflicts of interest: The authors declared that they have no conflict of interest.

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