Growth Matters?

Revisiting the Enigma of Child Undernutrition in India

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Abstract

Higher economic growth in the post-liberalization phase since the 1990s was expected to translate into rapid all around improvements in well-being of the people. A notable exception in defiance of this association is apparent in the form of a persistently high level of child undernutrition in the face of rapid economic growth in India. We revisit this discordant association in this paper. Our findings are based on the analysis of four waves of the National Family Health Survey (NFHS 1992-93, 1998-99, 2005-06 and 2015-16) data on child undernutrition, demographic and socioeconomic characteristics of households and the per capita state domestic product. Descriptive statistical analysis as well as econometric methods including multilevel logistic models are used to understand the association between child undernutrition and economic growth. Sensitivity analysis is conducted to comprehend the robustness of the association across alternative specifications and adjustments. In particular, effect of growth on child undernutrition are found to be changing in analysis of NFHS third and fourth waves data compared to combined data in all the four waves. We argue that the quantum of growth is important for effect to be felt on child undernutrition. Apart from relying on growth, direct investment in health and nutrition sector is recommended as an important priority for policymaking.

Keywords: Economic Growth, Child Undernutrition, Anthropometric Failure, Asian Enigma

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1. Introduction

Long-term higher economic growth achieved by India in the post-1991 period was expected to translate into improvements in multidimensional well-being of the people. For instance, when income poverty line is benchmarked against calorie intake as in India, there is a significant trend reduction in incidence of poverty during the last 3 decades (Datt et al 2016). India's economic transformation also gets reflected in social spheres like fertility decline, child mortality decline, school enrolment and bridging of the gender gap in key developmental indicators (Alkire and Seth 2015). However, child nutrition is one key social development area where India has not fared well.

Prevalence of high level of child undernutrition in India has attracted wide attention in recent decades. Since 1990s, various studies have drawn attention toward the high prevalence of child underweight in South Asia and enigmatically found this to be higher than that in Sub-Saharan Africa despite having better per capita income and lower income poverty (Ramalingaswami et al 1997, Coffey 2015). Since Bangladesh and Nepal have improved their performance on undernutrition in recent years, it looks like the phrase ‘Asian Enigma’ is increasingly getting referred to as the Indian Enigma (Headey et al 2012; 2015).

Child under nutrition needs to be a focus area of attention for several reasons. Improvement in child nutrition and health are major components of progress towards Sustainable Development Goals (SDGs). Successful human development is questionable with high level of child undernourishment. Some estimates show that eliminating childhood undernutrition could cut child mortality by over 50% and reduce the burden of diseases by about 20% (Murray and Lopez, 1997; Pelletier, 1994). Nearly a quarter of all children are born with a major nutritional disadvantage – low birth weight; they weigh less than 2.5 kg at birth. Child undernutrition not only puts children at a greater risk of disease vulnerability, but also adversely affects physical and cognitive development of children (Barker, 1995). It adversely impacts productivity during working age (Strauss and Thomas, 1995).

There are two main path ways for economic growth to affect nutrition (Smith and Haddad 2002, Subramanyam et al 2011). First, a higher level of per capita income may mean higher income for a typical individual household that might invest more in food consumption, access to good hygiene, better child care arrangements, and effective health care. Second, a higher gross domestic product will mean more resource availability for the government which could partly be used for public action directly affecting health and nutrition thus enhancing access to safe drinking water, better quality of health care centres, provision of better sanitation systems and consumption of adequate nutritious diet. Programmes such as Integrated Child Development Services (ICDS), Midday Meal Scheme (MDMS), National Health Mission (NHM), safe drinking water and Public Distribution System (PDS) in India are examples of such public action.

Almost all the studies admit the role and importance of direct intervention measures in the health and sanitation sector for reducing undernutrition. While cross country studies lay emphasis on economic growth as a major driver as well (Smith and Haddad, 2002, 2015; Haddad et al 2003), some other studies based on micro-level data virtually dismiss the role of economic growth in reducing child undernutrition (Subramanyam et al, 2011; Vollmer et al, 2014).

In this paper, we revisit the issue and examine whether economic growth matters for reducing child undernutrition in the Indian context. More specifically, we ask the question if the risk of undernutrition among children residing within in a relatively rich state (say, Maharashtra) is less compared to that of a child residing in a relatively poor state (say, Odisha). We use data from the National Family Health Survey (NFHS) for four rounds[1] conducted in during the period 1992-93 to 2015-16. A part of the analysis is confined to NFHS-3 (2005-06) and NFHS-4 (2015-16) rounds only to examine effect of high growth because the period between NFHS-3 and NFHS-4 happened to be a high economic growth period in India when gross domestic product (GDP) per capita grew at an average rate of 6.8% per annum. We present several evidences of changing association of child undernutrition with economic growth. Further, it may be noted that several children in India are not only stunted but are also underweight and/or wasted at the same time. In this regard, we argue that economic growth may have relatively

[1] The first set of summary findings for 17 states in the Fifth NFHS conducted in 2019-20 have been released in December, 2020; the survey got postponed in many states due to outbreak of COVID-19. Unit level data are likely to be made available on completion of survey in all states.

greater influence on cases of joint anthropometric failure whereby a child experiences two or more forms of anthropometric failure simultaneously.

With this backdrop, the rest of the paper is organized as follows. Section 2 briefly summarizes the key arguments and findings from the literature regarding the growth and undernutrition association. Section 3 describes the data and methods used for the analysis. Section 4 describes the status of child undernutrition in India and presents the key findings from the econometric analysis regarding the association of economic growth with reductions in child undernutrition. Section 5 concludes by briefly discussing the results and its policy implications.

2. Review of literature

Child nutrition literature have focused on anthropometric failure in recent decades. Both policymakers and researchers have been using the nationally representative survey based anthropometric data on child height and weight for assessments of anthropometric failure. Three common anthropometric based measures of child undernutrition used in the literature are: (a) stunting which measures low height-for-age, (b) underweight which measures low weight-for-age, and (c) wasting which measures low weight-for-height. A child is considered to be undernourished when found to have low height-for-age, or weight-for-age, or weight-for -height with reference growth reference norms prescribed by the World Health Organization (WHO). The norms are specified in terms of a Z-score which is derived from a reference population and is a standardized indicator defined for a given age-sex combination as:

Z = (observed height or weight of child – reference median) / reference standard deviation

A child is considered undernourished if his/her score is below -2Z value[2].

The literature investigating the association of anthropometry-based nutritional outcome and economic growth may be classified into two categories. The first category uses macro-level data and examines the effect of per capita incomes on *average* child nutritional indicators at the country (or state) level based on cross-country (or cross-region) econometric analysis. The second category of studies use micro-level data on nutritional indicators at the individual child

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

level and explain their association with macro- and micro-level variables. Given the binary nature of the data (undernourished = 1 or not = 0), logistic regressions are commonly employed to explore how the risk of undernourishment at the individual level changes with per capita income at the country or state levels (with or without controlling for other variables).

In the first category of studies on macro-level associations, Smith and Haddad (2002) estimated effect of growth on child undernutrition using a panel of 63 developing countries over the period 1970-95 from 179 surveys. Employing pooled ordinary least square (OLS), random effect (RE) and fixed effect (FE) regressions, they found strong effect of income on child undernutrition (measured as child underweight) and concluded that rise in GDP per capita explained about half of reduction in prevalence of child underweight between 1970 and 1995 among these 63 countries. Haddad et al (2003) asked the question regarding how far income could take in achieving the Millennium Development Goal (MDG) of reducing undernutrition among children. Assuming a moderate per capita GDP growth of 2.5% till 2015, they concluded that income had a sizeable effect on reducing underweight by 34% of the initial prevalence between 1995 and 2015. This result also meant that income growth alone was not sufficient to achieve the MDG target. In order to achieve the targeted reductions in malnutrition, they emphasized upon a balanced strategy of income growth and investment in more direct interventions. Based on cross country data for different regions, Klasen (2008) also found effect of income on undernutrition to be small but significant.

In another follow up paper, Smith and Haddad (2015) note that 'stunting has replaced underweight as the preferred measure of child undernutrition for setting and monitoring international goals'. Using panel data for an expanded set of 116 developing countries for the period 1970-2012, they investigate effect of per capita income on stunting along with several covariates such as food availability at national level, diversity in food, women education, degree of gender equality, access to safe water and sanitation, and governance structure. They found a strong negative effect of per capita national income on stunting with an elasticity of 0.63 implying that per capita income of a country happens to be a major macro-driver of nourishment.

Even when other average covariates at parental or household levels are controlled, the aggregate average relations have been criticised for ignoring micro-level complexities such as household's actual income change due to inequality and differences in household level access to public services. Accordingly, the second categories of studies based on micro-level data (from Demographic and health Surveys, DHS) attempt to consider undernutrition at individual child level. Subramanyam et al (2011) use the micro level data from NFHS 1 to 3 (1992-2005) in India to examine if per capita net state domestic product (NSDP) has an influence on child undernutrition in terms of stunting, underweight and wasting. Based on their multilevel logistic regressions, they find an inverse relationship of per capita state income and child undernutrition in model that did not consider survey-period effects. But, once survey-period effects (time fixed effects) are controlled, they did not find consistent evidence of state income growth influencing risk of undernourishment among children with or without adjustments for demographic and socioeconomic covariates. Similarly, using data from 121 Demographic and Health Surveys (DHS) from 36 countries representing the period 1990 and 2011, Vollmer et al (2014) found null-to-small association between increases in per-capita GDP and reductions in early childhood undernutrition.

Joe et al (2016) also review the findings from Subramanyam et al (2011) and argues that between NFHS-1 and NFHS-3, the state-level situation of economic growth had not led to significant improvements in the level of public spending for developmental component. Also, there was only small state level association with changes in poverty head count ratio at the state level. The authors accordingly conclude that child undernutrition reductions were affected because of macroeconomic growth did not lead to major investments in development spending during this phase of economic growth. Accordingly, the analysis lends greater support for a 'support-led' strategy to address the problem of child undernutrition.

Harttgren et al (2013) examine the issue for Sub-Saharan Africa at both macro- and micro-level and find modest effect of per capita GDP on reducing undernutrition. Their macro-level exercise indicate elasticities between -0.2 to -0.3. These effects are significant for stunting and underweight, but not for wasting. The micro-level results found that per capita GDP was associated with lower odds of being stunted, underweight and wasted and all results were statistically significant. Another major point to note is that they found a large effect of relative socioeconomic status of households as measured by an asset index.

Strauss and Thomas (1998) found reduction in poverty leads to reduction in malnutrition. Subramanian et al. (2009) found maternal height to be inversely associated with child mortality and anthropometric failure which suggests possibility of an intergenerational transfer of poor health from mother to child. Headey et al (2015) find rapid wealth accumulation and large gains in parental education helped Bangladesh to sustain reduction in undernutrition.

In the Indian context, Mondal and Sen (2010) found significantly higher thinness among boys than girls in their sample in West Bengal. Panigrahi et al. (2014) found factors like birth order of child, mother's education, and period of initiation of breast feeding to be predictors of wasting, while stunting was found to have been affected by presence of toilet facilities in home, drinking water conditions in Bhubaneswar.

Based on the brief review of the literature and to the best of our knowledge we did not come across any study that explores the association of economic growth with child undernutrition for the recent period (2005-06 to 2015-16) for India. The analysis therefore assumes relevance toward the strategic discussions, including POSHAN *Abhiyaan*, on accelerating reductions in child undernutrition in India.

3. Data and Methods

The 4 rounds of NFHS survey data used by us have been conducted in 1992-93, 1998-99, 2005-06 and 2015-16. The surveys provide representative information on health and family welfare of households, including child nutrition, at national and state levels. The survey design has remained broadly similar across rounds to make the main data across rounds comparable over time. The survey is funded by the government and several international agencies. The International Institute for Population Sciences (IIPS), Mumbai serves as the nodal agency under the technical guidance of an international body. Sample is selected from villages in rural areas and Census Enumeration Blocks in urban areas.

So far as child nutritional information is concerned, height of children was not measured in 5 states (Andhra Pradesh, Himachal Pradesh, Madhya Pradesh, Tamil Nadu, and West Bengal) in the first round in 1992–93. Information on children was not available for the states of Sikkim for 1992–93 and Tripura for 1998–99. Nutritional information in the first 2 rounds are available for children below 3 years and in the next 2 rounds for children below 5 years. To ensure uniformity in analyses, children in age group 0-35 months were considered when we use data for all the 4 rounds. The final pooled sample size for stunting, wasting and underweight are 205177, 202806 and 218336 respectively. Children below 5 years are considered in part of the analysis that uses data for the last 2 rounds and the pooled sample size for stunting, wasting and underweight are 273045, 269569 and 278487 respectively.

Child's height and weight were measured by trained investigators during the survey. Three anthropometric outcome indicators were constructed to measure child's undernutrition status: weight-for-age, height-forage, and weight-for-height. Child growth standards provided by World Health Organization (WHO) were used to determine anthropometric outcome. We used a Stata program provided by WHO to obtain the standardized z scores associated with weight-for-age, height-for age, and weight-for-height. To calculate the Z-score, the computation involves division of weight (height) by median weight (height) for a child belonging to specific age and sex group. Similarly, to obtain Z-score for weight for height weight is divided by median weight of a child of specific height and sex. The numbers are standardized with a mean of 0 and standard deviation of 1 to calculate the Z-score. A child suffers from anthropometric failure if Z-score is 2 standard deviations below the median.

The socio-economic variables for the analyses include age, sex, and birth order of the child; age of mother, marital status; mother and father's education, caste, religion, wealth, place of residence, NFHS round and State. NFHS 3 and 4 provide information on wealth quintile a household belongs to, based on principal component analysis. This data is not available for NFHS 1 and 2. We have created a wealth variable for the first and second round was created following the same method on household characteristics and assets such as electricity, radio, refrigerator, bicycle, motorcycle/scooter, car/truck, telephone, watch, animal-drawn cart, bank account, mattress, pressure cooker, chair, bed, table, electric fan, television, sewing machine, internet, computer, air conditioner, and washing machine.

Per capita Net State Domestic Product (NSDP) data for different series have been converted to 2004-05 constant prices. Four new States – Chhattisgarh, Jharkhand, Uttarakhand, and Telangana - have been formed during the period covered here and the data for new states have been consolidated with the parent states for comparability across rounds.

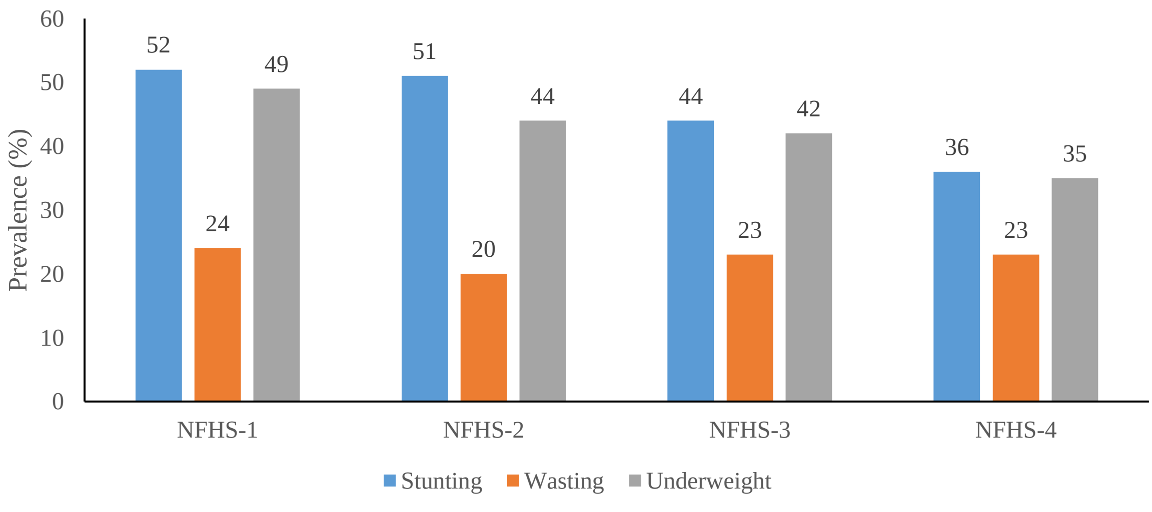
The unit of analyses in NFHS data is child. We calibrated a series of logistic regression models to establish the association between the indicators of anthropometric failures and per capita SDP. First, unadjusted models were calibrated where no other correlates except for per capita SDP was used as independent variable. Then, all the socio-economic correlates were introduced in the adjusted models. Three set of models were run, one each for stunting, wasting and underweight. As a part of sensitivity analyses, three-level logistic regression models were also calibrated with child (level 1) nested in NFHS round (level 2) nested in State (level 3). Per capita SDP is a macro variable while all the other variables are available at a micro level i.e household. As a secondary analysis, we aggregated the data at State level for each variable in percentage terms and analyzed the variables in a fixed effect panel data framework to validate the results obtained using logistic and multilevel models.

4. Results

4.1. Prevalence of Undernutrition

Figure 1 shows prevalence of stunting, underweight and wasting among children below 3 years as revealed at the national level in the four rounds of NFHS. Stunting (height for age) prevalence among children has decreased from 52% in NFHS 1 (1992-93) to 36 % in NFHS 4 (2015-16) with almost the entire decrease occurring between NFHS 3 (2005-06) and NFHS 4. Incidence of underweight has steadily declined over the rounds from 49% in NFHS 1 to 35% in NFHS 4. On the other hand, prevalence of wasting has stagnated over the 23 years of the survey rounds. It fell from 24% in 1992–93 to 20% in 1998-99 (NFHS 2), but rose thereafter to remain at 23% during the next two rounds.

Figure 1: Undernutrition indicators in India: stunting, wasting and underweight (NFHS)



Source: Authors based on NFHS (various rounds)

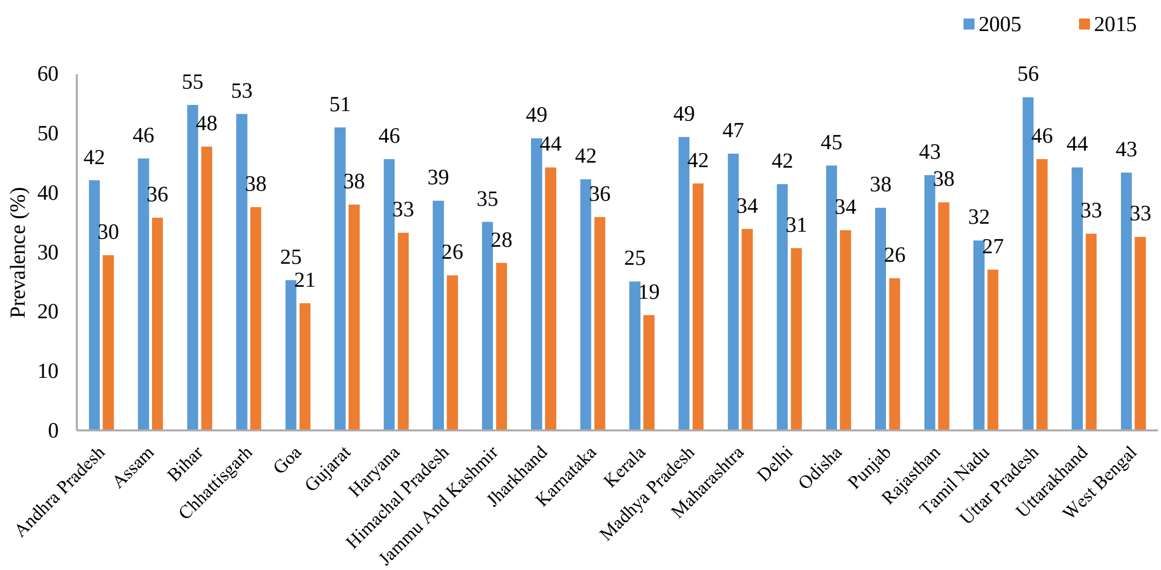
Prevalence of stunting, underweight and wasting are shown in Figures 2, 3 and 4 respectively for various Indian states as revealed by NFHS 3 and 4. There is huge variation in prevalence of all the three indicators of undernutrition across the States in a particular round. We may note the following:

Stunting: Prevalence of stunting was the highest in Bihar at 48% in 2015-16 and the lowest in Kerala at 19% in 2015-16. But, it may be observed that prevalence of stunting has declined in all the states in NFHS 4 compared to NFHS 3 and the relative positions of the states have not undergone much change.

Underweight: The picture for underweight is similar to that of stunting: variations across states are substantial and all the states indicate a fall in prevalence during 2005-15 except for a small rise for Goa and Delhi.

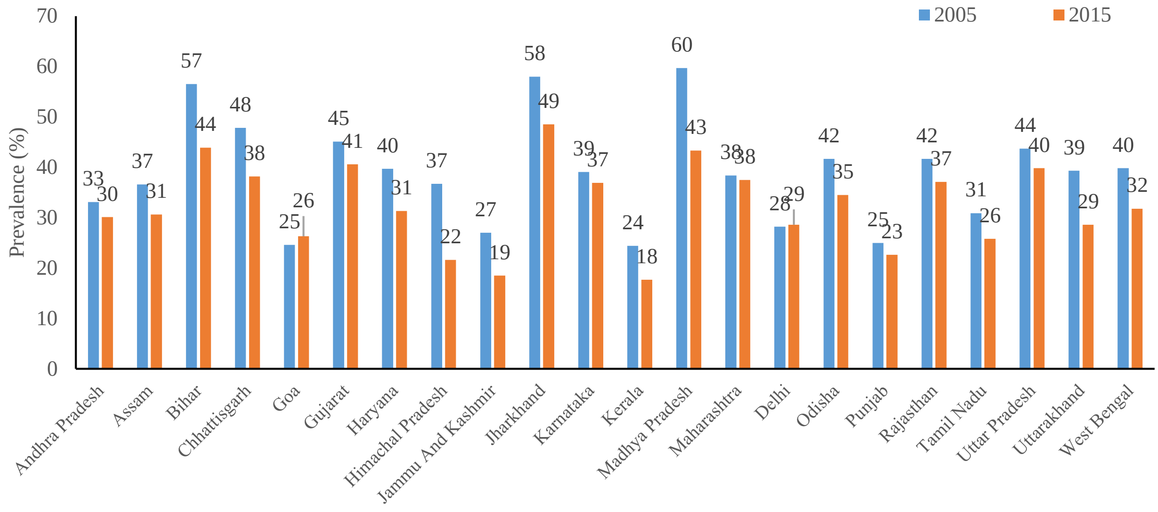
Wasting: It also exhibits large variations across states. But, changes between the two rounds do not have the same pattern. Wasting rate falls in several states such as Bihar, Himachal Pradesh, Jammu and Kashmir, Jharkhand, and Madhya Pradesh. But, it also rises in several other states like Andhra Pradesh, Assam, Chhattisgarh, Goa, Gujarat, Haryana, Karnataka, Maharashtra, Punjab and Uttar Pradesh. These changes in either direction have led to stagnancy in wasting rate between NFHS 3 and 4 at all-India level.

Figure 2: Prevalence of stunting in states, NFHS 3 and 4



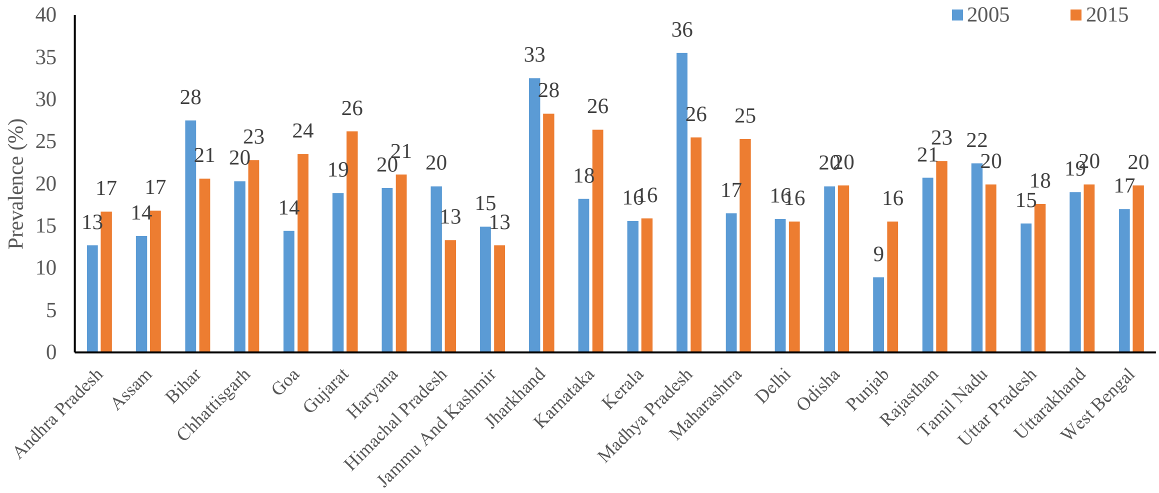
Source: Authors based on NFHS (various rounds)

Figure 3: Prevalence of underweight in states, NFHS 3 and 4



Source: Authors based on NFHS (various rounds)

Figure 4: Prevalence of wasting in states, NFHS 3 and 4



Source: Authors based on NFHS (various rounds)

4.2. Econometric associations

To begin with, we present in Table 1 a set of 3 regression results that shows the effect of log of per capita NSDP on the three child undernutrition measures without using other associated demographic or socioeconomic variables likely to affect nutrition. The first two are in line with the macro-level analysis based on state level average undernutrition prevalence and the third one relates to logistic regression at individual or micro level nutrition data. The panel data model is one of fixed-effect type controlling for state and rounds.

Table 1: Unadjusted Regression results: OLS, Panel data and Logistic, NFHS 1-4 (independent variable: log of per capita NSDP)

Model	Stunting	Underweight	Wasting
OLS Regression	-11.05***	-9.90***	-1.04
N	*90*	*95*	*90*
Panel data Regression (Fixed Effect)	-12.99***	-8.93***	1.16
N	*90*	*95*	*90*
Logistic regression	0.60***	0.62***	0.94***
N	*205177*	*218336*	*202806*

Note: *** denotes significance at 1% level

Source: Authors based on NFHS (various rounds)

The first two regressions results reveal an inverse association of stunting and underweight with log of per capita NSDP and the coefficients are significant. The logit regression shows the odds ratio less than 1 which indicates a lower risk of child undernutrition as state income rises. The association of wasting with income, however, is not consistent across models. The logistic model indicates a moderately lower risk for wasting and the coefficient is significant; but, OLS and panel regressions do not reveal any significant relationship.

We provide results for logistic regression of nutritional failure on income controlling for several other variables in Appendix Table A.1. The income factor still has a significant influence on underweight, though of moderate magnitude. It does not significantly affect stunting or wasting. Several other factors such as age and sex of child, maternal education and age, caste and wealth quintiles are seen to affect one or more indicators of child undernutrition. The effect of survey period for 3rd and 4th rounds are negative and significant on stunting and underweight, though not on wasting.

Despite not being uniformly consistent, these results based on the 4 rounds of NFHS data are different from Subramanyam et al (2011) who used data for the first 3 rounds. The inclusion of data for the 4th round for 2015-16 makes a difference. India's growth performance during 2005-15 was one of the highest by international comparison and it is of interest to assess growth impact during this period. Hence, we re-do the exercise by limiting to NFHS 3 and 4 only. As noted earlier, these rounds provide nutrition outcome data for children up to 5 years whereas the first two rounds provide data for children up to 3 years only. Another additional advantage is that information on all states[3] and all indicators of undernutrition are available in 3rd and 4th rounds while the first rounds omitted height information for some states.

Results Based on NFHS 3 and 4

Table 2 presents logistic regression results using data from NFHS 3rd and 4th rounds in 2005-06 and 2015-16. The independent variable is log (per capita NSDP) in Model 1 while it is growth in per capita NSDP in Model 2. Both the models control for age and sex of the child and survey round. The odds ratio in both the models turn out to be less than 1 for stunting and underweight and are statistically significant pointing towards a lower risk of prevalence of stunting or underweight as income rises. Wasting, however, does not share any such association and, in fact, the odds ratios are just marginally higher than 1.

Table 2: Logistic regression based odds ratio for association adjusted for age, sex and period (NFHS 2005-06; 2015-16)

			Model-1			Model-2
	Stunting	Underweight	Wasting	Stunting	Underweight	Wasting
Growth rate	-	-	-	0.91***	0.94***	1.02***
S.E	-	-	-	0	0	0
Log of NSDP per capita	0.64***	0.71***	1.03**	-	-	-
S.E	0.01	0.01	0.01	-	-	-
Nfhs-3	1	1	1	1	1	1
Nfhs-4	0.86***	0.90***	1.03	0.67***	0.75***	1.05**
S.E	0.01	0.01	0.02	0.01	0.01	0.02
Less than 12 months	1	1	1	1	1	1
12 to 23 months	1.34***	1.01	1.07***	1.34***	1	1.07***
S.E	0.02	0.01	0.02	0.02	0.01	0.02
23 and above	1.39***	1.11***	0.88***	1.38***	1.11***	0.88***
S.E	0.02	0.02	0.02	0.02	0.02	0.02
Female	1	1	1	1	1	1
Male	1.03***	1.04***	1.12***	1.03***	1.04***	1.12***
S.E	0.01	0.01	0.02	0.01	0.01	0.02
Constant	61.52***	20.27***	0.17***	1.12***	0.93***	0.22***
S.E	6.89	2.26	0.02	0.02	0.02	0.01
N	272409	277828	268947	272409	277828	268947

Source: Authors based on NFHS (various rounds)

[3] Telangana is the only state formed between NFHS 3 and NFHS 4.

Table 3: Distribution of households by states in wealth quintiles (NFHS 3 and NFHS 4)

State/UTs	Poorest (Quintile 1)		Poorer (Quintile 2)		Middle (Quintile 3)		Richer (Quintile 4)		Richest (Quintile 5)	
	NFHS-3	NFHS-4	NFHS-3	NFHS-4	NFHS-3	NFHS-4	NFHS-3	NFHS-4	NFHS-3	NFHS-4
Andhra Pradesh	12.1	6.7	18.1	17.2	28.9	29.3	24.6	27.5	16.3	19.3
Arunachal Pradesh	20.5	19.4	24	24.2	20.1	25.5	17.2	22	18.2	8.9
Assam	20.3	24.8	30.1	37.7	21.6	18.4	15.3	12.7	12.7	6.4
Bihar	31.1	52.9	29.6	22.3	17.6	12.9	13	8.5	8.7	3.3
Chhattisgarh	43	34.6	26.2	24.4	13.1	15.5	8.2	12	9.4	13.5
Delhi	0.2	0.2	3	2.1	9.7	14.7	19.9	21.9	67.2	61.1
Goa	2.6	0.3	6	5.3	14.3	12.1	22.4	27.8	54.6	54.5
Gujarat	7.1	9	14.6	16.2	18.8	20.2	27.3	24.7	32.2	29.9
Haryana	3.9	1.9	13.2	7.8	25	18.2	27.8	26.4	30.2	45.8
Himachal Pradesh	1.4	2	9	9.7	23.4	23.4	31	33.1	35.2	31.8
Jammu & Kashmir	3	7.1	12.7	19.3	28.1	24.1	28.5	23.6	27.7	26
Jharkhand	52	47.9	15.1	20.1	10.1	13.3	11.1	9.7	11.6	9
Karnataka	11.4	7.5	22.5	19.8	23.5	25.5	22	26.2	20.7	21
Kerala	1.3	0.5	4.6	2.7	12.5	13.7	36.7	35.1	44.9	48.1
Madhya Pradesh	38.4	32.8	23.6	21.9	12.7	15.3	11.9	14.2	13.4	15.8
Maharashtra	11.6	10.2	15.7	16.4	17.5	22	23.1	25.4	32	26
Manipur	2.6	9.8	17	31.3	34.2	30.2	30.8	19.3	15.4	9.5
Meghalaya	12.5	11.9	21.7	35	23.4	31	26.1	15.5	16.4	6.5
Mizoram	2.5	6.4	5.9	10.7	18.7	21.1	35.6	29.3	37.4	32.6
Nagaland	7.1	12	22.2	30.9	30.1	26.6	26.1	20	14.6	10.5
Orissa	42.4	38.1	19.7	25.7	16.8	18.1	12	10.7	9.1	7.2
Punjab	1.4	0.8	6.9	4.4	16.6	12.5	30	21.6	45	60.7
Rajasthan	25	18.1	17.4	23.6	21.2	21	16.9	18	19.5	19.2
Sikkim	1.9	0.6	10.1	7	21.5	40.9	31.4	39.8	35	11.6
Tamil Nadu	12.2	4.6	16.3	15.3	29.1	27.2	23.3	30.9	19	22
Tripura	10.8	13.4	24.8	42.3	40.4	23.1	16.2	14.9	7.8	6.3
Uttar Pradesh	27.8	31.8	25.1	22.3	18.2	16.3	15.5	14.1	13.4	15.5
Uttarakhand	7.1	5.4	15.8	17.7	21.3	24.5	23.2	23.4	32.6	29
West Bengal	25.4	24.2	23.5	29.3	18.7	20.1	17.6	17.2	14.8	9.2

Source: Authors based on NFHS (various rounds)

Next, we attempt to control for wealth quintile (WQ) obtained by considering the wealth quintile at the national level. Table 3 provides distribution of population by states in different wealth quintiles for NFHS 3 and NFHS 4. There are considerable changes in share in population of different states across quintiles. Expectedly, the relatively rich states contribute proportionately more in the upper wealth quintiles and the relatively poor states appear more prominently in the bottom quintiles. Delhi and Goa are two other states where majority of households belonged to the top most quintile in both the rounds, though there is a marginal decline in the proportions over the two rounds. 45% Punjab's households belonged the top wealth quintile in 2005-06 and this proportion increased to 61% in 2015-16. Haryana too had an increase of 16% over the two rounds to 46% in top quintile. Turning to the bottom quintile, 52% of Jharkhand's population were in the lowest quintile in NFHS 3 with a marginal fall to 48% in NFHS 4. The lowest quintile accounted for 31% of Bihar's population and the figure increased to as much as 53% in 2015-16.

Table 4: Logit regression results indicating association of child undernutrition on NSDP and interaction of NSDP with wealth quintile.

		Stunting	Underweight	Wasting
	Log of NSDP per capita	0.85***	0.97***	1.19***
	S.E	0.01	0.01	0.02
Age of child	Less than 12 months	1	1	1
	age12to23 months	1.36***	1.01	1.08***
	S.E	0.02	0.01	0.02
	age23to35 months	1.41***	1.13***	0.88***
	S.E	0.02	0.02	0.02
Sex of child	Female	1	1	1
	Male	1.05***	1.06***	1.12***
	S.E	0.01	0.01	0.02
Wealth * period	NFHS-3 *WQ1	1	1	1
	NFHS-3 *WQ2	0.80***	0.76***	0.85***
	S.E	0.03	0.03	0.04
	NFHS-3 *WQ3	0.67***	0.55***	0.67***
	S.E	0.03	0.02	0.03
	NFHS-3 *WQ4	0.49***	0.40***	0.56***
	S.E	0.02	0.02	0.03
	NFHS-3 *WQ5	0.26***	0.20***	0.41***
	S.E	0.01	0.01	0.02
Wealth * period	NFHS-4 *WQ1	0.76***	0.72***	0.87***
	S.E	0.02	0.02	0.03
	NFHS-4 *WQ2	0.57***	0.52***	0.72***
	S.E	0.02	0.02	0.02
	NFHS-4 *WQ3	0.44***	0.40***	0.63***
	S.E	0.01	0.01	0.02
	NFHS-4 *WQ4	0.33***	0.30***	0.59***
	S.E	0.01	0.01	0.02
	NFHS-4 *WQ5	0.23***	0.22***	0.54***
	S.E	0.01	0.01	0.02
	Constant	6.11***	1.68***	0.05***
	S.E	0.72	0.2	0.01
	N	272409	277828	268947

Source: Authors based on NFHS (various rounds)

As we move up the wealth quintiles in a round, the risk of undernutrition falls significantly revealing strong effect of wealth on stunting, underweight and wasting. The risk of a child belonging to the highest wealth quintile being undernourished is only about a quarter for stunting and underweight and about half for wasting compared to a child belonging to the bottom quintile. More interestingly, the risk of undernutrition falls significantly in NFHS 4 compared to their counterparts in NFHS 3.

Joint Anthropometric Failures

The metric of child undernutrition is wrapped in several layers of deprivations and disadvantages whereby certain layers are found to be more responsive to economic growth than others. We present the prevalence of child undernutrition by one or more categories (Svedberg 2000) of undernutrition for NFHS 3 and NFHS 4 in Table 5. Percentage of children who were not affected by any of the anthropometric deficiencies was 39% in 2005-06 and 45% in 2015-16. Incidence of child getting affected by only stunting, only underweight or only wasting is relatively low. Incidence of children getting affected by two or all three deficiencies is high. In particular, 25% of children were affected by both stunting and undernutrition in 2005-06 and this percentage fell to 18% in 2015-16.

Table 5: Prevalence of categories of Anthropometric Failure (%), India

Categories of Anthropometric Failure	2005-06	2015-16
No failure	38.6	44.7
Wasting only	4.2	6.2
Underweight only	2.3	2.6
Stunting only	6.8	13.4
Underweight and wasting	14.7	8.2
Stunting and underweight	24.6	18.3
Stunting/underweight/wasting	8.8	6.6
Composite Index of Anthropometric Failure	61.4	55.3

Source: Authors based on NFHS (various rounds)

In view of the above, we examine association of income with different combinations of anthropometric failure. As Table 6 shows per capita NSDP is found to be associated with lower risk of stunting controlling for different sets of socio-economic and demographic features of the household. A similar relationship is observed when both underweight and stunting or underweight and wasting are combined. Only underweight cases do not show a consistent pattern of association with income. Wasting again seem to be positively related with income.

Table 6: Econometric association of economic growth and categories of anthropometric failure

		S only	U only	W only	SU	UW	SUW
Model-1	Log(Per capita NSDP)	0.87***	0.99	1.36***	0.63***	1.07***	0.76***
	Standard Error	0.01	0.03	0.03	0.01	0.02	0.02
Model-2	Log(Per capita NSDP)	0.92***	1.04	1.29***	0.84***	1.19***	1.03
	Standard Error	0.01	0.04	0.03	0.01	0.02	0.02
Model-3	Log(Per capita NSDP)	0.95***	1.03	1.29***	0.94***	1.18***	1.14***
	Standard Error	0.02	0.04	0.03	0.02	0.03	0.03

Note: Model 1 is adjusted for age-sex and period; In Addition, Model 2 is adjusted for wealth quintile; Model 3 is further adjusted for socioeconomic, demographic and health care covariates
Source: Authors based on NFHS (various rounds)

5. Conclusion

In this paper, we have examined the effect of economic growth on anthropometric indicators of child undernutrition. We have used data from four rounds of NFHS to explore the association and robustness across specifications. An earlier study had concluded that state economic growth is not associated with risk of undernutrition once survey period effects are controlled. Our results, however, shows that growth reduces the risk of child undernutrition in several cases.

More specifically, our results suggest that:

- In the combined data for all the four rounds, per capita NSDP has a significant effect on stunting and underweight. In other words, risk of a typical child being stunted or underweight reduces in states at the higher end on per capita income scale.
- When we use data for NFHS-3 and 4 only, we get similar results. In addition, we found significant effect of household standard of living (as captured through the wealth index) for all the three indicators of undernutrition.
- Survey period effects of round 3 and 4 are significant which possibly captures some effect of time related public health and hygiene related programmes.

While the inverse relationship of undernutrition with per capita SDP is not revealed by all the indicators in our results, it is very different from the current literature that virtually dismisses any income effect and focuses only on investments on health interventions. The growth effect assumes importance.

Furthermore, from the NFHS data at the household level we do observe that those who belong to higher wealth quintiles are more likely to have better nutritional outcomes (IIPS, 2016). In addition, a number of socio-economic factors such as female literacy, access to safe water and improved sanitation facilities, antenatal check-ups, and timely vaccination are significantly correlated with child nutrition. Clearly, investment in health care services has its own independent effects. The lack of proper distribution channel to deliver public services such as food and basic health services also limit the role of growth in reducing child undernutrition. At times investment in public services such as water and sanitation, vaccination and distribution of food could be more effective even if growth is not being experienced.

There are certain limitations to our study. Although, we have used data from the four round of survey, the nature of study does not follow a longitudinal design. We also do not make a causal inference since bi-directional causality cannot be ruled out. However, it takes a lot of time for nutrition indicators to affect growth. We believe such long term trends might not be visible in our data which covers a short span of time. Moreover, it is possible that children might be suffering from anthropometric failure at time of survey but might have recovered later on. But again, these children could be a very small proportion of the overall sample. Most of the information are self-reported by women. However, the indicators for undernutrition provided by DHS program are of high quality and measured by trained investigators using specialized equipment. We also cannot deny issues in measurement of state domestic product which is quite challenging in developing countries.

In concluding, it may be reiterated that economic growth is a necessary condition for the improvement of the nutritional related outcomes among children but not a sufficient one. In view of emphasis by international bodies on stunting in the context of India’s commitments to Sustainable Development Goals. What is needed is a balanced strategy that recognizes economic growth effect along with direct intervention programmes on the WASH (water, sanitation and hygiene) sector.

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Supplementary Tables

Table A-1: Adjusted Regression results Logistic regression model

		Stunting	S.E	Wasting	S.E	Underweight	S.E
	Log of SDP per capita	0.98	0.02	1.02	0.02	0.95***	0.02
NFHS round	NFHS-1	1		1		1	
	NFHS-2	0.95	0.04	0.82***	0.04	0.85***	0.03
	NFHS-3	0.70***	0.03	1	0.05	0.76***	0.03
	NFHS-4	0.52***	0.02	0.97	0.05	0.62***	0.02
Age of child	Less than 12 months	1		1		1	
	12 to 23 months	2.84***	0.05	0.74***	0.01	1.43***	0.02
	23 and above	3.18***	0.05	0.56***	0.01	1.59***	0.02
Sex of child	Female	1		1		1	
	Male	1.14***	0.01	1.15***	0.02	1.16***	0.01
Birth order	First	1		1		1	
	Second	1.11***	0.02	1	0.02	1.06***	0.02
	Third	1.18***	0.02	1.02	0.02	1.12***	0.02
	Fourth	1.35***	0.03	1.12***	0.03	1.32***	0.03
Age of mother at birth	17 to 19 years	1		1		1	
	13 to 16 years	1.31***	0.08	0.96	0.07	1.25***	0.07
	20 to 24 years	0.98	0.02	1.05*	0.02	0.97	0.02
	25 to 29 years	0.86***	0.02	1	0.03	0.88***	0.02
	30 and above	0.84***	0.02	1.02	0.03	0.87***	0.02
Stay with husband	No schooling	1		1		1	
	Yes	0.97	0.02	1.07***	0.02	1.03	0.02
Partner education	No schooling	1		1		1	
	Primary	0.97	0.02	1.02	0.03	1.01	0.02
	Secondary	0.97	0.02	0.94***	0.02	0.92***	0.02
	Higher	0.87***	0.03	0.82***	0.03	0.79***	0.02
Maternal education	No schooling			1		1	
	Primary	0.84***	0.02	0.94***	0.02	0.85***	0.02
	Secondary	0.69***	0.01	0.92***	0.02	0.72***	0.01
	Higher	0.53***	0.02	0.91**	0.03	0.55***	0.02
Caste	Other	1		1		1	
	SC	1.15***	0.02	1.02	0.02	1.13***	0.02
	ST	1.06***	0.02	1.33***	0.03	1.24***	0.02
Religion	Hindu	1		1		1	
	Muslim	1.04	0.04	0.96	0.05	1.04	0.04
	Other	0.99	0.04	0.87***	0.05	0.91**	0.03
Wealth	Lowest	1		1		1	
	Second	0.87***	0.02	0.88***	0.02	0.82***	0.01
	Third	0.74***	0.01	0.77***	0.02	0.67***	0.01
	Fourth	0.61***	0.01	0.70***	0.02	0.55***	0.01
	Highest	0.47***	0.01	0.62***	0.02	0.42***	0.01
Place of residence	Urban	1		1		1	
	Rural	0.95***	0.02	0.91***	0.02	0.89***	0.02
	Constant	0.9	0.15	0.39***	0.07	1.78***	0.3
	N	205177		202806		218336	

Table A-2: Fully adjusted logistic regression model, NFHS-3 and NFHS-4

		Stunting	S.E	Underweight	S.E	Wasting	S.E
Log of per capita SDP	Log of SDP per capita	0.96***	0.01	1.08***	0.01	1.24***	0.02
Age	12 to 23 months	1.38***	0.02	0.98	0.02	1.06***	0.02
	23 and above	1.43***	0.02	1.13***	0.02	0.90***	0.02
Gender	Female	1		1		1	
	Male	1.06***	0.01	1.07***	0.01	1.14***	0.02
Birth order	1st	1		1		1	
	2ndor3rd	1.11***	0.02	1.10***	0.02	1.06***	0.02
	3rdor4th	1.20***	0.03	1.21***	0.03	1.11***	0.03
	6thabove	1.39***	0.04	1.36***	0.04	1.15***	0.04
Place of residence	Urban	1		1		1	
	Rural	0.95***	0.02	0.89***	0.02	0.91***	0.02
Mother education	No education	1		1		1	
	primary	0.85***	0.02	0.87***	0.02	0.96*	0.02
	secondary	0.72***	0.01	0.78***	0.01	1	0.02
	higher	0.60***	0.02	0.68***	0.02	0.97	0.03
	college	0.52***	0.02	0.58***	0.02	0.99	0.04
Maternal height	160+ cm	1		1		1	
	155-159.9 cm	1.36***	0.04	1.33***	0.04	1.11***	0.04
	150-154.9	1.86***	0.05	1.77***	0.05	1.16***	0.04
	145-149.9	2.50***	0.07	2.38***	0.07	1.26***	0.04
	<145 cm	3.69***	0.12	3.18***	0.1	1.25***	0.04
Maternal BMI	Below Normal	1		1		1	
	Normal	0.81***	0.01	0.63***	0.01	0.73***	0.01
	Above Normal	0.67***	0.02	0.42***	0.01	0.48***	0.01
Child Marriage	No	1		1		1	
	Yes	1.05***	0.01	1.01	0.01	0.93***	0.01
Early breastfed	No	1		1		1	
	Yes	0.93***	0.02	0.97*	0.02	1	0.02
Infectious disease	No	1		1		1	
	Yes	0.94***	0.01	1.01	0.01	1.05***	0.02
Improved water	No	1		1		1	
	Yes	1.13***	0.02	1.03	0.02	0.96**	0.02
Safe stool disposal	No	1		1		1	
	Yes	0.99	0.02	0.94***	0.02	0.93***	0.02
Sanitation	No	1		1		1	
	Yes	0.90***	0.02	0.90***	0.02	0.93***	0.02
Full immunization	No	1		1		1	
	Yes	1.17***	0.02	1.08***	0.01	0.86***	0.01
Vitamin a supplement	No	1		1		1	
	Yes	1.04***	0.01	1.02	0.01	0.97*	0.02
SBA delivery	No	1		1		1	
	Yes	0.85***	0.01	0.91***	0.01	1.08***	0.02
Family planning	No	1		1		1	
	Yes	0.97**	0.01	0.95***	0.01	0.88***	0.01
Wealth*period	NFHS-3 *WQ1	1		1		1	
	NFHS-3 *WQ2	0.93*	0.04	0.86***	0.04	0.87***	0.04
	NFHS-3 *WQ3	0.90**	0.04	0.70***	0.03	0.72***	0.04
	NFHS-3 *WQ4	0.79***	0.04	0.63***	0.03	0.65***	0.04
	NFHS-3 *WQ5	0.56***	0.03	0.40***	0.02	0.52***	0.04
	NFHS-4 *WQ1	0.85***	0.03	0.81***	0.03	0.87***	0.03
	NFHS-4 *WQ2	0.78***	0.03	0.71***	0.02	0.77***	0.03
	NFHS-4 *WQ3	0.71***	0.03	0.62***	0.02	0.72***	0.03
	NFHS-4 *WQ4	0.63***	0.03	0.57***	0.02	0.73***	0.03
	NFHS-4 *WQ5	0.55***	0.03	0.52***	0.02	0.72***	0.04
	Constant	0.81	0.11	0.40***	0.06	0.05***	0.01
	N	240502		245198		237389	

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