The Impact of Parental Education on Child Health and Development

An Indian Perspective

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Author:
Anuragh Balajee
(Student Number: 444153)

Supervised by:
Dr. L.D.S Hering

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Abstract

Using data from the National Family Health Surveys (NFHS) 3rd round of surveys for India, this paper studies the possible effects of parental education on prevalence of undernutrition in children between the ages of 0-59 months. The reason why parental education is so important is because enables them to be more aware: education helps increase awareness to various issues (including healthcare). Therefore, higher the education, more the ability to make informed decisions about healthcare, and thereby circumvent issues related to this. This is why parental education is so important: because it is necessary to overcome or circumvent issues of anthropometric failures. Using a linear probability model, while controlling for wealth of the household and other child demographic indicators, the OLS regression results show that there is a negative and significant relationship between parental education and the probability of undernutrition in children in the above-mentioned age group.

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1. Introduction

India has been one of the top emerging economies[1] in the last decade, maintaining a consistent growth rate of more than 5% real gross domestic Product (GDP). However, looking beyond the scope of aggregate economic indicators paints a very contrasting picture of India. Corruption continues to be a huge problem (as in other developing and emerging economies), gender gaps have not reduced even though provisions have been introduced to ensure equal pay, equal opportunities for men and women both in the workplaces and in education, and child development remains an issue of major concern in many parts of the country. As a consequence, societal development has been hindered while efforts are focused on achieving higher economic growth rates.

India is home to 194.6 million undernourished people[2] and child health in the country has been a concern for decades. Given the prevalence of infectious diseases and poor quality of health-related resources in most developing countries, children, especially between the ages of 0-2 years, are highly vulnerable to growth retardation and acute respiratory infections among other diseases (IIPS, 2007). In such cases, the socioeconomic status of a household determines their access to health-care, and thereby, improvements in child health (Currie, 2008). Socioeconomic status consists of variables (or indicators) such as education, income, and occupation of household members (among others). For example, the inadequate education of adults may reduce the likelihood of their seeking help for illness because of beliefs about the causes and cures (for these illnesses) that have not kept up with modern medicine (Bradley and Corwyn, 2002). It could also be the case that a low-income household will be constrained by their resources to receive good quality treatment, in most cases.

The World Health Organisation (WHO) measures malnutrition using three different anthropometric indicators[3]:

a. Height-for-Age (measure of stunting);
b. Weight-for-Height (measure of wasting);
c. Weight-for-Age (measure of overweight and underweight)

Table 1 shows the occurrence of stunting, wasting, and under/overweight in Indian children between the ages of 0-59 months. These figures have been obtained from the 3rd round of the

[1] Source: http://www.thenewstribune.com/news/business/article165357147.html

[2] Source: https://www.wfp.org/stories/10-fact-about-food-and-nutrition-india

[3] All three definitions sourced from Gaiha et al. (2010)

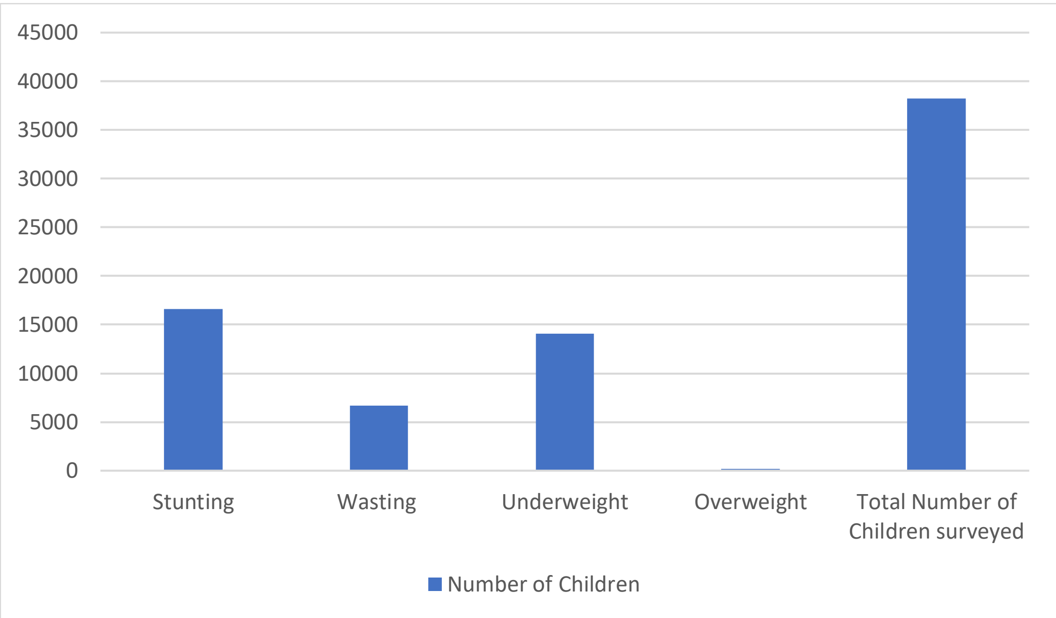
National Family Health Survey (NFHS-3), conducted in India, and are representative only of the children surveyed. The NFHS-3, conducted in 2005-06 by the International Institute of Population Sciences (IIPS), Mumbai, provides estimates of indicators on family welfare, maternal, and child health, and nutrition. (The IIPS is responsible for the publishing of the results of the survey and came out with the report of NFHS-3, 2007). Furthermore, this survey also provides more information on emerging issues such as family life education, safe vaccinations, perinatal mortality, prevalence of tuberculosis, and malaria, to name a few. It is an improvement over its predecessors- NFHS-1 (1992-93) and NFHS-2 (1998-99)- on account of the more qualitative information that is has provided. This survey covered all the 29 states in India (covering almost 99% of the country's population (IIPS, 2007).

Table 1: Prevalence of undernutrition in children between the ages of 0-59 months

Group	% Children*
Stunted growth	43.46
Wasted growth	17.40
Underweight and Overweight	37.29

Source: Author's own calculations
*Total number of children = 38,244

Figure 1: Number of children suffering from Malnutrition in India (2005-06)



Source: Author's own calculations

Figure 1 is visual representation of the data points in table 1. Among all the children surveyed in the NFHS-3, most children appear to be suffering from stunting followed by the issue of being underweight and wasted respectively. However, it is highly possible that these anthropometric failures could be simultaneously occurring in children and, therefore, some children who suffer from stunting could also be suffering from one (or both) of the other two anthropometric failures.[4]

Socioeconomic status is related to a number of health, cognitive, and socioemotional outcomes in children (Bradley and Corwyn, 2002). They state that children from low-socioeconomic status households are more likely to experience growth retardation, more likely to be born prematurely, have low birth weight and other similar growth-related issues. Growing up with poor health has severe repercussions for the future (Bradley et al., 1994; McLoyd, 1998). An interesting concept was put forth by Deaton (2002): he talks about the existence of an income-health gradient (a gradual positive relationship between the two indicators i.e. as income increases, health also improves). This is one of the most important tools for economic interpretation and policy formulation in this field. The link between child health and socioeconomic status can vary depending on factors such as culture, race, and geography and this situation can further be disrupted by internal strife and even natural disasters (Bradley and Corwyn, 1999; Wachs, 2000; Deaton, 2002).

In this context, the paper examines the impacts of parental education (which is one component of socioeconomic status) on child health and development for children aged between 0-59 months. I use proxies for parental education level (the highest education level of the household and partner's education level) as the main explanatory variable while controlling for demographic factors such as wealth status of the household, sex of the household head, number of children per household, sex of the child, and geographical factors such as the place of residence (urban or rural), access to health care centres and the source of drinking water.

The data for this paper has been sourced from the NFHS-3 in India. Parental education is a factor of paramount importance as it has significant positive impact on child health (Thomas et al., 1991). The NFHS-3 report published by IIPS (2007) also finds that education (and wealth) are important determinants of fertility rates: at the then-prevailing fertility rates, woman in the poorest households will have two more children than women in the richest households. This would also have significant impacts on child health as a rich household would be able to afford better health services ensuring better health for a child while a child from a poor household could suffer due to parents being poorly educated or lacking the resources to

[4] Refer to section 3.3 for empirical proof of simultaneous occurrence of these anthropometric failures.

improve quality of life. Additionally, in a poor household, with more children, the health of the younger children will be poorer than the older ones.

OLS regression results indicate that parental education does have a significant effect on improving child i.e. using a linear probability model, I find that a higher level of education (of the parents) and a wealthier household help reduce the probability of occurrence of anthropometric failures. This has important policy implications: in a country like India, where there is a huge disparity across different parts of the country in access to education, this study would help stress on intensifying efforts to create more avenues to increase access to education through investments and increased spending by the government. Additionally, within the same framework, I also interact parental education with the wealth status of the household to determine the role these socioeconomic status indicators, together, play in alleviating child health. This is a more realistic model as socioeconomic status indicators do not work independently in determining child health. In this context, OLS regression results indicate a negative and significant impact on the occurrence of anthropometric failures i.e. as the education level and wealth of a household increase, child health also improves and the probability of occurrence of anthropometric failures decreases. Apart from establishing an unequivocal relationship between parental education and child health, especially with respect to India, the model considering the interaction effect is a unique element which would be highly useful in policy formulation and implementation.

Following this section, I provide a review of papers dealing with related topics while discussing their results. A section on the data and methodology used for the study comes after this where I provide details about the source of the dataset and the methodology used for the empirical analysis. Next, I discuss the empirical results from my analyses while trying to draw connections with existing studies (if any). Finally, I explore the limitations of this paper and suggest scope for improvements for future analyses in this field and end the study with some concluding remarks.

2. Review of Literature

As mentioned earlier, there is a general consensus in the literature of this field that socioeconomic status is represented mainly by parental education, household income, and occupation status. Although I study only the relationship between parental education and child health in this paper, I also control for other socioeconomic status indicators (mentioned in detail in section 3.3). On account of this, I provide a brief review of literature of the relationship between socioeconomic status and child health in addition to reviewing those papers which talk specifically about the former relationship.

In this section, I have classified studies analysing the effect of socioeconomic status on child health into two broad fields: (i) the various 'pathways'[5] through which socioeconomic status affects child health; and (ii) impact of parental education on child health and child health seeking behaviour. Here, I review literature from the two fields.

2.1. The various 'pathways' through which socioeconomic status affects child health

Currie's (2008) paper is imperative in the context of developing and emerging economies as it shows a potential pathway for policy makers to focus their efforts on specific aspects of societal development. It looks specifically at the role of socioeconomic status and its impact on child health. In this regard, she tests for possible relationships between parental socioeconomic status (i.e. education, income, occupation etc.) and child health and the causal links between child health and future educational and labour market outcomes. Research by Grossman (2000), Case et al. (2005), and Smith (1999) has shown that health capital significantly affects education and earnings. However, Currie's focus is on developed countries considering the fairly common health problems developing countries face. The paper identifies a "chicken and egg" problem that has eluded a solution in this area of research: why is income so important to determine educational attainment? Consequentially, Currie concludes that there is strong evidence of links between parental socioeconomic status and child health and between child health and all related future outcomes: parental socioeconomic status does affect child health at early stages. Despite this result, a problem with this study, and other related ones, is that, based on existing evidence, it is difficult to evaluate the magnitude of the impact of health due to its multi-dimensionality (i.e. it is difficult to capture these health effects in a single index).

The relationship between health and income in this area of research is referred to as a "gradient"- it emphasises the gradual relationship between the two indicators i.e. as income

[5] Aslam and Kingdon (2012) list the following socioeconomic 'pathways' through which child health is affected: educated parents' greater household income, exposure to media, literacy, labour market participation, health knowledge and the extent of maternal empowerment within the home.

increases, health also improves, and consequently, poverty has more than a "threshold"[6] effect on health (Deaton, 2002).

It is in this context that Case et al. (2002) study the relationship between children's health and household income. By focusing on children, the authors are able to eliminate the relationship that runs from health to income thereby simplifying the analysis. Using cross-sectional data from the annual National Health Interview Survey (NHIS) in the U.S. the 1988 child health supplement to the NHIS (NHIS-CH), the Panel Study of Income Dynamics with its associated 1997 Child Development Supplement (PSID-CDS), and the Third National Health and Nutrition Examination Survey (NHANES), Case et al. study the above-mentioned gradient using a linear probability model (LPM). Their main objective is to test whether the observed chronic health status of adults has connections to their childhood health and whether this health, is in fact, affected by the income earning capacity of the household. Their results suggest that such a relationship does, in fact, exist i.e. the medical condition in a poorer child is more adverse when the child grows older. Following from this conclusion, the authors also state that poorer children, when they become adults, have a lower health status and lower education levels. Their conclusions are imperative in analysing the role of socioeconomic indicators in improving children's health. However, these results do not establish a causal relationship running from household income to child health.

Using the results obtained by Case et al. (2002), Currie and Stabile (2002) study the effects that socioeconomic status on older children based on the socioeconomic gradient. This paper is an improvement over Case et al. (2002) in that the cross-sectional study in the latter it is not possible to distinguish between two different possible mechanisms that give rise to a steep gradient (i.e. as income increases, spending on health increases and, consequently, health improves. This also helps the poor slowly move out of the poverty trap). Currie and Stabile (2002) state that this relationship grows stronger in time mainly due to the negative health shocks that children from low-socioeconomic status households face. Using panel data on Canadian children, they show that:

(i) the gradient estimated in the cross section is similar to the estimates of U.S. children arrived at by Case et al. (2002);

(ii) children from high and low-socioeconomic status households recover from past health shocks to almost the same degree;

[6] A threshold effect can be defined as a sudden or radical change in a phenomenon occurring after crossing a certain quantitative limit (called the threshold). (Source: https://en.wikipedia.org/wiki/Threshold_effect)

(iii) the relationship between socioeconomic status and health grows stronger over time mainly because children from households with low socioeconomic status face ore negative health shocks.

Their results indicate that family income and maternal education is negatively and significantly correlated with having poor health i.e. a higher family income lowers the probability of poor health. They conclude that children from a low socioeconomic background will suffer more from health shocks in the short-run than those children from a high socioeconomic background. However, in the long-run, children from both these backgrounds recover to the same extent and this was because children from high-income families are subjected to fewer health shocks.

A similar study which does not agree with the results of Case et al. (2002), and Currie and Stabile (2002) is that of Cameron and Williams (2009). Their study on the income-health gradient in developing countries presents a completely different picture: though low income adversely affects health status the impact income has on health does not differ by age. They show this by using data from the Indonesian Family Life Survey on children between the ages of 0-14 years. The general health of children improves with age in Indonesia which contrasts with results in developed countries (which show that children's health decline as they grow older) and this finding is robust even after inclusion of health at birth and parental health. The reason the authors give as to why household resources do not have a stronger effect on older children's general health is due to the prevalence of acute (short-lived) illnesses in developing countries, and due to the short-term nature of these illnesses, they are significantly correlated with parental decisions regarding child health.

2.2. Impact of parental education on child health and child health seeking behaviour

An interesting study by Flores et al. (1999) looked at disparities between different ethnicities for children's health and the use of health services in the US. Obtaining data from the1989-91 National Health Interview Survey (NHIS) for children between 0 and 17 years of age, the authors performed a bivariate and multivariate analysis on 99,268 children. They find that Native American, Black, and Hispanic children are among the poorest, least healthy, and have the least well-educated parents compares to Whites. Non-White children average fewer doctor visits than White children. These results indicate that there are major disparities in access to and use of child health care services between Whites and non-Whites. Even more shocking is their result that these disparities exist after adjusting for family income and parental education. They do find that a child's sub- optimal health status is inversely linked with the level of parental education. Desai and Alva (1998) obtained similar results for their study wherein controlling for individual socioeconomic characteristics reduced the effect on child health (albeit while analysing effects on slightly different dependent variables). However, these two papers show a reducing effect of parental education on child health indicators when certain individual factors are controlled for.

Using data from the 3rd round of the National Family Health Surveys (NFHS) III in India, Naline and Viswanathan (2016) examine the determinants of nutritional indicators for children aged 0-59 months. With the use of Seemingly Unrelated Regressions (SUR) Model, the authors estimate that mother's health indicators are highly significant in explaining impacts on child's height-for-age, weight-for-age, and weight-for-height. Additionally, factors such as access to drinking water, wealth index of households, and sanitation are all closely linked with improvements to child health. In effect, they conclude that the mother to child transmission and early child care are, by far, the most significant factors affecting child growth.

Navaneetham and Dharmalingam (2001) analyse the variations in the utilisation of maternal health care services in the four south Indian states of Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu. Using data from the first round of NFHS (1992-93) in India, they study the inter-state differences in utilisation of maternal health care services: these are due to variations in implementations of health care programmes and availability and accessibility of such services in these four states. To determine the patterns and determinants of maternal health care services, Navaneetham and Dharmalingam use a multivariate logistic regression. They identify six different measures of utilisation of maternal health care services and the regression results show that almost all mother in Kerala and Tamil Nadu received some antenatal care (98% and 95% respectively) while it was slightly lower in Andhra Pradesh and Karnataka (88% and 85% respectively). More than 90% of the women in Kerala had received a minimum of four antenatal check-ups while less than 70% of the woman had four or more antenatal check-ups in the other three states. The maximum variation in the utilisation of these maternal health care services was found the in the hospital delivery of births and assistance by health professionals wherein only 3 women out of 10 in Tamil Nadu and 1 out of 10 women in Kerala delivered their babies at home. These numbers are higher in Andhra Pradesh and Karnataka: 6 out of 10 in both these states. From this, the authors conclude that factors such as antenatal care, timing of first antenatal check-up and the its frequency henceforth, institutional delivery, and delivery assistance played a significant role in determining the access to such health care services.

Desai and Alva (1998) test for a causality between maternal education and child health using Demographic and Health Surveys for 22 developing countries. Using markers such as infant mortality, child's height-for-age (HFA), and immunization, Desai and Alva state that though there exists a correlation between these markers and maternal education, a causality is difficult to establish. This finding is similar to that of Currie's (2008) paper. Using an OLS or logit model, the effects of maternal education on infant mortality and HFA seem to reduce when controls for husband's education and access to piped water are and toilet facilities are included. Additionally, controlling for area of residence (urban or rural) further reduces effects of maternal education on the above two dependent variables. However, while using a fixed effects model, the effect that maternal education has on infant mortality and HFA is statistically significant only in some of the 22 countries used in the research. In contrast to these results, immunisation status remains statistically significant in both the models for half of the countries used in the study.

Chou et al (2007) use a natural experiment to estimate the impact of parental education levels on child health in Taiwan. This study follows from a reform introduced by the Taiwanese government which extended compulsory education from six to nine years. Using differences-in-differences, regression discontinuity design and linear probability models of completed schooling, Chou et al find that, after forming treatment and control groups of women or men aged 12 and under and aged 13 and 20 or 25 respectively, mother's schooling leads to favourable outcome for infant health. This effect was more in the case of the mother's education than the father's education. They state that the increase in schooling following the reform saved almost 1 infant life in 1000 live births leading to a decline in infant mortality of approximately 11%. In effect, according to their analysis, an increase in mother's schooling lowers the probability that an infant will be born with poor health or will die in the neonatal or postnatal periods[7].

Aslam and Kingdon (2012) analyse the relationship between parental schooling and child health outcomes and parental health-seeking behaviour using data from the North-West Frontier Province and Punjab in Pakistan. The study is aimed at understanding how parents' education is translated into outcomes for child health and health seeking behaviour for both themselves and their children. Baseline model estimates show that father's education is positively correlated with immunisation while mother's education positively determines child

[7] Neonatal: general care given to a child in a month immediately following a child's birth
Postnatal: general care given to a child immediately after the birth of the child

health outcomes. Using instrumental variable estimation to control for endogeneity in maternal schooling, the results show that the father's knowledge of health is an even larger positive determinant, than the OLS estimates, of child immunisation. This estimation method also helps conclude that the mother's health knowledge (and a more significant role within the household) have large positive effects on children's health. This study clearly establishes the impact of parental education on child health (a positive relationship).

3. Data and Methodology

3.1. <u>Source of Data</u>

The data for this paper was obtained from NFHS-3 undertaken in 2005-06. The survey covers households in rural and urban areas in all 29 states of India. NFHS-3 follows NFHS-1 and NFHS-2 which were conducted in 1992-93 and 1998-99 respectively, and all three surveys provide detailed information and estimates of family welfare, maternal and child health, and nutrition across the country. The household interviews covered all women aged between 15 and 49 and all men aged 15-54. The survey also provides information on the nutritional status of young children which further justifies the use of this dataset for the paper. NFHS-3 was conducted under the stewardship of the Ministry of Health and Family Welfare (MOHFW), in agency[8] for this survey. The funding for NFHS-3 came from the United States Agency for International Development (USAID), Department for International Development (DFID) of the United Kingdom, the Bill and Melinda Gates Foundation, United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), and MOHFW.

3.2. <u>Dependent variables: measures of anthropometric failures</u>

This paper studies the impact of parental education on child health and development while controlling for demographic and geographic factors. The empirical analysis of this paper uses the following anthropometric indicators (also the dependent variables) for measuring different levels of malnutrition:

a. Height-for-Age (HFA): an indicator of chronic undernutrition due to prolonged food deprivation and/or illness (stunted growth or stunting);

[8] Often an appointed commission (either permanent or semi-permanent) overlooking the functioning of government agencies or other commissions alike.

b. Weight-for-Age (WFH): an indicator of acute undernutrition (wasted growth or wasting)
c. Weight-for-Height (WFA): a composite indicator of acute and chronic undernutrition (underweight and overweight).

In their description of the WHO Global Database on Child Health and Malnutrition, de Onis and Blössner (1997) state that these three indicators are measured using Z-scores as calculated by the World Health Organisation (WHO), which are expressed in units of standard deviation (SD) from the median of the reference population. The reference population is the standard used by the WHO i.e. the international reference population, which compares anthropometric values "across individuals or populations in relation to an acceptable set of reference values."[9] The database used for this comparison is the National Centre for Health Statistics (NCHS) growth reference – the NCHS/WHO international reference population.

The international reference population is based on the international reference growth curves formulated in the 1970s. The reference curves of the NCHS were adopted by the WHO based on the then-prevalent evidence that the pattern of growth of healthy pre-school children belonging to various ethnicities were similar. The adoption of this reference population has simplified the process of dealing with anthropometric data from all types of surveys. A point of caution, however, is that the international reference population should be used only "as a general guide for screening and monitoring and not as a fixed standard that can be applied in a rigid fashion to individuals from different ethnic, socioeconomic, and nutritional and health backgrounds."[10]

The Z-scores are calculated using the formula:

$$Z - score\ (or\ SD\ score) = \frac{observed\ value - median\ value\ of\ reference\ population}{SD\ of\ reference\ population}$$

where,

SD score → standard deviation score

Fortunately, the dataset provides the Z-scores of the surveyed individuals for all the three anthropometric indicators thereby removing the need to calculate Z-scores individually.

[9] Source: http://www.who.int/nutgrowthdb/about/introduction/en/index3.html
[10] Source: http://www.who.int/nutgrowthdb/about/introduction/en/index3.html

However, Z-scores have been reported only for 43,737 children across the country (from a survey covering more than 99% of the population) – a point I will elaborate on while discussing the limitations of the study.

Taking the minimum Z-score as the lower limit and keeping the absolute value of this Z-score as the upper limit, Z-scores which were either flagged or had values beyond the plausible range were removed. Consequently, the number of observations reduces to 38,244 (as in Table 1).

Table 2: Descriptive Statistics of the dependent variables (anthropometric failures)

Dependent Variables	(1) Number of Observations	(2) Mean	(3) Standard Deviation	(4) Minimum	(5) Maximum
Height-for-Age*	38,244	-168.3	164.0	-600	600
Weight-for-Age*	38,244	-157.7	120.9	-447	447
Weight-for-Height*	38,244	-87.84	130.4	-494	495
Number of states	29	29	29	29	29

* The variables are represented using Z-scores.

According to de Onis and Blössner (1997), using Z-scores has an advantage in that they are sex-independent thereby allowing for measurement of a child's nutritional status by considering both sex and age group. Furthermore, Wang and Chen (2012) state that the Z-scores are calculated based on the distribution of the reference population reflecting the reference distribution. This provides further justification for the use of Z-scores for this study. The WHO's Global Database on Child Growth and Malnutrition states that the following Z-scores will indicate malnutrition using the three anthropometric indicators (HFA, WFH, and WFA):

1. Z-score < -2 SD implies low HFA, low WFH indicating the prevalence of moderate and severe undernutrition (a Z-score < -3 SD indicates severe undernutrition);
2. Z-score < -2 SD implies low WFA indicating the prevalence of moderate and severe undernutrition (in terms of a child being underweight) while a Z-score < -3 SD indicates severe undernutrition; Z-score > 2 SD implies high WFA indicating that the child is overweight (i.e. over-nourished)

As mentioned earlier, the NFHS-3 dataset provides the calculated Z-scores but with values ranging between -600 and 600. However, after dropping flagged values and values outside the plausible range[11], this paper uses -200 and +200 as the cutoff points[12,13] in this paper i.e.

1. Z-score < -200 SD implies low HFA and low WFH indicating prevalence of moderate stunting and wasting, i.e. undernutrition and severe undernutrition (a Z-score < -300 SD indicating severe undernutrition);
2. Z-score < -200 SD implies low WFA indicating the prevalence of moderate and severe undernutrition (in terms of a child being underweight) while a Z-score < -300 SD indicates severe undernutrition; Z-score > 200 SD implies high WFA indicating that the child is overweight (i.e. over-nourished)

This cutoff value has been chosen based on the distribution of the Z-scores in the NFHS-3 dataset. The advantage of using cutoff values is that they are independent of reference standards implying that whatever be the reference standard used (NCHS/WHO international reference population, CDC growth charts etc.) the cutoff values can remain the same (Ramnath et al., 1993).

3.3. Independent variables: socioeconomic status indicators, demographic, and geographical factors

The explanatory variables used in this paper are:

- **Highest education level of household**: indicates the highest education level of household

- **Partner's highest education level**: the respondent's partners educational

- **Number of children (aged 5 and under)**: number of children per household under the age of 5

- **Sex of household head**: the household heads in India can be both males and females with the number of male household heads being more than female household heads. This variable indicates the sex of the household head

[11] The NFHS-3 dataset also shows values of Z-scores which are either flagged or unrealistically high and these values were excluded for the analysis.

[12] In the current context, cutoff values are the values within which a child will be classified as healthy. In this paper, the cutoff values are -200 and +200 Z-scores: between these values the child will be classified as healthy while a child with a Z-score outside this range will be classified as undernourished (for Z-sores less than -200) and over-nourished (for Z-scores greater than +200).

[13] Pelletier (2006) states that different cutoff points are required for different uses.

- **Sex of child**: indicates sex of the child

- **Size of child at birth**: this variable measures whether a child is born healthy or not using height and weight measurements

- **Antenatal care: from anganwadi/ICDS centre**: tells us whether the rural or urban household surveyed has an antenatal care centre in the form of an Anganwadi Centre or an Integrated Child Development Service Centre

- **Age (of child) in months (0-59 months)**: this paper only considers the health of children between the ages of 0-5 years

- **Wealth index**: this index is created to categories the wealth of households into three quantiles describing whether the household is in the high, "middle", or low-income group

- **Source of drinking water**: indicates source of drinking water for the household

- **Type of place of residence**: indicates whether the household is in a rural or urban area

Table 3: Descriptions of explanatory variables

Variables	Type of Variable
Highest education level of household	Categorical (values can take on primary, secondary, or higher education)
Partner's highest education level	Categorical (values can take on primary, secondary, or higher education)
Number of children (aged 5 and under)	Categorical (values vary from 1 to 9)
Sex of household head	Binary (male=0, female =1)
Sex of child	Binary ((male=0, female =1)
Size of child at birth	Categorical (can take on values such as very small, smaller than average, average, larger than average, and very large)
Antenatal care (from anganwadi/ICDS centre)	Binary (no = 0, yes=1)
Age (of child) in months (0-59 months)	Categorical (ages from 0-59 months)

Wealth index	Categorical (parents/households classified in poor, middle, or rich income categories)
Source of drinking water	Categorical (sources can be piped, well, surface, or other sources)
Type of place of residence	Binary (urban=0, rural=1)

A point of paramount importance: in this paper, I use the highest education level of the household and the respondent's partner's education levels as proxy for parental education level[14]: household heads can be both males and females in India and they are usually married with children. Therefore, these two variables would serve as good proxies for parental education levels.

Table 4: Descriptive Statistics of explanatory variables

Independent Variables	(1) Number of Observations	(2) Mean	(3) Standard Deviation	(4) Minimum	(5) Maximum
Highest Educational Level of Household					
Primary	38,244	0.144	0.351	0	1
Secondary	38,244	0.381	0.485	0	1
Higher	38,244	0.772	0.267	0	1
Partner's Education Level					
Primary	38,118	0.149	0.356	0	1
Secondary	38,118	0.496	0.499	0	1
Higher	38,118	0.124	0.330	0	1
Number of Children 5 and Under	38,244	1.891	0.927	1	9
Sex of Household Head					
Female	38,244	0.101	0.301	0	1
Sex of Child					
Female	38,244	0.479	0.499	0	1
Size of child at birth	38,244	2.985	0.842	1	5
Antenatal care: anganwadi/icds centre	22,865	0.070	0.255	0	1

[16] Gaiha et al. (2010) use schooling years of the household head as a proxy for mother's education. This provides further justification for the use of educational level of the household head and their partner's education level as proxies for parental education in this paper.

Age in months	38,244	30.387	16.907	0	59
Wealth					
Middle	38,244	0.433	0.495	0	1
Rich	38,244	0.213	0.410	0	1
Source of drinking water					
Well	38,243	0.474	0.499	0	1
Surface	38,243	0.077	0.267	0	1
Others	38,243	0.039	0.194	0	1
Residence					
Rural	38,244	0.625	0.483	0	1
Number of states	29	29	29	29	29

3.4. Empirical Specification

The anthropometric indicators (i.e. the dependent variables) can be coded as binary variables: 1 for Z-score < -200 SD i.e. presence of malnutrition, and 0 for Z–score ≥ -200 SD i.e. no malnutrition (for HFA and WFH). In the case of WFA, this specification would mean a value of 1 for Z-score < -200 SD or Z-score > 200 SD for presence of malnutrition and 0 for Z–score between -200 and +200 for no malnutrition i.e. -200 ≤ Z-score ≤ +200 for no malnutrition.

In this paper, the dependent variable is the probability of a child (aged between 0-59 months) being undernourished or suffering from anthropometric failures (stunting as measured by HFA; underweight or overweight as measured by WFA; or wasting as measured by WFH).

Gaiha et al. (2010) find that simultaneous occurrence of these health defects is pervasive. Therefore, running a test for correlation[15] between these three indicators shows that they are highly correlated meaning that:

i. children who are stunted are likely to be underweight/overweight (and vice-versa),
ii. children who are wasted are likely to be underweight/overweight (and vice-versa), or
iii. children who are stunted are likely to be wasted (and vice-versa)[16].

[15] Refer to Appendix B

[16] This combination is not physically possible because a child cannot be stunted and wasted at the same time and not be classified as underweight (Gaiha et al., 2010)

Table 5: Simultaneous occurrence of anthropometric failure (correlation between the three anthropometric failures)

Variables	Hfa Z-score	Wfh Z-score	Wfa Z-score
Hfa Z-score	**1.000**	**-**	**-**
Wfh Z-score	**-0.1426***	**1.000**	**-**
Wfa Z-score	**0.6756***	**0.6190***	**1.000**

Source: Author's own calculations
Note: * indicates that the results are significant at the 1% level.

The table above shows the correlation between the three anthropometric failures. The pairwise correlation shows a moderately strong correlation between the failures which are significant as the 1% level implying that there is simultaneous occurrence of stunting, wasting, and under/overweight in a child. However, as Gaiha et al. (2010) states, occurrence of stunting and wasting is physically impossible and that it does not make sense to not classify the child as underweight in this scenario.

Given the binary nature of the dependent variables, it is therefore possible to use an LPM. Using the LPM allows for the application of the fixed-effects estimator. The time-demeaned data (difference between the original model and its average) uses time variation within cross-sectional units (Wooldridge, 2015). Therefore, using state fixed-effects would allow for the elimination of the unobserved effects within these states i.e. time invariant factors will be removed. This is also the reason for not resorting to a logit model even though the dependent variables are binary in nature as they do not allow the use of a fixed-effects estimator. Furthermore, in a logit model, parameters of location i.e. the conditional mean or median, and the estimation of scale i.e. the dispersion around the conditional mean/median, are bound together making the estimates of location prone to misspecification of scale. This can lead to inconsistencies in the estimates of location.

Because the dependent variable is a binary variable, the coefficients of the independent variable cannot be interpreted as the change in the dependent variable given a one-unit change in the independent variable (Wooldridge, 2015). Assuming that the zero-conditional mean assumption (of the Gauss-Markov assumptions) holds i.e. $E(u|x_1,\dots, x_k) = 0$, where 'u' is the error term and $x_1,\dots, x_k$ are the *k* independent variables, then

$$E(y|x) = \beta_0 + \beta_1 x_1 + \dots + \beta_k x_k \qquad \dots\dots\dots\dots (1)$$

where,

y is the dependent variable;

$x_1, \ldots, x_k$ are the independent variables

When y is a binary dependent variable, $P(y=1|\mathbf{x}) = E(y|\mathbf{x})$, where **x** denotes all independent variables ($x_1, \ldots, x_k$) i.e. the probability that y equals 1 (or the probability of success) is the same as the expected value of y. Therefore, $E(y|x)$ can be replace with $P(y=1|\mathbf{x})$ in equation (1):

$$P(y=1|\mathbf{x}) = \beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k \qquad \ldots\ldots\ldots\ldots (2)$$

Equation **(2)** states that the probability of success is a linear function of independent variables, **x**. In an LPM, the coefficients measure the change in probability of success when **x** changes, holding other factors fixed, i.e.

$$\Delta P(y=1|\mathbf{x}) = \beta_j \Delta x_j \qquad \ldots\ldots\ldots\ldots (3)$$

where,

β_j is a shorthand for all the coefficients in a multiple linear regression equation, in this case: an LPM;

x_j is a shorthand for all the independent variables

Consequently, the equation estimated through the method of OLS can be written as follows:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \cdots + \hat{\beta}_k x_k \qquad \ldots\ldots\ldots (4)$$

where,

$\hat{y}$ is the predicted probability of success;

$\hat{\beta}_0$ is the predicted probability of success when the independent variables equal 0;

$\hat{\beta}_1$ is the predicted change in the probability of success when x_1 increases by one unit

In order to analyse how parental education levels impact child health, I estimate three models, one for each of the dependent variables mentioned earlier:

Model 1:

$$y_{ik} = \beta_1 a_{ik} + \beta_2 b_{ik} + \beta_3 X_{ik} + \alpha_r + \varepsilon_{ik}$$

where,

- i represents an individual,
- k represents a regressor,
- r represents a region,
- y_{ik} = 1 represents a child being stunted, wasted, or underweight,
- a_{ik} is a categorical variable indicating the household's highest education level,
- b_{ik} is a categorical variable indicating the partner's education level,
- X_{ik} represents all other explanatory variables mentioned in Table 3. This also includes an interaction term between parental education and household's wealth status $(a_{ik} * b_{ik})$,[17]
- α_r represents the fixed effect estimator capturing all time invariant factors. In this study, I use state fixed effects to capture all time invariant factors in the 29 states in India, and
- ε_I is the error term

Using this model as the foundation, I further probe into:

i. Overall impact of parental education and wealth status on child health (Section 4.4): after removing the categorical aspect from the parental education levels and wealth status variables, results would paint a holistic picture about overall impact of parental education and household wealth on child health

ii. Assessing the combined impact of parental education and wealth status on reducing occurrence of anthropometric failures (Section 4.5): to do this, I interact parental education and wealth status and regress all three indicators of anthropometric failures on this interaction term.

iii. Assessing the impact on underweight children only (Section 4.6): Using model 1, I specifically look at the impact of parental education on underweight children alone.

The results are discussed in Section 4.

[17] The interaction term has been included in the regression estimates presented in Tables 8 and 9.

3.5. LPM versus the Logit/Probit models

Using an LPM, within the class of limited dependent variable models, offers quite a few advantages over the use of logit or probit models. Firstly, it is simpler to interpret the coefficients in an LPM than in the logit or probit models. In an LPM, if the independent variable (say, x) is binary as well, the coefficient can simply be interpreted as the probability of the occurrence of y (the binary dependent variable) increases (decreases) by +x percentage points (-x percentage points); and if x is a categorical variable, the probability of occurrence of y, increases (decreases) by +x percentage points (-x percentage points). This interpretation is not so simple in the case of logit and probit models as interpretation of log odds (and odds ratios) is quite complex, especially with survey data (Hellevik, 2009; Hippel, 2015).

Secondly, one of the major drawbacks with the LPM is that the predicted probabilities could lie outside the plausible interval [0,1]. Therefore, to check if this is indeed the case with this dataset, I use the 'predict pr' command in Stata. Consequently, the results show that a very negligible number of observations lie outside the plausible interval[18]: (i) Model 1 has 27 out of 22,783 observations lying outside the plausible interval (all negative probabilities); (ii) Model 2 has 4 out of 22,783 observations lying outside the plausible interval; (iii) Model 3 has 21 out of 22,783 observations lying outside the plausible interval. Therefore, due to the fact that a negligible number of observations fall outside the plausible interval in this study, the results will have a negligible degree of bias (Wooldridge, 2015).

According to Hellevik (2009), heteroskedasticity in the error term is another issue with the LPM but it does not cause bias in the OLS estimators of the explanatory variables. However, this has a very negligible effect on the outcome of significance tests. Heteroskedasticity can be overcome by using robust standard errors and the model will produce satisfactory results (Wooldridge, 2015).

4. Empirical Results

Table 6: Results from the estimation of Model 1 (categorical effects)

Independent Variables	(1) Stunting	(2) Wasting	(3) Under/Overweight
Highest educational level of household			
Primary	-0.015*	-0.007	-0.020*
	(0.008)	(0.009)	(0.012)

[18] Refer to Appendix F for scatter plot of predicted probabilities for all three models.

Secondary	-0.045***	-0.025**	-0.056***
	(0.010)	(0.009)	(0.010)
Higher	-0.096***	-0.027***	-0.095***
	(0.018)	(0.009)	(0.012)
Partner's education level			
Primary	-0.012	-0.018**	-0.008
	(0.010)	(0.009)	(0.010)
Secondary	-0.048***	-0.016**	-0.038***
	(0.014)	(0.006)	(0.011)
Higher	-0.094***	-0.028***	-0.065***
	(0.019)	(0.010)	(0.012)
Number of children 5 and under	0.029***	0.001	0.014***
	(0.004)	(0.004)	(0.004)
Sex of household head			
Female	-0.016	0.006	-0.032***
	(0.010)	(0.008)	(0.011)
Sex of child			
Female	-0.016***	-0.019***	-0.002
	(0.006)	(0.004)	(0.006)
Size of child at birth	0.043***	0.028***	0.050***
	(0.003)	(0.003)	(0.005)
Antenatal care: Anganwadi or ICDS centre	0.006	0.025*	0.016
	(0.015)	(0.013)	(0.014)
Age in months	0.005***	-0.002***	0.003***
	(0.000)	(0.000)	(0.000)
Wealth			
Middle	-0.081***	-0.032***	-0.097***
	(0.014)	(0.009)	(0.010)
Rich	-0.200***	-0.055***	-0.194***
	(0.019)	(0.012)	(0.013)
Source of drinking water			
Well	-0.012	-0.004	0.011
	(0.007)	(0.008)	(0.010)
Surface	0.007	-0.009	0.003
	(0.017)	(0.013)	(0.016)
Others	0.009	-0.001	-0.010
	(0.017)	(0.014)	(0.013)
Residence			
Rural	-0.005	-0.002	-0.001
	(0.007)	(0.007)	(0.008)

Constant	0.264*** (0.015)	0.211*** (0.017)	0.250*** (0.018)
State FE	YES	YES	YES
Observations	22,783	22,783	22,783
Number of states	29	29	29
R-squared	0.079	0.020	0.069

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

4.1. Effect of parental education on stunting of children

The results from the estimation of column 1 in Table 6 gives the OLS regression of the height-for-age (stunting) Z-scores on parental education levels and other controls used for the study using an LPM. As expected, parental education levels (represented by highest education level of household and partner's highest education level) have a negative, and significant, impact on stunting in children: higher the education level of the parents, more the impact on stunting i.e. a higher education level reduces the probability of stunting by a higher magnitude. In this case, for those parents with a 'higher' level of education, the probability that a child is stunted reduces by 9.6 and 9.4 percentage points respectively (and this effect is statistically significant at the 1% level). Similarly, for parents with a secondary level of education, the probability that a child is stunted reduces by 4.5 and 4.8 percentage points respectively. This is so because a higher level of education increases awareness and enables people to make informed decisions regarding healthcare in the household. Through this increased awareness, parents will now know of various avenues that can be used to improve the child's health. Furthermore, Fuchs et al. (2010) found that the mother's education, specifically, is important for infant survival. Therefore, parental education is indeed an imperative factor in improving child health. These results are also in in accordance with those obtained by Chou et al. (2007) and Currie (2008).

The wealth status of the household (another important component of household socioeconomic status) also has a negative, and significant, impact on a child suffering from stunted growth. Here, parents who are in the rich or upper-income level category help reduce the probability of stunting in their children by 20 percentage points and parents who are in the middle-income level category help reduce the probability of stunting in their children by 8.1 percentage points. These are statistically significant at the 1% level[19]. From these findings, it

[19] This result is in line with the results obtained by Cameron and Williams (2009) who state that low income has an adverse impact on the health of a child.

would be reasonable to state that when the wealth/income level of the households increases, it becomes possible to treat issues related to undernutrition and, consequently, reduce occurrence of undernutrition in children[20] because facilities (clinics, hospitals etc.) which were earlier not affordable are now affordable. Furthermore, the fact that the number of poor/low-income households in the NFHS-3 is much higher than households in the middle and higher (rich) income levels would explain the widespread prevalence of undernutrition in the country.

Next, I look the number of children under the age of 5 years in a household (shown by the variable "Number of children 5 and under"). The results show that the probability of a child being stunted increases with the number of children in a household: more the number of children in a household, the probability of stunted growth in the younger children increases by 2.9 percentage points (the result is statistically significant at the 1% level). This is the case especially in poor/low-income households (or low-socioeconomic status households)-where the parents cannot afford good treatment for their children[21] because they face severe income constraints- or in households with low levels of education (Lutz and Samir, 2011, state that highly educated women tend to have fewer children). Because of these constraints, the eldest children are provided for more than the younger ones creating disparities in the health of the children.

If a child is suffering from stunted growth, it's health exacerbates as the child grows older (unless treated effectively and immediately). This effect is profound especially in the first five years of the child being born. The 'age in months' variable, where the age of the child is between 0 and 59 months, shows that the probability that stunting in the child become more pronounced increases by 0.5 percentage points as the child grows older and this is also statistically significant (at the 1% level). This, again, is the case in poor/low-income households because low-income households usually have more children than they can afford to take care of leading to poor or no treatment of the issue in most cases. This, in turn, makes it difficult to treat younger children in large households (who have low incomes) and the child's health worsens significantly as it grows older.

If a child born is female (represented by the binary variable 'Sex of child'), then the probability of that child being stunted is reduced by 1.6 percentage points (given by a negative and statistically significant impact). Based on the demographics of the country, this could be

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[20] Deaton (2002) also states that "proportional increases in income are associated with equal proportional decreases in mortality throughout the income distribution." This lends further justification to the result.

[21] Kramer (1987) and DiPietro et al. (1999) state that children from low–SES families are more likely to be growth retarded and have inadequate neurobehavioral development.

due to better quality of life and better treatment available for female children in urban areas. Because of this, female children will be able to live a healthier life, leading to increases in productivity (for example).

The variable 'Size of child at birth' measures the size of the child in the following ranges: 'very small', 'smaller than average', 'average', 'larger than average', and 'very large'. A child is categorised as 'very small' or 'smaller than average' if its birth weight is less than 2.5 kilograms[22] (I group these two categories into one category of 'smaller than average'.). Therefore, if the child born is 'smaller than average' the probability that the child is stunted increases by 4.3 percentage points. This relationship can be linked to the effect on the 'age in months' variable. A child being 'smaller than average' is bound to be suffering from stunted growth and unless treated, this situation will only worsen with time. Here, I only consider children who are 'smaller than average' as children who are 'larger than average' do not fit the measure of stunting.

4.2. Effect of parental education on the wasting of children

Column 2 of Table 6 shows the results from the OLS regression of the weight-for-height (wasting) Z-scores on parental education levels and other controls used for the study using an LPM. Higher levels of parental education significantly lower the probability of a child being wasted. In this case, for those parents with a 'higher' level of education, the probability that a child is wasted reduces by 2.7 and 2.8 percentage points respectively. For those parents with a 'secondary' level of education, the probability that a child is wasted reduces by 2.5 and 1.6 percentage points respectively. These effects are statistically significant at the 1% level showing that higher levels of education continue to play an important role in for reducing undernutrition among children between the ages of 0-59 months.[23] The results in this model are similar to those of the previous one implying that the results are consistent i.e. that parental education significantly helps reducing the probability of occurrence of anthropometric failures. The mechanism through which parental education acts on child health to help reduce anthropometric failures also remains the same.

Wealth status has a negative and statistically significant effect (at the 1% level) on the wasting of children: parents who are in the rich or upper-income level category help reduce the

[22] 2.5 kilograms is the limit used by the NFHS-3.

[23] This result is similar to Aslam and Kingdons' (2012) where they state that a higher level of health knowledge possessed by the mother positively impacts children's health while the father's knowledge is directly related to immunisation decision, both contributing to improved health on the child.

probability of wasting in their children by 5.5 percentage points while parents who are in the middle-income level category help lower the probability of wasting by 3.2 percentage points. Therefore, higher the wealth status of the household, the more actively they can avoid or overcome anthropometric failures. This, again, would be due to the fact that households in these two categories have access to, and can use, resources necessary and sufficient to treat these anthropometric failures. Therefore, higher the wealth, more the resources available, and more likely is the recovery from these health issues.

The binary variable 'Sex of child' shows that the probability of a child being wasted reduces by 1.9 percentage points if the child is a female. Similar to the result in the case of stunting, this could be due to better quality of life and better treatment in urban areas even though the number of female children is more in rural areas. However, significant differences in treatment for female infants between rural and urban areas could be one reason for this. This effect is also statistically significant at the 1% level.

With regards to the 'size of the child at birth' variable, if the child born is 'smaller than average', the probability that the child is wasted increases by 2.8 percentage points. The probability that wasting in the child become more pronounced increases by 0.2 percentage points as the child grows older (as shown by the 'age in months' variable). Both these effects are statistically significant at the 1% level. As stated in the previous section, this is accordance with the results obtained by Case et al. (2002) and Currie and Stabile (2002).

The 'Antenatal care: Anganwadi or ICDS centre' variable, as the name suggests, refers to whether an antenatal care is present in the area of survey or far away from it. Here, the presence of an antenatal care (ANC) centre increases the probability of wasting by 2.5 percentage points. The fact that the presence of an ANC centre leading to wasting in children implies something functionally wrong with the ANC centres: either poor or wrong treatment due to unqualified doctors worsens the health of children or just a lack of proper infrastructure in the ANC centre leading to an ineffective treatment could also be causing wasting in children, there could also be inefficiencies such as lack of doctors and/or nurses, lack of hospital facilities such as shortage of beds etc. which could contribute to this negative impact.

4.3. Effect of parental education on a child being underweight or overweight

While considering the weight-for-age measure, which indicates if a child is underweight or overweight, it is important to note that the interpretation of this measure varies compared to the previous two measures. This problem will be addressed in Section 5 of the paper.

Column 3 of Table 6 gives estimates of the OLS regression of the weight-for-age (under/overweight) Z-scores on parental education levels and other controls used for the study using an LPM. The impact of parental education on a child being underweight (undernourished) or overweight (over-nourished) are similar to previous two models: for those parents with a 'higher' level of education, the probability of a child being under or over-nourished reduces by 9.5 and 6.5 percentage points respectively. Similarly, for those parents with a 'secondary' level education, the probability of a child being under or over-nourished, reduces by 5.6 and 3.8 percentage points respectively. Therefore, higher the level of education, higher is the probability of reducing either of these two anthropometric failures. These results are statistically significant at the 1% level and are in accordance with the literature. Furthermore, the reasoning behind why this effect holds also remains the same and the results remain consistent.

In addition to the effect of higher education being the same, the effects of the wealth of the household on child health are also similar to the previous models: parents who are in the rich or upper-income level category help reduce the probability of a child being underweight/overweight by 19.4 percentage points while the probability of a child being underweight/overweight decreases by 9.7 percentage points if the parents are from the 'middle' income category. These effects are also significant at the 1% level. Therefore, in general, parents with a relatively higher level of wealth can reduce the probability of occurrence of an anthropometric failure by a higher magnitude than parents with a relatively lower level of wealth.

One interesting change is that if the household head is a female, the probability of a child being either under or over-weight reduces by 3.2 percentage points. This result is statistically significant (at the 1% level) and could mainly be due to the fact that more than 63% of female household heads surveyed have completed their education up to a certain level (primary, secondary, or higher)[24]. This means that the anthropometric failure can be circumvented to the extent that there is increased awareness among married females. Additionally, the number of female household heads with a certain level of education is high. there is a negative and significant impact of a female household head on child health i.e. that female household heads help reduce the probability of occurrence of undernourishment and/or over-nourishment.

The 'Age in months' variable here has a positive and statistically significant impact on a child being underweight/overweight implying that as the child grows, the probability that the

[24] IIPS (2007).

child becomes more undernourished or over-nourished increases by 0.3 percentage points. This result is similar to the one obtained in Section 4.1 for this variable thereby lending further justification to the relationship through consistency of results. Furthermore, the mechanism of this relationship remains the same as before.

A household having more than one child will face the situation that where the health of subsequent children born will be poorer. From table 6, the results show that more the number of children in a household, the probability of subsequent children being underweight or over-weight increases by 1.4 percentage points. This, of course, also depends on the health status and income level of the household. Literature regarding this relationship is divided between those who say that the health will worsen with age and the number of children (Case et al., 2002; Currie and Stabile, 2002) and those who state that income has no impact on child health as the child grows older (Cameron and Williams, 2009).

In essence, the relationship between anthropometric failures and the explanatory variables holds, and is consistent with literature, for all three anthropometric failures.

4.4. Overall impact of parental education and wealth status on child health

Table 7: Overall impact of Parental education and wealth on child health (i.e. without categories of parental education and wealth status)

Independent Variables	(1) Stunting	(2) Wasting	(3) Under/Overweight
Highest educational level of household	-0.029*** (0.005)	-0.011*** (0.004)	-0.031*** (0.004)
Partner's education level	-0.030*** (0.006)	-0.008*** (0.003)	-0.022*** (0.004)
Number of children 5 and under	0.030*** (0.004)	0.001 (0.004)	0.015*** (0.004)
Sex of household head			
Female	-0.015 (0.010)	0.006 (0.008)	-0.032*** (0.011)
Sex of child			
Female	-0.016*** (0.006)	-0.019*** (0.004)	-0.002 (0.006)
Size of child at birth	0.043*** (0.003)	0.028*** (0.003)	0.050*** (0.005)

Antenatal care: Anganwadi or ICDS centre	0.004	0.025*	0.015
	(0.015)	(0.013)	(0.014)
Age in months	0.005***	-0.002***	0.003***
	(0.000)	(0.000)	(0.000)
Wealth	-0.104***	-0.027***	-0.098***
	(0.009)	(0.009)	(0.007)
Source of drinking water			
Well	-0.012	-0.004	0.011
	(0.007)	(0.008)	(0.010)
Surface	0.010	-0.010	0.003
	(0.017)	(0.013)	(0.016)
Others	0.009	-0.001	-0.010
	(0.016)	(0.014)	(0.012)
Residence			
Rural	-0.004	-0.002	-0.001
	(0.007)	(0.007)	(0.008)
Constant	0.393***	0.234***	0.356***
	(0.019)	(0.018)	(0.021)
State FE	YES	YES	YES
Observations	22,783	22,783	22,783
Number of states	29	29	29
R-squared	0.077	0.020	0.069

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

Table 7 gives the regression estimates of model 1 with one minor difference: the different categories of parental education (i.e. the variables ‘highest education level of household’ and ‘partner’s education level’) and wealth status are excluded. This gives idea about the overall impact that these two variables have on the occurrence of anthropometric failures. Based on the estimates from table 7, the overall impact of parental education levels and wealth status on the occurrence of anthropometric failures is negative and significant at the 1% level implying that the relation holds (consistent with literature). The fact that the relationship between the categorical variables of parental education and wealth status and the probability of occurrence of anthropometric failures is mirrored in the overall impact shows that the regression results hold, and would be of huge help, in macroeconomic policy formulation as well. Additionally, the relationship between the other explanatory variables and the anthropometric failures also remain the same thereby implying consistency across the models. The intuition behind these results, as explained earlier, also remains the same.

4.5. <u>Effect of parental education and wealth interaction on child health</u>

Table 8: Impact of interaction between parental education and wealth status on child health

Independent Variables	(1) Stunting	(2) Wasting	(3) Under/Overweight
Highest education level of household	-0.010*	-0.015***	-0.026***
	(0.006)	(0.005)	(0.005)
Partner's education level	-0.020***	-0.010***	-0.019***
	(0.007)	(0.003)	(0.005)
Wealth	-0.089***	-0.031***	-0.094***
	(0.010)	(006)	(0.006)
Parental education*Wealth (interaction term)	-0.005***	-0.003***	-0.001
	(0.001)	(0.000)	(0.001)
Number of children 5 and under	0.029***	0.001	0.014***
	(0.004)	(0.004)	(0.004)
Sex of household head			
Female	-0.016*	0.006	-0.032***
	(0.010)	(0.008)	(0.011)
Sex of child			
Female	-0.016***	-0.019***	-0.002
	(0.006)	(0.004)	(0.006)
Size of child at birth	0.043***	0.028***	0.050***
	(0.003)	(0.003)	(0.005)
Antenatal care: Anganwadi or ICDS centre	0.006	0.024*	0.016
	(0.015)	(0.013)	(0.014)
Age in months	0.005***	-0.002***	0.003***
	(0.000)	(0.000)	(0.000)
Source of drinking water			
Well	-0.011	-0.004	0.011
	(0.007)	(0.009)	(0.010)
Surface	0.009	-0.010	0.003
	(0.017)	(0.013)	(0.016)
Others	0.010	-0.001	-0.010
	(0.016)	(0.014)	(0.013)
Residence			
Rural	-0.005***	-0.002	-0.001***
	(0.007)	(0.007)	(0.008)

Constant	0.357*** (0.021)	0.242*** (0.018)	0.347*** (0.019)
Interaction Effect	YES	YES	YES
State FE	YES	YES	YES
Observations	22,783	22,783	22,783
Number of states	29	29	29
R-squared	0.078	0.020	0.069

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

Table 8 shows the estimates of the OLS regression equation given by model 1 with the interaction term. Here, I interact parental education levels with the wealth status to assess the combined impact of these two socioeconomic status indicators on child health. In the earlier tables, the effects of parental education on child heath are measured when each of the other explanatory variables are zero or are held constant. In model 4, however, through the interaction term, it is possible to measure the impact of simultaneous changes in parental education levels and wealth status on the occurrence of anthropometric failures.

The estimates for the interaction term in table 8 show that the negative relationship between parental education and anthropometric failures, and between the wealth status and anthropometric failures holds when the interaction term is included as well. If the parents are educated and are wealthy (to some extent):

i. it reduces the probability of stunting by five percentage points,
ii. it reduces the probability by wasting by 3 percentage points,
iii. it reduces the probability of a child being under/overweight by one percentage point (but in this case, it is not significant)

These results imply that higher education and wealth are necessary for circumventing these anthropometric failures. Lower education implies a lower awareness (for example of new innovations in the field of medicine) thereby affecting the decisions of parents regarding the choice of treatment. Lower wealth constrains parents from obtaining the best treatment possible for their children implying that child health will only get worse (Deaton, 2002; Cameron and Williams, 2009). For example, for households suffering from the poverty trap, it would not be possible to obtain the best treatment (or any form of treatment in the case of the extreme poor) nor would they be aware of various avenues available for treatment. This would lead to an increase in the occurrence of any (or all) of the three anthropometric failures. On the other hand, parents with a relatively higher level of education combined with a relatively higher level of wealth would have a higher impact on circumventing these anthropometric failures. This mechanism is as follows: a higher level of education helps increase awareness (as stated earlier) about various avenues of treatment available while a higher level of wealth ensures access to resources essential to the treatment. Therefore, the combined effect of these two terms would have a positive effect on improving child health and reducing the probability of occurrence of anthropometric failures. In this context, the negative relationship between the occurrence of anthropometric failures and the interaction between parental education and wealth status makes perfect economic sense.

4.6. <u>Impact of parental education on underweight children</u>

Table 9: Impact of parental education on child health (categorical, total, and interaction effects)

Independent Variables	(1) Impact with categories of variables	(2) Total effect	(3) Interaction effect
Highest educational level of household	-	-0.031*** (0.004)	-0.025*** (0.005)
Primary	-0.018 (0.012)	-	-
Secondary	-0.057*** (0.011)	- -	- -
Higher	-0100*** (0.012)	-	-
Partner's education level	-	-0.022*** (0.004)	-0.019*** (0.005)
Primary	-0.006 (0.009)	-	-
Secondary	-0.039*** (0.011)	-	-
Higher	-0.065*** (0.012)	-	-
Parental education*Wealth (interaction term)	-	-	-0.002* (0.001)
Number of children 5 and under	0.016*** (0.004)	0.016*** (0.004)	0.016*** (0.004)
Sex of household head			
Female	-0.032***	-0.032***	-0.032***

	(0.011)	(0.011)	(0.011)
Sex of child			
Female	-0.003	-0.003	-0.003
	(0.006)	(0.006)	(0.006)
Size of child at birth	0.052***	0.052***	0.052***
	(0.005)	(0.005)	(0.005)
Antenatal care: Anganwadi/ICDS centre	0.015	0.014	0.015
	(0.015)	(0.015)	(0.015)
Age in months	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)
Wealth	-	-0.101***	-0.096***
		(0.007)	(0.007)
Middle	-0.098***	-	-
	(0.010)		
Rich	-0.199***	-	-
	(0.013)		
Source of drinking water			
Well	0.008	0.008	0.009
	(0.009)	(0.010)	(0.009)
Surface	0.003	0.004	0.004
	(0.017)	(0.017)	(0.017)
Others	-0.005	-0.006	-0.005
	(0.013)	(0.013)	(0.013)
Residence			
Rural	0.000	0.001	0.000
	(0.008)	(0.008)	(0.008)
Constant	0.238***	0.350***	0.336***
	(0.017)	(0.020)	(0.018)
Interaction Effect	NO	NO	YES
State FE	YES	YES	YES
Observations	22,716	22,716	22,716
Number of states	29	29	29
R-squared	0.074	0.074	0.074

Columns 1 and 2 of table 9 show the impact of parental education on underweight children alone without the interaction term. I have made this distinction based on the number of underweight and overweight children in the NFHS-3 dataset: there are relatively more children who are underweight than children who are overweight. Additionally, De Önis and Blössner (2003) identify some major issues with the interpretation of the 'overweight' category. This constrains the use of the ‘overweight’ category and has been mentioned in detail in section 5.

The regression estimates show that there is a negative and significant impact of parental education (and wealth status) on a child being underweight i.e. with a higher the education (and wealth status), the probability of occurrence of undernutrition in a child is lower (as shown by the estimates of ‘highest education level of household’ and ‘Partner’s education level’ in table 9). From column 2, the overall impact of parental education and wealth is also found to be negative and significant (implying consistency with the earlier regression estimates[25]) while the intuition and reasoning behind these results remains the same as in the regression, without interaction terms (for underweight and overweight children – Section 4.3).

Column 3 shows the estimates of the regression equation in model 1, after including the interaction between parental education and wealth status of the household, but only for underweight children.

The negative relationship between parental education and child health and wealth status and child health is mirrored even in the regression including the interaction term which also exhibits a negative and significant effect on child health (i.e. underweight children to be specific). As long as parents have a certain level of education and a certain level of wealth that goes hand-in-hand with overcoming the occurrence of anthropometric failures in children, the result for the interaction terms shows that the probability of a child being underweight reduces by 2 percentage points. Underweight implies a low weight for age. Therefore, as the child ages, it needs more nutrition to remain healthy. More nutrition implies more food which can be obtained, for example, only if one has sufficient monetary resources, or is educated enough to be employed and earn income (which in turn allows for obtaining various sources of nutrition). Hence, when we combine increased awareness with increased monetary resources, it helps reduce the probability of occurrence of anthropometric failures.

5. Limitations

Deaton (1997), in his text on household surveys, talks about how survey data are highly prone to a variety of issues which stem from the very fact that survey data must be put into the context of econometric models to analyse them for policy formulation purposes. He refers to dependency and heterogeneity in the regression residuals, and possible relationships between

[25] Regressions from sections 4.1, 4.2, and 4.3.

the regressors and the residuals while talking about issues arising specifically from survey data alone and not the econometric specification which the data is put into.

Secondly, predicted probabilities in an LPM are not restricted to the interval [0,1]. They can take on negative values as well as values greater than 1. Wooldridge (2015) states that a probability cannot be linearly related to the independent variables for all their possible values i.e. the probability change is the same across all units of change which is unrealistic. However, this is not considered as a major hindrance for interpretation of results.[26]

Wang et al. (2006) and Wang and Chen (2012) identify certain limitations of the NCHS/WHO international reference population itself (which was used to calculate the Z-scores in the NFHS-3 dataset): (i) since this reference population includes data only from the United States, including data from several countries would help make this reference population robust and more efficient for interpretation and policy formulation purposes; (ii) the distribution of weights in this reference population is positively skewed with a long tail to the right and a high prevalence of overweight children; (iii) the international reference population dataset is comprised of unrelated samples and this will undoubtedly affect the assessment of growth in height. Point (ii), especially, is of particular importance as it affects the interpretation of model 3 in this paper.

Another problem lies with the interpretation of the weight-for-age measure. De Onis and Blössner (2003) mention that the interpretation of this anthropometric measure is tricky especially in the context of developing countries: the extent of the issue itself is unknown which, in turn, stems from a lack of reports and studies addressing this issue. The paper has also stated that the interpretation of 'overweight' variable still has certain issues overlapping with the interpretation and statistical limits for obesity and these are yet to be overcome in the new NCHS/WHO international reference population. Wang et al. (2006) also states that the Z-scores of -2 and 2 for the same measure causes conceptual, methodological and practical problems. In addition to this, the same indicator changes with age and maturation status.

Finally, in section 3.2, I mentioned that information regarding only 43,737 children were provided in the dataset. Although these many observations would give an unbiased result, it could be argued that the dataset would not be representative of the population of children below 5 years of age. However, results from the regression in this study have largely been consistent with literature published so far which prompts a suggestion that this dataset could indeed be representative of the population of children below 5 years of age.

[26] Refer to section 3.4 for justification of the use of the LPM.

6. Recommendations for Future Research

The NFHS-3 dataset is one of the most extensive household survey datasets produced in recent decades. It holds significant improvements over the its predecessors, NFHS-1 and NFHS-2, in terms of the extent of the survey. Bringing into focus new and emerging issues such as family life education, safe immunisations, perinatal mortality, different aspects of sexual behaviour, and occurrences of tuberculosis and malaria, the NFHS-3 dataset provides a larger picture of the socioeconomic status of households across the Indian subcontinent. With the extensive nature of the dataset, it is possible to probe further into different areas of research, not just for the age group of 0-59 months of children, but also for ages of the working-class population, the effects of religious beliefs on the socioeconomic status of households, and other studies related to socioeconomic indicators.

Additionally, a new and improved reference population is required to improve the statistical quality of these indicators and to circumvent skewed data. It is important to note that though cutoff points can essentially remain the same for all datasets, the estimates of the number of people suffering from under- or over-nutrition can vary depending on the underlying reference population or growth standard used (de Onis et al., 2006; Pelletier, 2006). From this, it is important to use a reference population that takes into account characteristics of both developed and developing countries to ensure a holistic analysis and so that the resulting estimates are unbiased.[27]

7. Conclusion

India has been hailed as one of the fastest growing economies in the last decade with opportunities arising for investment in the IT services, agriculture, health, and transportation sectors, to name a few. The health sector, specifically, has observed a huge transition in terms of its quality, the number of patents owned by Indian pharmaceutical companies, and the costs of treatment. Within the health sector, however, child care has been an area of concern for quite some time. Against this background, my analysis has been focused on the impact of parental education levels on child undernutrition.

[27] Unlike the NCHS/WHO international reference population used by the NFHS-3 which derives data only from the US.

Using a limited dependent variable model in the form of an LPM, this paper analysed the impact of parental education levels, along with other socioeconomic status indicators, on child (aged between 0-59 months) undernutrition across the 29 states of India. Household characteristics- mainly education of the household head and his/her partner as a proxy for parental education, wealth of the household, size of the child at birth, age of the child, and the sex of the child- are all closely linked to child undernutrition and these results are in accordance with theory and other works in this field.

Based on the results from the OLS regression, a higher level of education lowers the probability of the child suffering from undernutrition (and over-nutrition in the case of an overweight child). Similarly, wealth/income level of the households (as represented by the wealth index) had significant negative impacts on undernutrition implying that higher the income level of the households, lower is the probability of a child suffering from undernutrition (or over-nutrition). The case is more severe when a child, whose parents have a lower level of education and income, is in poor health because the child's health condition worsens as it grows older (Bradley and Corwyn, 2002). This confirms the existence of an income-health gradient in this analysis.

Parental education, evidently, is a factor of paramount importance. To increase education levels in the majority of the population, drastic improvements in educational infrastructure (such as number of schools, number of teachers, proper educational funding etc.) are required. Furthermore, a number of interventions comprising of better health care services and opportunities for income growth are required to ensure that adequate child care services are provided, especially to children in rural areas (where a majority of the population of India live in). These interventions can be in the form of an increase in the number of health clinics, per village and per town, with adequate and quality staff and a clean and sanitised environment, especially around residential areas. In conclusion, a basic awareness for hygienic and sustainable living is required to ensure a reduction in child undernutrition and, consequently, ensure a more sustainable future for generations to come.

Appendix A: Parental Education Levels and Occurrence of Anthropometric Failures

Table 10: Parental education level and occurrence of stunting

Education Level of Household Head	% Stunted Children*	Partner's Education Level	% Stunted Children**
No education	21.46	No education	12.73
Primary	6.76	Primary	7.46
Secondary	13.59	Secondary	20.08
Higher	1.39	Higher	2.94

Source: Author's own calculations
*Number of children: 38244
** Number of children: 38118

Table 11: Parental education level and occurrence of wasting

Education Level of Household Head	% Wasted Children*	Partner's Education Level	% Wasted Children**
No education	8.11	No education	4.85
Primary	2.58	Primary	2.74
Secondary	5.56	Secondary	8.03
Higher	0.93	Higher	1.55

Source: Author's own calculations
*Number of children: 38244
** Number of children: 38118

Table 12: Parental education level and occurrence of underweight/overweight

Education Level of Household Head	% Children Under/Overweight*	Partner's Education Level	% Children Under/Overweight**
No education	19.08	No education	11.37
Primary	5.69	Primary	6.44
Secondary	10.99	Secondary	16.66
Higher	1.19	Higher	2.48

Source: Author's own calculations
*Number of children: 38244
** Number of children: 38118

Tables 4, 5, and 6 show the prevalence of anthropometric failures (i.e. stunting, wasting, and under/overweight) according to various education levels of the parents in a household. Children with parents who possessed a ‘higher’ level of education were less likely to be stunted than compared to those children with parents who possessed lower levels of education. Secondly, the reason why parental education is so important is because of the fact that it enables them to be more aware. Education helps increase awareness to various issues. Therefore, higher the education, more the ability to make informed decisions, and thereby circumvent issues. This is why parental education is so important: because it is necessary to overcome or circumvent issues of anthropometric failures. Thirdly, the reason why occurrences of anthropometrics failures were higher in cases of parents with a ‘secondary’ level of education than for those with a ‘primary’ level of education is mainly due to the fact that the absolute number of parents with ‘secondary’ education is higher than those with a ‘primary’ education.

Appendix B: Wealth Index and Occurrence of Anthropometric Failures

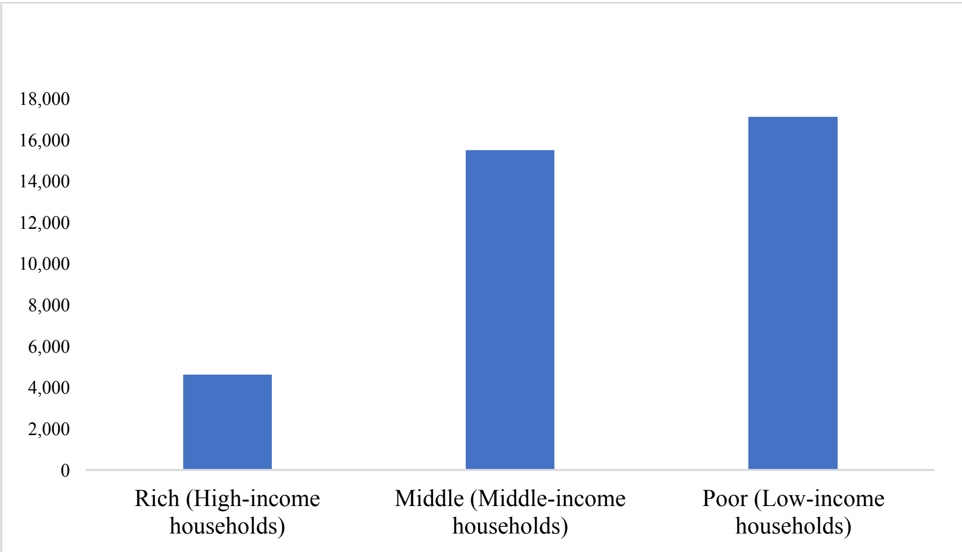
Table 13: Wealth index and occurrence of stunting

Wealth (level) of the Household	% Stunted Children*	% Wasted Children*	% Children Under/Overweight*
Poor	19.46	7.53	17.75
Middle	18.51	6.98	15.00
Rich	5.23	2.67	4.20

Source: Author's own calculations
*Number of children: 38244

Table 10 shows the occurrence of malnutrition across households in three different wealth categories. The wealth index variable has been created to divide the total number of respondents into three different categories which is given by three quantiles i.e. rich, "middle", and poor. From this table, it can be observed that occurrence of all three anthropometric failures decreases as the wealth status increases. Intuitively, this is so because poor households lack the access to good quality healthcare thereby increasing the probability of occurrence of these health issues. Figure 5 shows the occurrence of malnutrition in children (in absolute numbers) based on the wealth of the household.

Figure 2: Number of children suffering from malnutrition in India (2005-06) based on wealth of households



Source: Author's own calculation

Appendix C: Robustness Checks

Table 14: OLS regression of anthropometric failures on parental education levels

Independent variables	(1) Stunting	(2) Wasting	(3) Under/Overweight
Highest education level of household	-0.068*** (0.005)	-0.018*** (0.003)	-0.067*** (0.004)
Partner's education level	-0.049*** (0.005)	-0.011*** (0.003)	-0.043*** (0.003)
Constant	0.584*** (0.005)	0.210*** (0.004)	0.512*** (0.004)
State FE	YES	YES	YES
Observations	38,118	38,118	38,118
Number of States	29	29	29
R-squared	0.042	0.005	0.040

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

The results in Table 9 show the OLS regression of the three anthropometric failures on parental education levels alone. This regression results in a negative and significant impact on the occurrence of anthropometric failures. This result is highly beneficial for the analysis including other controls[28] as it shows that parental education alone would also help in reducing malnutrition in children aged between 0-59 months.

Table 15: OLS regression of anthropometric failures on the wealth index

Independent variables	(1) Stunting	(2) Wasting	(3) Under/Overweight
Wealth	-0.149*** (0.006)	-0.037*** (0.003)	-0.144*** (0.005)
Constant	0.709*** (0.012)	0.241*** (0.006)	0.638*** (0.009)
State FE	YES	YES	YES
Observations	38,244	38,244	38,244
Number of States	29	29	29
R-squared	0.043	0.005	0.043

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

[28] Refer to section 3.2 for a detailed description of all the variables used in the analysis.

Table 10 shows the OLS regression of the three anthropometric failures on wealth of the household alone. As stated earlier, the wealth variable has been divided into three quartiles, categorising households into rich, “middle” (i.e. middle-income), and poor households. The results here indicate that wealth index, in the absence of other controls and other SES indicators, would also help in reducing occurrence of malnutrition in children aged between 0-59 months. This result is highly useful as it complements the results of the relationship analysed in this paper.

Appendix D: Predicted Probabilities (Scatter Plot)

Figure 3: Predicted probabilities for the occurrence of Stunting

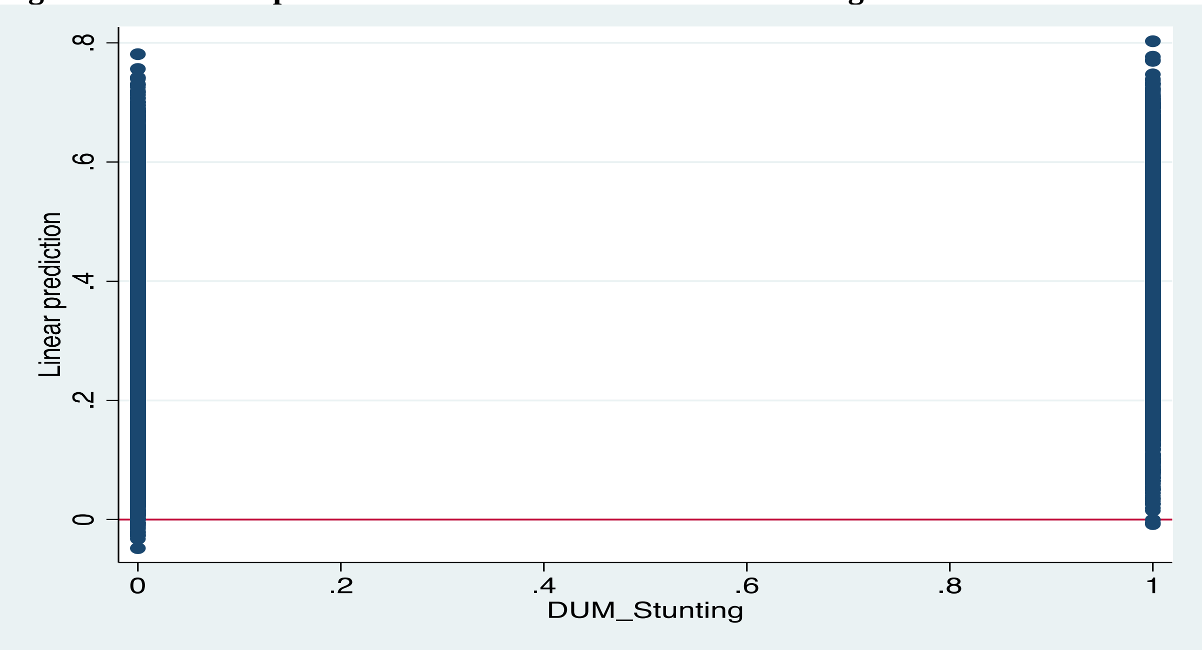


Figure 6 shows the predicted probabilities of stunting (the dependent variable in model 1). Since it is a binary variable, the observations take values of either 0 or 1 depending on the occurrence of stunting. In this model, only 27 of the 22,783 observations lie outside the plausible interval of [0,1] and this can be inferred from the cluster of points below 0: all of these 27 observations have predicted probabilities lower than 0.

Figure 4: Predicted probabilities for the occurrence of Wasting

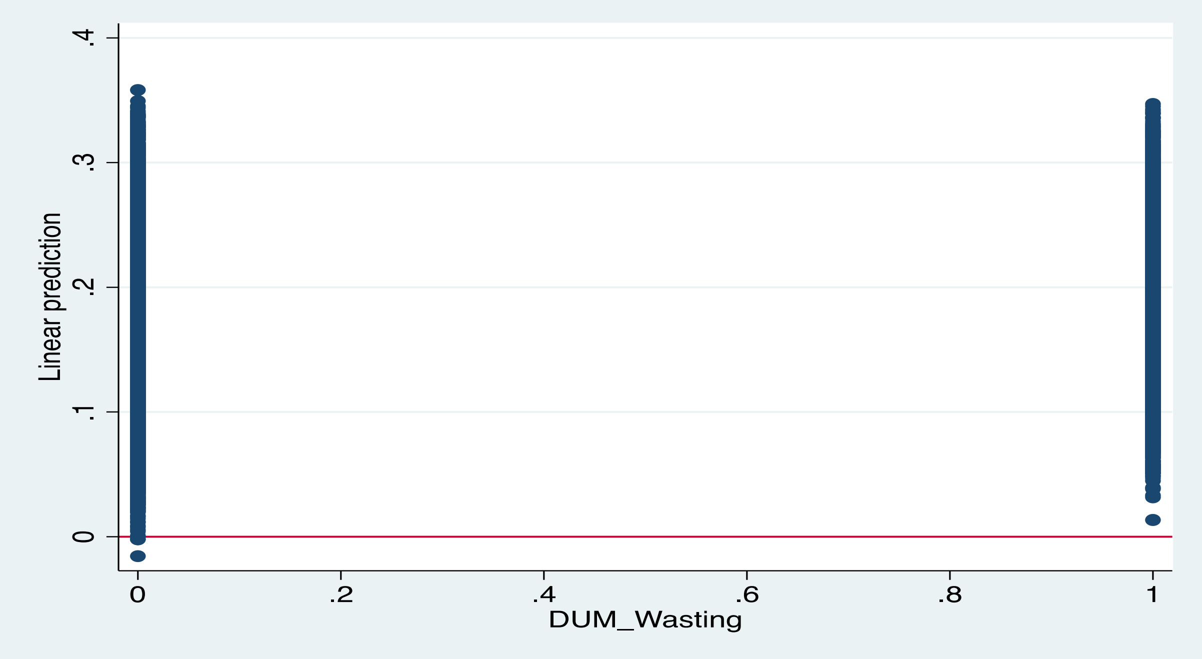


Figure 7 shows the predicted probabilities of wasting (the dependent variable in model 2). Since it is a binary variable, the observations take values of either 0 or 1 depending on the occurrence of wasting. In this model, only 4 of the 22,783 observations lie outside the plausible interval of [0,1] and this can be inferred from the cluster of points below 0: all of these 4 observations have predicted probabilities lower than 0.

Figure 5: Predicted probabilities for the occurrence of under/overweight in children

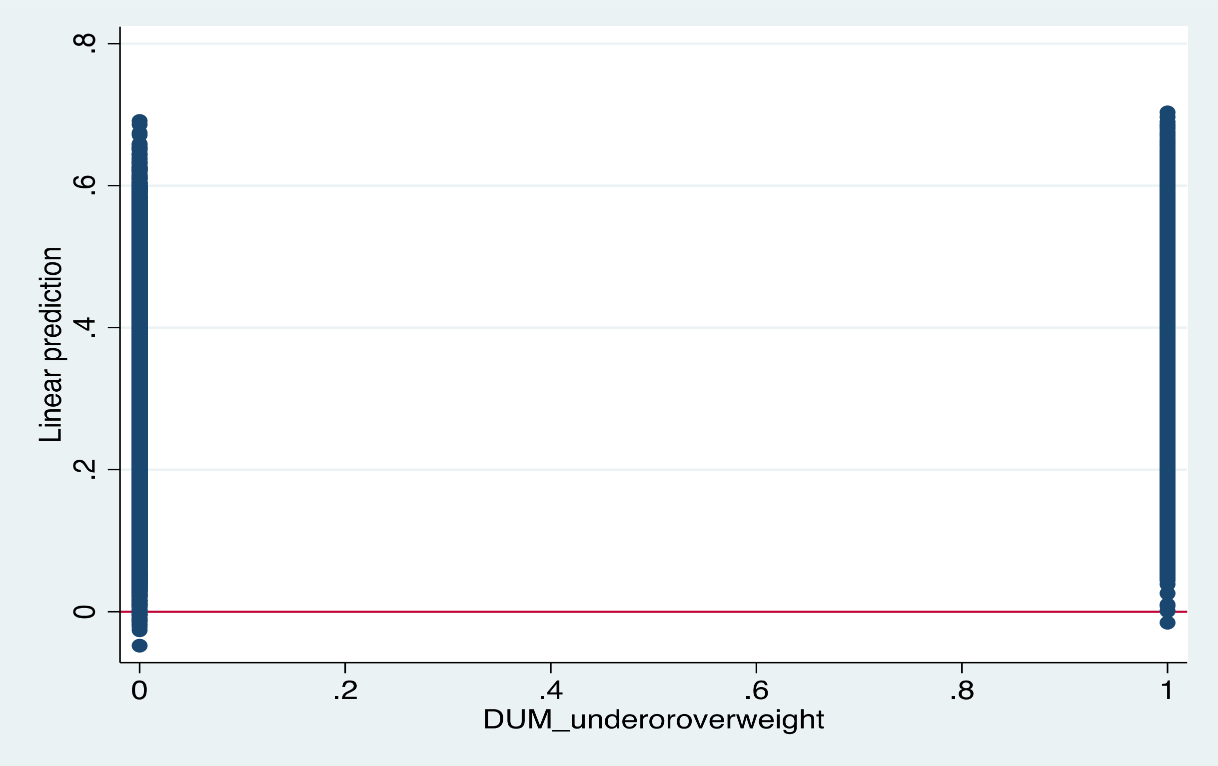


Figure 7 shows the predicted probabilities of wasting (the dependent variable in model 2). Since it is a binary variable, the observations take values of either 0 or 1 depending on the occurrence of under/overweight children. In this model, only 21 of the 22,783 observations lie outside the plausible interval of [0,1] and this can be inferred from the cluster of points below 0: all of these 21 observations have predicted probabilities lower than 0.

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