Student Paper

Young Lives

An International Study of Childhood Poverty

Childhood Malnutrition and Educational Attainment: An Analysis using Oxford's Young Lives Longitudinal Study in Peru

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Paper submitted in partial fulfillment of the requirements for the MSc in Applied Economics at the University of Minnesota.

The data used come from Young Lives, a longitudinal study of childhood poverty that is tracking the lives of 12,000 children in Ethiopia, India (Andhra Pradesh), Peru and Vietnam over a 15-year period. **www.younglives.org.uk**

Young Lives is core-funded from 2001 to 2017 by UK aid from the Department for International Development (DFID) and co-funded by the Netherlands Ministry of Foreign Affairs from 2010 to 2014.

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Abstract

This study estimates the impact of childhood malnutrition on educational achievement of Peruvian children. While there is growing evidence in the literature that a child's nutrition is important for his or her own educational development, this paper will focus on the nuances of what type of nutritional status, and at what stage of childhood, is most critical for educational achievement. The data used in this study comes from a longitudinal survey in Peru conducted by Oxford University's Young Lives project. This study accounts for the potential endogeneity and measurement error in the child anthropometric measures by using instrumental variables approach.

Introduction

Studies have shown that improving child health in the early years of life can have major impacts on educational achievement and productivity later on in life, but little research has been done on this topic in the Peruvian context. Glewwe and Miguel (2008) outline theoretical and empirical evidence that points to how child health impacts educational attendance and performance. This paper examines the impact of childhood malnutrition, as measured by different anthropometric indicators, collected at three different stages of childhood, on the development of educational skills in Peru. This study will investigate the specifics of which kinds of malnutrition, acute or chronic, and at which ages, have the largest impact on educational achievement. An additional contribution of this research is in assessing the impact of improved water sources, access to sanitation and access to health care to better child health and, consequently, on educational achievement in the Peruvian context. The data used in this study come from a longitudinal survey in Peru conducted by Oxford University's Young Lives project.

Investing in child nutrition can have important consequences for educational attainment and lifelong productivity. Alderman et. al. (2001) find that a child's height for age when he or she is five years old has a strong positive effect, especially for girls, on the probability of being enrolled in school at age seven. Glewwe, Jacoby, and King (2001) find that better nourished children do significantly better in school because they have greater learning productivity and also tend to enter school earlier. Maluccio et. al. (2009), using a longitudinal survey from rural Guatemala, found that higher intake of nutrients during early childhood has a long-term, substantial impact on adult educational outcomes. Additionally, the improvement of child health can translate into large productivity gains later on in life. Behrman et. al. (1988) find a positive effect of improved nutrition on agricultural labor productivity. Thus, improving child health status can have a large impact not only on educational achievement, but also on many areas of productivity later on in life.

In 2008, 28% of Peruvian children under five years old were malnourished, as measured by height for age (World Bank, 2012). This indicates that almost a third of all children in Peru were stunted, or chronically malnourished. Poor sanitation, contaminated water sources and lack of access to medical professionals are a few factors that contribute to poor health among children. In Peru, there are dramatic differences between rural and urban areas in access to improved sanitation facilities and improved water sources; in rural areas only 36% of the population have access to improved sanitation, while 80% of the urban population have such access (World Bank, 2012). Turning to improved water sources, only 64% of the rural population has access, compared to 91% of the urban population (World Bank, 2012). These striking differences in access to sanitation and improved water sources point to the inequalities between people living in urban and rural areas. Both access to sanitation and access to improved water sources have a relationship with child health and nutrition. Where there is poor sanitation and contaminated water, there are higher risks for diarrheal diseases for children, which have negative impacts on their health and nutritional intake and in turn, their educational achievement.

Research Objectives

While there is growing evidence in the literature that a child's nutrition is important for his or her educational development, this paper will focus on the nuances of what type of nutritional status, and at what stage of childhood, is most critical for educational achievement. Specifically, this paper will look at two types of anthropometric measures of child nutritional status to compare the impacts of both at various stages of childhood on educational achievement. The fact that the Peru Young Lives dataset is a longitudinal study allows one to look at these different measures of child health at three distinct stages in their lives: infancy (1 year old), early childhood (5 years old), and school-age (8 years old). By measuring different aspects of child nutrition at different stages of life, this paper will contribute to the existing literature by providing evidence from Peru.

Estimating the impact of child health on educational achievement is not straightforward, as there may be unobserved heterogeneity in parent's decision making that impacts both child health outcomes and educational achievement. This potential endogeneity poses a challenge to estimating the impact of childhood malnutrition on education outcomes. Additionally, anthropometric variables measure a child's underlying nutritional status with a high degree of error. One potential problem with some of the previous studies is that they ignore issues of endogeneity and measurement error, so the effects of child health on education are underestimated. An important contribution of this paper is that I will address the issue of measurement error to more correctly estimate the impact of child health on education more accurately.

Thus, the objective of this study is to answer three research questions:

1. How does child nutrition in the first year of life affect educational assessments when children are school-aged?
2. Which anthropometric measure of malnutrition has the largest impact on educational achievement?
3. At what stage of childhood (infancy, early childhood, or school-aged) does malnutrition most affect educational achievement?

Literature Review

Based on previous literature, a wide range of factors can influence child health and nutrition, ranging from mother's education to a more indirect effect of food prices. Foster (1995) finds that child growth depends on the households' expenditure on food, which is dependent on the household's income and their access to credit. In particular, lack of access to credit can interfere with a household's effort to smooth their consumption, which can interrupt their ability to provide nutritious foods and sufficient medical attention to a child during the first year of life. Using data from rural Bangladesh in 1988, Foster examines how prices and credit markets affect child growth. He finds that household level borrowing and village average borrowing both have predictive power for changes in children's weight among landless households, but not for land-owning households. He also finds that diarrheal disease reduces child weight gains and that food prices have negative impacts on weight. Kandpal (2011) uses data from the Indian Integrated Child Development Services (ICDS) program, which aims to improve child nutrition by providing nutritional supplements and pre- and post-natal services to targeted villages. The author finds significant treatment effects particularly for the most malnourished children, but that targeting does not work uniformly well: it effectively targets poor areas, but fails to target areas with low levels of average education or those with unbalanced sex ratios. Both of these studies show that interventions aiming to improve child health and nutrition are largely effective in poor, landless households, but there are constraints to the improvement of child health. Some of these constraints include income and credit restrictions, high food prices, and the education levels of the parents.

Glewwe, Jacoby and King (2001) look at the impact of early childhood nutrition, as measured by height-for-age, on learning (measured by test scores), delayed entry and grade repetition in the Philippines. The authors use panel data on a sample of 3,000 children, with data collection starting at birth, and continuing every two months for the first two years of life. Additionally, there were follow-up surveys when the children were 8 years and 11 years old. The authors find large effects of early childhood malnutrition on learning, delayed school enrollment and grade repetition. For example, a one standard deviation increase in child height for age is estimated to raise test scores by 0.4 standard deviations, equivalent to about 15 more months of school enrollment.

Wisniewski (2010) estimates the impact of nutrition and health problems on test scores of grade four students in Sri Lanka. The author finds that stunting problems in children have both a direct and indirect impact on tests scores since parents may adjust to small changes in nutrition and health by changing the educational inputs provided to their child. It is important to recognize that child health and nutrition are both impacted by, and impact, family and household decisions and characteristics.

Turning to the impact of water and sanitation on child health, Lavy et. al. (1996) find that both height and weight for age measures are significantly associated with a composite measure of the quality of water and sanitation facilities in rural communities. Additionally, they find that the negative effect of poor sanitation and water has a greater impact on the height of older children; this finding could suggest that older children have had longer exposure to poor water sources and bad sanitation and for this reason there is a greater impact. The authors also find this negative effect of poor sanitation for children in families with uneducated household heads and their partners. This is an important finding because it relates the education of household members with the ability to navigate poor sanitation and water resources. This suggests that improving child health and nutrition in places where there is poor sanitation and water is more difficult for households where the head of household is less educated.

The heads of household and adult members of the household also play an important role in child health and nutrition. Other studies, including the body of work on intra-household allocations, show that when women have power over decisions about how to invest their earned and unearned income, they tend to spend it in ways that improve the health and education of their children (Haddad, 1999; Quisumbing, 2003). Quisumbing et al. (1995) show that women play a critical role in meeting the nutritional needs of their families through food production, economic access to food, and nutritional security. Thomas (1997) finds that increasing women's control over income is associated with larger budget shares spent on human capital, health and education, and suggests that this control also leads to higher nutritional value in food, which consequently, leads to a higher anthropometric status of children in that household. Parents not only play an important role in their children's nutritional status, but for their educational achievement as well. Alderman and King (1998) hypothesize that investments in a child's schooling may be determined in part by parental empathy and that, in general, mothers may be more empathetic towards their children. It is clear that parents, particularly mothers, play an important role in child health, nutrition and educational achievement.

In Peru, enrollment in primary education has increased over the past few years, as has enrollment in secondary education (Cueto et. al., 2011). However, as a whole, enrollment in secondary education is low compared to enrollment in primary school. More recently, the Ministry of Education of Peru has focused its efforts on measuring how much students learn in school in order to get a measure of educational progress that goes beyond the enrollment statistics. The Ministry of Education has been evaluating achievement since 1996 and has found that both math and reading comprehension scores have increased, but are still below the appropriate level (Cueto et. al., 2011). Findings indicate that there are wide gaps between students in private and public schools as well as between those from urban and rural areas, with smaller gaps between genders.

The United Nations reports a notable difference in enrollment rates in Peru between the primary and secondary levels of education. In 2000, net enrollment rates for the primary level were 97.6%, yet only 65.8% for the secondary level (United Nations, 2011). The net enrollment rate is calculated by taking the number of enrolled children in the official school age group for a given level of education and dividing it by the total number of children in the official school age group for that education level. In contrast, the gross enrollment rate is calculated by taking the number of enrolled children of *all* ages for a given level of education and dividing it by the total number of children in the official school age group associated with that level of education. The net enrollment rate percentages for 2000, 2006, and 2009 are shown in Table I and the gross enrollment rates by education level are depicted in the following graph.

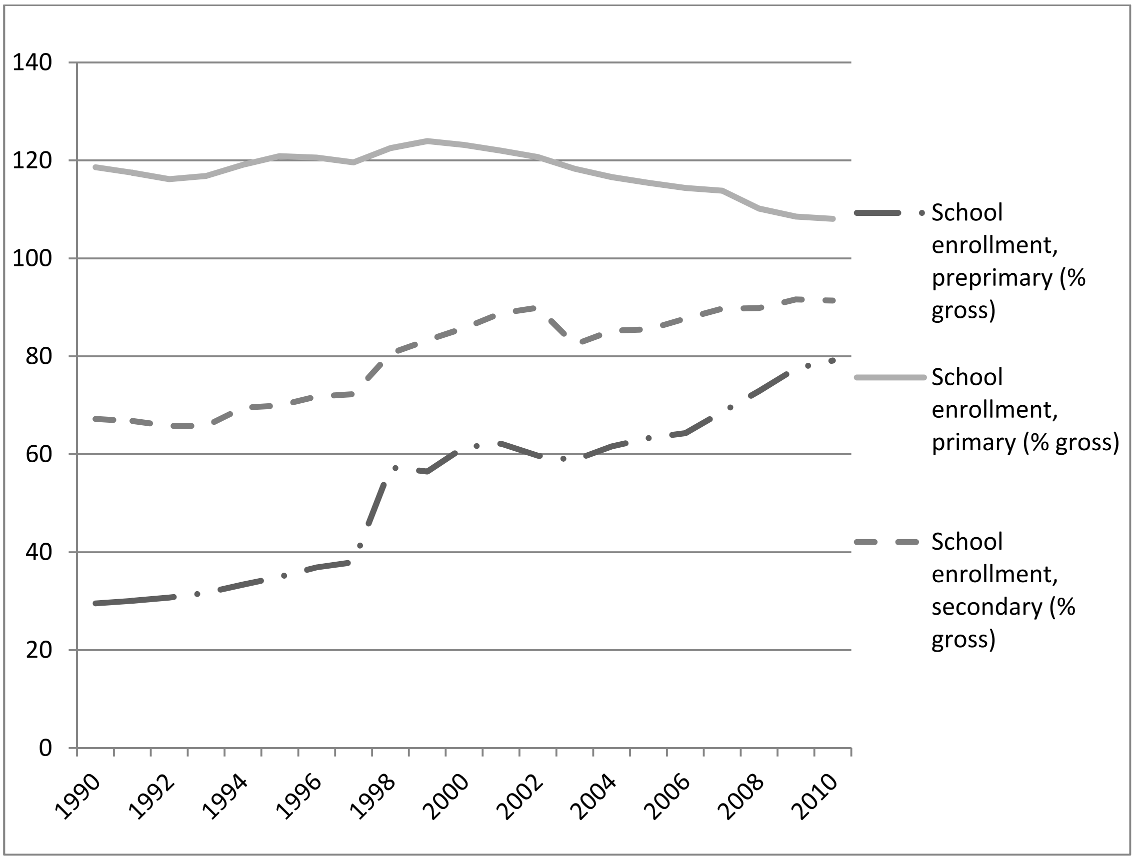
Table I: Peruvian Education Statistics

	2000	2006	2009
Net Enrollment Rate Primary Level Education	97.6	96.9	94.5
Net Enrollment Rate Secondary Level Education	65.8	71.8	78.4
Average number of pupils per teacher at primary level	29	22	20
Average number of pupils per teacher at secondary level	15 (2004)	16	17
Public Expenditure on Education (% of GDP)	2.8 (2004)	2.5	2.6

Source: United Nations, 2011

This table presents national level education statistics to show education trends in Peru. It appears that the net enrollment rates of primary level education have decreased slightly since 2000, while increasing more dramatically at the secondary level. An encouraging finding is that the average number of students per teacher at the primary level has been reduced by 30% since 2000. This suggests an increase in the quality of education because there are fewer students per teacher, allowing teachers to spend more time with each individual student in the classroom. While there are many arguable reasons for why smaller class sizes are better for students, there is evidence in the literature that a reduction in class size has little effect on test scores in (Hanushek et. al., 1999). The number of students per teacher at the secondary level increased slightly during the time the Young Lives Study was conducted in Peru, but this could simply reflect the increased enrollment rates at the secondary level. The percent of gross domestic product that is spent on education in Peru decreased since 2004. Gross enrollment rates (Figure 1) seem to be trending upwards in both pre-primary and secondary education, while reaching the upper bound in primary school enrollment.

Figure 1: Gross Enrollment Rates in Peru (1990-2010)



Source: World Bank, 2012

The education system in Peru has undergone some important changes in the past few decades. Most notably, a new Constitution was enacted in 1993 that broadened compulsory education (UNESCO, 2001). Specifically, both pre-school and secondary school became compulsory and in 1997 an amendment was proposed to progressively extend pre-school education to 3 and 4 year old children (UNESCO, 2001). All three levels of education, pre-school, elementary and secondary are provided free at public schools. In 1999, 41% of 3 year olds, 63% of 4 year olds, 82% of 5 year olds, 97% of 6-11 year olds, and 86% of 12-16 year olds were enrolled in education (UNESCO, 2001). For the elementary school aged children, there is almost universal enrolment in education, an achievement that was made in the decade leading up to 1999. However, there are gender gaps in rural areas, with adult men achieving an average of two more years of education than adult women (UNESCO, 2001). The educational system in Peru has reached some critical milestones in the past few decades and education initiatives have surfaced as a priority on the public agenda.

Turning to child health and nutrition in Peru, there has been little improvement in chronic child malnutrition in the past few decades. In 1992, 33% of children under five years old were chronically malnourished and by the year 2000 this number had only reduced by 3% to 29% (Valdivia, 2004). This small decrease may be partially due to the economic situation in Peru in the past few decades. Looking at the impact of the economic crisis of the late 1980s in Peru on infant mortality, Paxson and Schady (2005) find that the infant mortality rate increased by 2.5% for children born during the crisis. This finding is equivalent to about 17,000 more children mortalities than there would have been in the absence of the economic crisis. It is apparent from this finding and the fact that there has been little change in the percent of chronically malnourished children that those studies, like this one, are important to better understand the dynamics of childhood malnutrition in Peru.

While chronic malnutrition hasn't changed much as a whole, there are some remarkable differences in child malnutrition rates between the richest and poorest populations. Chronic child malnourishment among children in the poorest wealth decile is 15 times that of children in the richest wealth decile (Valdivia, 2004). Additionally, in the decade between 1996 and 2006, the percent of moderately stunted or underweight children under the age of five among households in the lowest wealth quintile did not change (World Bank, 2009). These inequities among wealth distributions demonstrate a need for public programs or policies to target the poorest groups. In 1994, the World Bank supported a project in Peru, the Basic Health and Nutrition Project

(BHNP), with the objective to improve maternal and child health and nutritional status. However, this program only saw moderate impacts on improved child health and nutrition status from this project. Furthermore, according to the World Bank, maternal mortality rates in Peru are almost twice as high as average for Latin America (World Bank, 2009).

Turning to water sources and sanitation, a total of 82% of Peruvians were using an improved drinking water source and 68% an improved sanitation facility in 2008 (United Nations, 2010).[1] In urban areas 91% of the population was using improved drinking water in 2009, but in rural areas only 64% of people were using improved drinking water. With respect to access to sanitation facilities, 80% of urban populations and 36% of rural populations were using improved facilities in 2009. The following table shows these differences in access to improved water and sanitation by rural and urban regions.

Table II: Access to Improved Water Sources and Sanitation Facilities

	2002	2006	2009
Improved Sanitation Facilities (% of population with access)			
Rural	29%	33%	36%
Urban	77%	79%	80%
Improved Water Source (% of population with access)			
Rural	57%	61%	64%
Urban	90%	90%	91%

Source: World Bank, 2012

The World Bank Development Indicators also depict some striking differences between rural and urban areas, as outlined in Table II. In Peru, there appear to be clear differences between rural and urban areas with respect to poverty as well. These differences are highlighted by the striking differences in access to improved water sources and sanitation facilities. The

[1] Improved drinking water sources include piped water into the dwelling or plot, public tap or standpipe, tubewell, protected dug well, protected spring or rainwater collection. Improved sanitation includes use of the following facilities: flush or pour-flush into piped sewer system, septic tank or pit latrine, ventilated improved pit latrine, pit latrine with slab, or composting toilet.

dramatic differences between urban and rural areas point to persistent inequalities with respect to access to services. At the national level, poverty was 54.7% in 2001 and then reduced significantly in 2010, when the poverty rate was 31.3%. Poverty rates in urban areas were at 19.1% and in rural areas they were 54.3% in 2010 (United Nations, 2010).

Methodology & Data

The objective of this study is to look at the impacts of child health and nutrition on educational outcomes. This research uses data from Oxford's Young Lives project, which is a long-term international research project investigating the changing nature of childhood poverty in Ethiopia, India, Peru, and Vietnam. This study will use panel data from Peru that follows the lives of 3,000 children. These children are divided into two cohorts, around 2,000 children in a younger age group and 1,000 children into an older age category. There were three rounds of data collection included in this study, however, the Young Lives Study is on-going in its evaluation of these children that continues through five rounds or until the children in the younger cohort are 14-15 years old. The younger cohort was surveyed when they were around one years old (round 1), five years old (round 2), and eight years old (round 3). Children in the older cohort were eight years old during the first round of data collection and fifteen years old at the time of the third round. Since this study focuses on childhood malnutrition, only children from the younger cohort are included in the analysis. Initially, there were 2,052 children in this cohort from 20 randomly sampled clusters in Peru. The organizers of the Young Lives project in Peru decided to over-sample poor areas of the country, excluding rich areas from the sampling frame (Cueto et. al., 2011). However, Escobal and Flores (2008), compared the Young Lives sample with the Living Standard Measurement Survey 2001 and Demographic and Health Survey (DHS) 2000 and found that the Young Lives sample are similar to the urban and rural averages derived from these surveys, although slightly wealthier than the households in the DHS 2000 group. The final sample sizes of youth included in each round of data collection are outlined in Table III, along with average ages. There were 1, 915 children who were surveyed in all three rounds of data collection in the younger cohort.

Table III: Sample Sizes and Average Ages of Children in Younger Cohort

Younger Cohort	Sample Size	Mean Age	Standard Deviation of Age
Round 1 (2002)	2,052	1.00	0.30
Round 2 (2006)	1,963	5.33	0.39
Round 3 (2009)	1,943	7.91	0.30

Source: Cueto et. al., 2011

Between rounds one and three of data collection, the total attrition rate was 4.4% (Cueto et. al., 2011). Some of the change in sample size between the first and the third rounds of data collection is due to child mortality; there were 20 deaths among the children included in the younger cohort, 17 of which occurred before the age of five. There were a large number of refusals, as depicted in Table IV, which was noted by data collection teams to be likely linked to cooperation problems encountered in one particular municipality[2] (Ames et. al., 2009). Additionally, tracking children is particularly difficult in Peru due to high rates of migration, geographical diversity (ranging from coastal regions to mountain and jungle areas) and long distances across the country (Cueto et. al., 2011).

Table IV: Reasons for Survey Attrition among the Younger Cohort

	From Round 1 to Round 2	From Round 2 to Round 3[3]
Death	17	3
Refused	46	-
Untraceable	26	-
Overall Attrition Rate (excluding deaths)	3.5%	0.9%

[2] This was noted as likely linked to a religious organization's activities occurring at the time of the survey.
[3] The number of participants who refused or were untraceable between Rounds 2 and 3 was missing.

Source: Cueto et. al., 2011

It appears that the children in the younger cohort of the Young Lives study have seen a reduction in absolute poverty at the household level and an improvement of household living standards. The Young Lives project witnessed an improvement in household living standards between the first and second rounds of data collection, as measured by a wealth and asset index (Cueto et. al., 2011). The percent of children living in households below the absolute poverty line decreased, as shown in Table V.

Table V: Percent of Children living in Households below the Absolute Poverty Line

	Round 1[4] (2002)	Round 2 (2006)	Round 3 (2009)
Full Sample	-	60.5%	44%
Rural	-	74.5%	59.4%
Urban	-	52.3%	36.2%

Source: Cueto et. al., 2011

In the Younger Cohort, higher rates of stunting were found among rural children, but both rural and urban populations showed increased rates of stunting in the second round, with an overall increase from 31% to 37%. Some increase is expected, as growth retardation leading to stunting mainly occurs in the first two years of life and some of the children included in the sample were as young as 6 months (Cueto et. al., 2011). There was evidence of 'catch-up' growth during the second and third rounds of data collection and the likelihood of this happening is greater for urban children aged 4 to 5 years old. Current results in the Young Lives Study show that part of the catch-up process is mediated by maternal education and public services such as electricity, safe water, and proper sanitation facilities (Cueto et. al., 2011). Children living in urban areas may have better access to safe drinking water and sanitation facilities. Young Lives

[4] This information was unavailable for Round 1.

used the World Health Organization's standards to measure stunting rates (see World Health Organization 1995).

Household Characteristics

A number of demographic variables are used in this study, ranging from household characteristics to demographic statistics about the child and his or her parents. The children included in the first round of data collection are evenly split with respect to sex, with 50% female and 50% male. The average household size in the first round of data collection was 5.7 people. Approximately 55% are from rural areas and 45% from urban regions. These children are found in all three main regions of Peru, with 35% of children living in the coastal region, 15% of children living in the jungle, and 50% of children living in the mountains. The most common materials used in the dwellings of the younger cohort include adobe/mud walls (43%), galvanized iron roofs (44%), and earth floors (60%). Only 37% of the homes in the sample have cement flooring, however, households in urban areas are seven times more likely to have cement flooring than households in rural areas. For those living in a household with cement flooring, as compared to earth flooring, there is a reduction in diarrhea by 49%, parasitic infestations by 78%, and anemia by 81% (Cattaneo et. al., 2007). In the younger cohort sample, a total of 77% of households have access to sanitation and electricity. The main sources of drinking water include piped water into the house or plot, a tubewell in the home, public tap/standpipe/well, unprotected well/spring/pond/river, and acquiring water from a neighbor or family. The frequencies of each of these sources are presented in Table VI, by rural and urban areas of residence.

Table VI: Main Source of Drinking Water by Area of Residence

	Rural	Urban
Piped into dwelling/yard/plot	599 (68.1%)	984 (83.7%)
Tubewell in dwelling	43 (4.9%)	13 (1.1%)
Public Standpipe/common tap /public well	42 (4.8%)	29 (2.5%)
Unprotected well, spring, pond, river	150 (17.1%)	67 (5.7%)
Obtains water from neighbor or family	45 (5.1%)	76 (6.5%)
Other	1 (0.1%)	6 (0.5%)

There are some noticeable differences between mothers and fathers of children in the sample. Only 12% of the children live in a female-headed household. There is a significant difference in education levels between mothers and fathers in the sample; only 1.4% of fathers have no education at all, while 8.8% of mothers have no education. On the other end of the spectrum, 5.7% of fathers have completed university, but only 3.2% of mothers have completed this same level[5]. Additionally, 72% of fathers and 68% of mothers are fluent in Spanish. Aside from Spanish, other languages commonly used in Peru include Quechua and Aymara. During the first round of data collection, questions were asked about who was present at the child's birth. A total of 48% of the children in the sample had a doctor present at delivery, 65 % had a nurse present, and 57% had a midwife present.[6] One third of all children in the sample had all three medical professionals present at birth, but a quarter did not have either a doctor, nurse or midwife present at birth. There are substantial differences between rural and urban areas; in urban areas 9% of children didn't have any medical professionals present at their birth, but for children living in rural areas 44% didn't have a medical professional present at their birth. The presence of a medical professional at the delivery of the child could be considered a proxy for distance to

[5] See Appendix A1 for the full frequency table of parent's education levels.
[6] See Appendix A3 for a correlation table of medical professionals present at birth.

healthcare. In the dataset, distance to a health facility was collected at the community level and therefore not very informative for the individual level differences in access to healthcare.

Child Anthropometry

There are two measures of child health and nutritional status that are used in this study. Height for age is a measure of stunting, or chronic malnourishment. Chronic malnourishment is caused from long-term inadequate intake of calories, micronutrients, or protein, which can be a result of poverty. Weight for height is a measure of wasting, or current nutritional status. A child who has recently gone through a bout of diarrhea or had inadequate food intake may have lost a substantial amount of weight and appear to be wasted, but still has a height for age that indicates they are not stunted. Acute malnourishment is a short-term period of malnourishment caused by any one of a multitude of factors, including diarrhea, illness, or an income shock that causes the child to intake insufficient calories. Finally, weight for age is a composite measure of these two indicators, chronic and acute nutritional status, since weight for age is the ratio of weight for height and height for age. As a composite measure, it is difficult to disaggregate the impact of childhood malnutrition on educational achievement due to acute malnutrition or chronic malnutrition; for this reason weight for age is not a useful measure for this study. For each of these measures, standardized scores are calculated by the World Health Organization. By comparing the child's measurements to that of a healthy reference population one can assess the degree to which the child is malnourished. Therefore, one can classify children with low measurements, defined as two standard deviations below 'normal', as undernourished or malnourished.

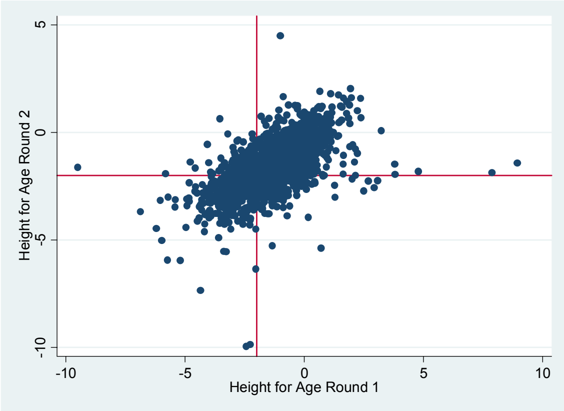
Table VII: Stunting and Wasting by Sex, Area of Residence, and Maternal Education Level

	Stunting (Height-for-Age) Round 3	Wasting (Weight-for-Height) Round 3
Boys	23.4%	5.8%
Girls	20.5%	5.6%
Rural	37.3%	9.2%
Urban	14.2%	3.9%
Maternal Education Level: Incomplete Primary or less	35.7%	8.8%
Maternal Education Level: Complete Primary or more	17.6%	4.9%

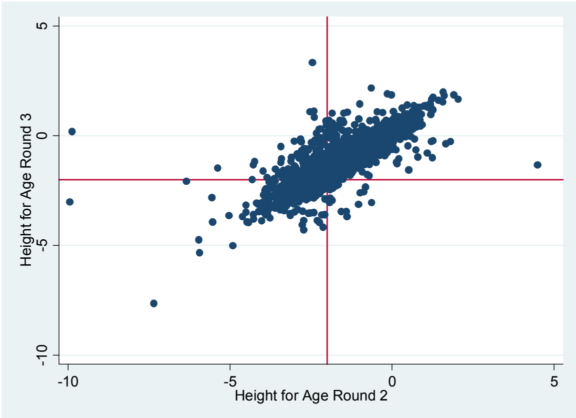
Source: Cueto et. al., 2011

There appears to be movement across groups of health status among children over the three rounds of data collection. Of those who were stunted in the first round (a Z-score of less than -2 standard deviations), 64% were still stunted in the second round and 49% in the third round. Of those who were severely stunted in the first round (a Z-score of less than -3 standard deviations), 41% were still severely stunted in the second round and 26% in the third round. While there are some cases where children were stunted in all three rounds of data collection, it appears that there were more instances of nutritional improvement among those in the lower tails of the distribution of stunting. Figure 2 shows the relationships among stunting measures over the different rounds of data collection.

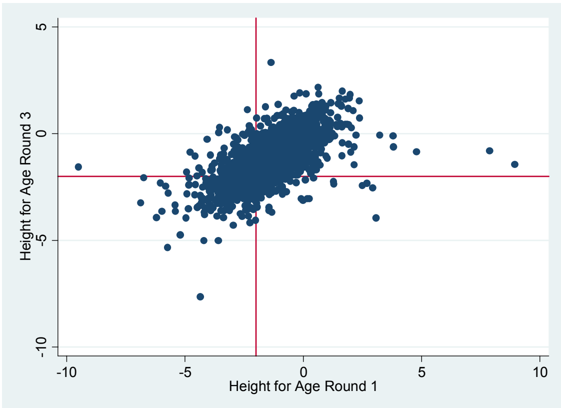
Figure 2: Scatter Plots of Height for Age Z-Scores



(a) Round 1 and Round 2 Z-Scores



(b) Round 2 and Round 3 Z-Scores



(c) Round 1 and Round 3 Z-Scores

The scatter plots in Figure 2 show the relationship between the height for age Z-scores over the various rounds of data collection. There are lines marking -2 standard deviations below normal, indicating the point below which children are severely malnourished. These diagrams demonstrating the relationship of height for age over the different time periods show that the height for age variables are very noisy and supports the hypothesis that there is a great deal of measurement error in these variables. As will be explained in the estimation strategy section, the measurement error and noise in these variables will be accounted for by the use of instrumental variables.

Educational Assessments

A series of educational assessments were conducted during the third round of data collection that measure a variety of skills and abilities. The Peabody Picture Vocabulary Test (PPVT) and Early Grade Reading Assessment (EGRA) were adapted locally and administered in Peru. The Peabody Picture Vocabulary Test was launched in 1959 to assess an individual's verbal intelligence, and if administered to a school-aged child, it can estimate the child's scholastic aptitude. The raw scores of the PPVT ranged from 0-204 and the exam was administered in local languages spoken by the child and by the field worker who administered the exam. The frequencies of the languages used during the PPVT, EGRA and Math exams are described in Table VIII.

Table VIII: Language Spoken by the Child during Exam Administration

	PPVT		EGRA		Math	
Spanish	1,751	(92.7%)	1,743	(93.3%)	1,777	(94.7%)
Quechua	59	(3.1%)	53	(2.9%)	43	(2.3%)
Other	79	(4.2%)	73	(3.9%)	57	(3.0%)

The EGRA assessment had three components; one measures familiar word identification, another consists of reading a passage aloud, and the third component includes a listening comprehension exercise. For the familiar word identification, the child has 60 seconds to read the word on a card, but self-corrections are counted as correct. In the section where the child reads a passage, they have 60 seconds to read as many words as possible. Then, the child re-reads the passage and answers questions to measure their reading comprehension. Finally, the listening comprehension section is an untimed exercise where the fieldworker reads aloud a passage twice, very slowly, and then asks questions. Additionally there were other reading and writing measurements that were administered with literacy cards; however, these measures had very few response options. The response options for the reading items were 1-4 (can't read anything, reads letters, reads words, reads sentences) and 1-3 on the writing items (No, Yes with difficulty or errors, and Yes without difficulty or errors). These additional reading and writing items were excluded from this analysis because of the lack of variance in the responses; only the PPVT and EGRA were included in this study as measures of language, reading, writing, and listening comprehension.

Finally, there was a Mathematics Achievements test that each child completed. The test included number recognition, where the child had to place their finger over the correct number. There were also questions that required some simple computation problems, such as addition, subtraction and multiplication. Lastly, there was a math computation booklet where the child had eight minutes to work on the problems in the booklet, with the enumerator marking how far they had completed at the fourth minute. Descriptive statistics, including the range, mean and standard deviation (in parenthesis) of scores from the PPVT, EGRA, and Math Achievement Exams are presented in Table IX.

Table IX: Educational Achievement Scores by Rural and Urban

	PPVT (range 1-125)	EGRA (range 0-14)	Math (range 0-29)
Whole Sample	58.9 (17.6)	8.0 (3.4)	14.2 (5.8)
Boys	59.8 (17.5)	8.1 (3.31)	14.6 (5.7)
Girls	58.1 (17.8)	8.0 (3.5)	13.8 (5.8)
Rural	49.3 (17.5)	6.6 (3.5)	11.9 (5.6)
Urban	66.9 (13.2)	9.2 (2.8)	16.1 (5.3)

The scores described in Table IX are the education achievement exam scores before they were normalized. Before using these three measures in the regression analysis I re-calculated them as normalized scores so that they each have a mean of zero and a standard deviation of one. This ensures that the scores are comparable with those in other studies. The table above reveals that boys scored slightly higher than girls on all three of the exams and that in urban areas children scored much higher than children in rural areas.

Estimation Strategy

This study looks at the impact of child anthropometric measures on educational assessments using data from Oxford's Young Lives longitudinal study in Peru. The participants in this study were surveyed at three points in their lives, each corresponding to a round of survey collection. There are three education assessments that were conducted in Round 3 and used in this study: Early Grade Reading Assessment (EGRA), Peabody Picture Vocabulary Test (PPVT), and a Math Achievement Exam. Additionally, the Peabody Picture Vocabulary Test was conducted during the second round, when the children were five years old. Two different anthropometric Z-scores are used to measure child health and nutrition: height for age and weight for height. The dependent variables included in this study are the educational assessments. The explanatory variables include sex, age, anthropometric measures, Spanish language fluency of both the child's mother and father, a dummy variable indicated a female headed household, education levels of both mother and father, a wealth index, and dummy variables to indicate whether they live in the jungle or the mountains and have access to electricity. The coefficient of interest is that on the anthropometric variable, measuring childhood malnutrition. The relationships that will be estimated are shown in the following equation:

$$Edu_{child} = \beta + \beta_1 \boldsymbol{X}_{child} + \beta_2 \boldsymbol{X}_{hh} + \beta_3 Health + \epsilon$$

The variable *Edu* represents the educational assessment measure, the PPVT, EGRA or the Math Achievement Exam. The vector $\boldsymbol{X}_{child}$ includes child-specific variables, such as the child's age and sex. The vector $\boldsymbol{X}_{hh}$ includes household-specific variables, such as access to electricity and a household wealth index. The variable $Health$ represents the different anthropometric variables measuring child health and nutrition. The error term, ϵ, contains unobservable variables that have a causal effect on educational achievement.

One might suspect that there are unobserved community level variables that will impact educational achievement and are correlated with childhood nutritional status and other explanatory variables. For example, the distribution of health infrastructure and access to the educational system are at the community level. There may be better health infrastructure in wealthier communities and poorer health facilities in poorer communities. Omitted variable bias could be present due to parental preferences for the child's general wellbeing, where parents may have certain immeasurable tastes for both their child's educational achievement and nutritional status. There may be community-level differences with respect to the omitted variables that would bias the estimation because they are unobserved community characteristics. Using community fixed effects to estimate the model allows one to consistently estimate the impact of the observed explanatory variables. The first step in solidifying the use of this estimation strategy was to compare estimates from ordinary least squares (OLS) with community fixed effects (CFE) to see if it is necessary to use community fixed effects in the regression model.[7] The Hausman test of the differences between OLS and community fixed effects gives a χ^2 of 470.92, with a p-value of 0.000 for the case of the regression including height-for-age from round 1 on PPVT scores. Given these results, one can reject the null hypothesis that the differences in the coefficients from the two estimation methods are statistically insignificant. Therefore, community fixed effects will be used in this study. The estimation equation now becomes, where $comm$ represents community:

$$Edu_{child} = \beta + \beta_1 \boldsymbol{X}_{child} + \beta_2 \boldsymbol{X}_{hh} + \alpha X_{comm} + \beta_3 Health_{child} + \epsilon_{child}$$

In order to answer the research questions posed by this study, various anthropometric variables from the different rounds of data collection, as well as various educational assessments, will be used in the regression analyses. The coefficients of interest are those on the anthropometric variables (β_3), which could be either height for age or weight for height. The error term in the equation, ϵ, contains unobservable variables that impact educational achievement. It could be that this term is correlated with child health and nutrition. For example, parents may have certain preferences for their children's lives and well-being that impact both how well they do in school and their nutritional status. Therefore, the anthropometric measures

[7] The regression results can be found in Appendix A8.

may be endogenous, (i.e. $E(\epsilon|X, Health) \neq 0$) where $\boldsymbol{X}$ is a vector of the demographic variables, which would bias the estimation. Failure to account for this possible endogeneity would lead to an overestimation of the impact of child health on educational achievement. Due to this endogeneity, instrumental variables will be used to more correctly estimate the relationship between child health and education.

Another reason for using instrumental variables approach is to correct for measurement error in the anthropometric variables. Anthropometric variables, such as height for age, measure the underlying nutritional status of a child with substantial error; ignoring this measurement error can lead to underestimation of the effects of child health on educational achievement. Measurement error increases the error variance and is likely to bias the parameters estimated using ordinary least squares towards zero. This would lead to underestimation of the impact of child health on educational achievement and highlights the need to account for measurement error in the estimation strategy.

Using instrumental variables (IV) will address bias due to both endogeneity and measurement error of the anthropometric variables, leading to consistent estimates of the impact of child health on educational outcomes. Therefore, this study will use instrumental variable (IV) methods, which requires finding instruments for the measures of child health and nutrition. The two stage equations for this model now become:

$$Health_{child} = \gamma + \gamma_1 \boldsymbol{X}_{child} + \gamma_2 \boldsymbol{X}_{hh} + \alpha X_{comm} + \delta \boldsymbol{Z}_{child} + \mu_{child}$$

$$Edu_{child} = \beta + \beta_1 \boldsymbol{X}_{child} + \beta_2 \boldsymbol{X}_{hh} + \alpha X_{comm} + \beta_3 \widehat{Health}_{child} + \epsilon_{child}$$

To use instrumental variables, the instrument (Z) must satisfy two fundamental conditions (1) the exclusion restriction, $Cov(Z,\epsilon) = 0$ and (2) relevance, $Cov(Z, Health) \neq 0$. This first condition states that the instrument must be exogenous with respect to the error term in the equation of interest. Informally, this means that the variable being used as an instrument can be excluded because it does not have predictive power for educational achievement, the dependent variable. The second condition says that the instrument must be correlated with child health. In order to have valid instruments, both of these conditions must be satisfied.

In this study, several instrumental variables will be tested and used. Initially, access to sanitation and piped water were tested as instruments for the child health measures. Intuitively, these two indicators would make good instruments because one would not expect them to have predictive power for educational achievement, but they do affect childhood malnutrition. Access to both improved sanitation facilities and piped water reduce a child's exposure to bacteria and to diseases that impair nutritional status. However, there are some major differences in access to sanitation and piped water between rural and urban areas. For this reason, three main regressions are presented: the entire sample, rural areas only, and urban areas only. As will be seen below, these three combinations of data (the full sample, rural areas, and urban areas) require different instrumental variables.

In the search for valid instruments for each of these subsets several variables were tested as possible instruments. These included having cement flooring - households who have floors made out of concrete are better able to keep the house clean than households with earth flooring. It is plausible that cement flooring would not have predictive power for educational achievement, but does affect childhood malnutrition. Another possible instrument is distance to health facility, however, in the Young Lives data for Peru this information was only available as 'distance to health facility from the center of the community'. Since the regression analysis uses community fixed effects this variable would drop out by construction, so the next step was to interact distance to health facility with an individual wealth index. However, the data on distance to health facility was only available for a small percentage of the sample, which made the instrument more of a limiting factor. In search for a proxy of distance to healthcare, the variables from the first round of data collection about a doctor, nurse or midwife present at the child's birth were tested as possible instruments. The presence of a doctor, nurse or midwife at the child's birth would indicate access to healthcare and proxy for distance to a health facility since the household would have to live within a reasonable distance to be able to make it to a health clinic during childbirth. Additionally, the presence of a medical professional at birth may not predict educational achievement of the child later on in life, unless it was correlated with parental preferences related to the child's wellbeing. Access to sanitation, piped water, cement flooring, presence of doctor at birth, presence of nurse at birth, and presence of a midwife at birth are all possible instruments.[8] However, since community fixed effects are used there could still be endogeneity issues with respect to parent's decision making given the availability of resources at the community level.

The possible instrumental variables for child health in the dataset will need to be tested for their validity as instruments. To test that the possible instruments satisfy the relevancy condition, or that the instrument is correlated with child health, I tested that the combination of instruments have explanatory power on the child nutrition variables. I tested the null hypothesis that the coefficients on the instruments are jointly equal to zero; the results of these tests are shown in Tables X and XI.

[8] The variables used as instruments were excluded from the wealth index.

Table X: Testing that Instruments have Explanatory Power on Round 1 Child Health

	Weight for Height Z-Score (Round 1)			Height for Age Z-Score (Round 1)		
		F-Statistic	Prob>F		F-Statistic	Prob>F
Full Sample *Access to Sanitation, Piped Water, Doctor at Birth, Nurse at Birth*	F(4, 2034)	10.02	0.0000	F(4, 2035)	39.72	0.000
Rural *Access to Sanitation, Cement Floor, Doctor at Birth*	F(3,868)	2.38	0.0685	F(3, 868)	8.22	0.0000
Urban *Piped Water, Doctor at Birth, Access to Sanitation*	F(3, 1074)	10.40	0.0000	F(3, 1076)	6.18	0.0004

For the first round child health variables, it appears that the instruments have strong explanatory power in all but a few of the cases. Weight for height and height for age in the first round in rural areas subset and height for age in round one in urban areas are relatively weak. Having weak instruments will impact the performance of the instrumental variables estimation and are a limitation of this study because they affect the statistical significance of the coefficients. Overall, the instruments demonstrate greater explanatory power for the height for age measure of stunting in the third round of data collection, as depicted in Table XI.

Table XI: Testing that Instruments have Explanatory Power on Round 3 Child Health

Height for Age Z-Score (Round 3)			
		F-Statistic	Prob>F
Full Dataset			
Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth	F(6, 1930)	73.73	0.0000
Rural			
Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth	F(6, 852)	13.99	0.0000
Urban			
Piped Water, Access to Sanitation, Doctor at Birth, Nurse at Birth	F(4, 1046)	11.97	0.0000

As a whole, the results of these tests tell us that the instruments have strong explanatory power in all but a few cases. Ideally, the F-statistic would be greater than ten, however, Bound et. al. (1995) show that when the F-statistic is greater than one, it is better to use instrumental variables than ordinary least squares. Thus, a limitation of this study is that the instruments used in the models are relatively weak in a few of the cases, but have F-statistics sufficiently large enough to justify the use of instrumental variables over ordinary least squares. In future studies of the Young Lives Peruvian dataset, more time should be allocated to identifying stronger instruments. For this study, there are several of main regressions – one using the two anthropometric measures from the first round of data collection, one using only height-for-age in the third round, and another using height for age in the first and third round.[9] The instruments tested for explanatory power in Tables X and XI are the ones used in estimation for the first and third round child health measures, respectively.

[9] Weight for height was not available during the third round.

Overidentification tests check to see if there are more instruments than needed to identify the parameters of interest, in this case child health, to test the validity of the instruments. Estimates from instrumental variables are consistent only if the vector of instruments satisfies that $E[\boldsymbol{Z}\epsilon] = 0$. The null hypothesis is that the overidentification restrictions are satisfied, or that $E[\boldsymbol{Z}\epsilon] = 0$ and the assumption of homoscedasticity. This tests that the instruments are not correlated with the error term in the second stage equation. The results from the overidentification tests are shown in Table XII.[10]

Table XII: Overidentification Test Results

	Weight for Height (Round 1) & Height for Age (Round 1)			Height for Age (Round 3)			Height for Age (Round 1) & Height for Age (Round 3)		
	Degrees of Freedom	χ^2	p-value	Degrees of Freedom	χ^2	p-value	Degrees of Freedom	χ^2	p-value
PPVT Z-Scores									
Full	2	0.88	0.975	5	1.01	0.975	4	0.53	0.975
Rural	1	0.27	0.90	5	2.10	0.90	4	0.61	0.975
Urban	1	0.58	0.90	3	7.18	0.10	2	1.54	0.90
EGRA Z-Scores									
Full	2	0.48	0.975	5	2.81	0.90	4	0.49	0.975
Rural	1	1.29	0.90	5	8.76	0.20	4	7.07	0.20
Urban	1	1.44	0.90	3	6.51	0.10	2	6.28	0.05
Math Z-Scores									
Full	2	1.32	0.90	5	3.49	0.90	4	2.80	0.90
Rural	1	1.65	0.20	5	5.39	0.90	4	2.84	0.90
Urban	1	1.78	0.20	3	4.09	0.90	2	3.18	0.90

In general, results from the overidentification test that have p-values of less than 0.05 indicate that the instrument is correlated with the error term in the second stage equation of instrumental variables. The results from the overidentification tests are shown in Table XII and

[10] Before calculating the χ^2 statistic for the overidentification test, the community fixed effect equivalent for each variable was calculated and used in the test.

the low χ^2 with high p-values suggests that at least one of the instruments is valid. Additionally, none of the p-values are less than 0.05, a finding which supports the validity of the instruments used in this study. The next section will present the results of this research and will include a comparison of both community fixed effects and instrumental variables approaches.

Results

There are several important results of this paper corresponding to the different objectives of the research. The first set of results compare the anthropometric measures, height for age (HAZ) and weight for height (WHZ), over the different time periods. This analysis, using community fixed effects, identifies the time period in which that measure of child health has the largest effect on each of the three educational assessments. The second section of the results, also using community fixed effects, test the various measures of health during the first two rounds on the Peabody Picture Vocabulary Test results that were collected during the second round. Of the three educational assessments, only the PPVT was appropriate for five year olds and thus conducted during the second round. The subsequent result sections compare estimates from community fixed effects and instrumental variables approaches, dividing the results by the full sample, rural areas, and urban areas for each educational assessment. The third section uses anthropometric measures from the first round of data collection, the fourth uses height for age in the third round only. Finally, the fifth section uses height from age from both the first and third rounds to test when during childhood stunting most impacts educational achievement. This analysis is then split in section six by those children that were twelve months and younger during the first round and those that were older than twelve months during the first round.

I. Comparisons of Anthropometric Measures across Time Periods

The first set of results examines the extent to which height for age and weight for height in the different rounds of data collection affect educational assessments. The findings from the community fixed effects analysis corresponding to the height for age measures are presented in Table XIII[11]. The following table, Table XIV, shows the results of the community fixed effects analysis corresponding to the weight for height measures in the first two rounds of data collection[12]. The purpose of this analysis is to compare the different anthropometric variables over time periods to determine which one has the largest impact on educational achievement.

The findings suggest that height for age is significant at the 1% level during all three rounds of data collection. As a measure of stunting, height for age measures chronic malnourishment and intuitively this type of malnutrition would impact a child's cognitive development. Comparing the size of the coefficients on the height for age measure, it appears that height for age in the third round of data collection has the largest impact on educational assessments. This was true for all three measures of educational achievement, the PPVT, EGRA, and Math Achievement Exam. Since height for age is a measure of chronic malnourishment, the older the child, the more that stunting impacts their educational achievement.

Turning to the results from the community fixed effects regressions comparing weight for height across the first two rounds of data collection, the results are less revealing. It appears that weight for height, a measure of wasting, only has a significant impact during the first round of data collection, when the child is between 6 and 18 months old. The impact of weight for height during the first round is significant at the 5% level on Math Achievement Exam scores. Additionally, the impact of weight for height during the first round on EGRA scores is significant

[11] The full table of regression results can be found in Appendix A9.
[12] The full table of regression results can be found in Appendix A10.

at the 10% level. The weight for height scores were not significant in the regressions on PPVT scores. One possible explanation for this is that the PPVT is a picture vocabulary test and may require less cognitive ability than the Early Grade Reading Assessment or the Math Exam. A child who experienced acute malnutrition as a young child, for example from diarrheal diseases, may have been able to catch-up in most, but not all, cognitive skill acquisitions.

Table XIII: Comparing Height-for-Age across Three Rounds of Data Collection using Community Fixed Effects (CFE)

	PPVT Z-Scores			EGRA Z-Scores			Math Z-Scores		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Height-for-Age Z-Scores (Round 1)	0.094*** (0.016)			0.090*** (0.018)			0.099*** (0.017)		
Height-for-Age Z-Scores (Round 2)		0.117*** (0.019)			0.110*** (0.022)			0.109*** (0.02)	
Height-for-Age Z-Scores (Round 3)			0.131*** (0.02)			0.114*** (0.024)			0.138*** (0.022)
Observations	1,805	1,807	1,811	1,707	1,708	1,713	1,846	1,848	1,852
Number of communities	82	82	82	82	82	82	82	82	82

* significant at 10%; ** significant at 5%; *** significant at 1%

Table XIV: Comparing Weight-for-Height across Two Rounds of Data Collection using CFE

	PPVT Z-Scores		EGRA Z-Scores		Math Z-Scores	
	(1)	(2)	(1)	(2)	(1)	(2)
Weight-for-Height Z-Scores (Round 1)	0.014 (0.015)		0.033* (0.017)		0.039** (0.016)	
Weight-for-Height Z-Scores (Round 2)		-0.017 (0.044)		0.004 (0.055)		-0.051 (0.044)
Observations	1,804	501	1,706	440	1,845	516
Number of communities	82	72	82	73	82	74

* significant at 10%; ** significant at 5%; *** significant at 1%

The results from these regression analyses suggest that weight-for-height in the first year of life and height for age at the age of eight (during the third round) of childhood are the most important for educational achievement at eight years old. These two measures of childhood malnutrition will be used in the succeeding regressions. Since the PPVT assessment was conducted during the second round in addition to during the third round, one can check to see if similar results are found for children who are five years old.

II. Impact of Child Health on PPVT Scores from Round 2

Then next set of analysis compares the impact of height for age and weight for height on the Peabody Picture Vocabulary Test conducted during the second round. These results reflect community fixed effects estimates and include anthropometric measures for the child during the first and second round, when they participated in the PPVT. The purpose of this analysis is to compare the findings from the first section, which analyzed different anthropometric measures on educational achievement scores from the third round, with the educational achievement scores from the second round. The results from this regression can be found in Table XV.[13]

[13] The full table of regression results can be found in Appendix 14.

Table XV: Comparing Impact of HAZ & WHZ across Time on Round 2 PPVT Scores

	PPVT Z-Scores (Round 2)			
	(1)	(2)	(3)	(4)
Height-for-Age Z-Scores (Round 1)	0.062***			
	(0.014)			
Weight-for-Height Z-Scores (Round 1)		0.011		
		(0.013)		
Height-for-Age Z-Scores (Round 2)			0.110***	
			(0.017)	
Weight-for-Height Z-Scores (Round 2)				0.025
				(0.032)
Observations	1,845	1,844	1,853	502
Number of communities	81	81	81	74
R-Squared	0.196	0.188	0.209	0.181

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

The results of the community fixed effects analysis of the impact of the first two rounds of anthropometric measures on Round 2 PPVT standardized scores are inconclusive. While the estimated coefficients for height for age from both rounds one and two are significant at the 1% level, neither of the weight for height estimates are significant. The results are consistent with the previous finding that suggests that height for age at the time of exam administration has the largest impact on educational achievement. This is an intuitive finding because stunting is a measure of the child's accumulated nutritional status and at the time of the exam has had the most amount of time to accumulate.

III. Comparing Estimates from CFE and IV using WHZ Round 1 and HAZ Round 1

The next series of results present the findings after instrumental variables were included, comparing these findings with community fixed effects. Instrumental variables are used to correct for any endogeneity issues with respect to child health and to account for measurement error in the anthropometric measures. This section of analysis seeks to address which anthropometric measure of malnutrition during the first round only has the largest impact on educational achievement and whether child malnutrition affects cognitive skill sets differently. Table XVI shows the results for PPVT scores, Table XVII depict results for the Early Grade Reading Assessment, and Table XVIII the results for the Math Achievement Exam.[14] Within each table, there are estimation results using the full sample, for urban areas only, and for rural areas only.

Focusing on PPVT scores, Table XVI compares OLS and instrumental variables using community fixed effects.[15] From the community fixed effects estimates, weight for height in the first round is significant at the 10% level using the full sample and at the 1% level in rural areas. However, weight for height is no longer significant when instrumental variables are added, and while the coefficient size is greater in absolute value in some cases, it actually becomes negative. This finding is not statistically significant and is likely the result of weak instruments. In all three community fixed effects models, height for age during the first round is significant at the 1% level. Using instrumental variables approach, height for age is significant at the 10% level for the full sample, urban areas and rural areas. The size of the coefficients on height for age is roughly ten times larger using instrumental variables than with the ordinary least squares. This finding reinforces the hypothesis that ordinary least squares underestimates the impact of child health on educational achievement in the face of measurement error.

[14] The first stage regression equations are located in Appendices A11, A12, and A13.
[15] The full table of regression results can be found in Appendix 15.

Table XVI: Comparison of CFE and IV for PPVT Scores using WHZ & HAZ Round 1

PPVT	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Weight for Height Z-Scores	0.026*	-0.119	0.009	0.005	0.065***	0.193
(Round 1)	(0.015)	(0.702)	(0.019)	(0.350)	(0.024)	(0.583)
Height for Age Z-Scores	0.101***	1.170*	0.077***	0.684*	0.113***	1.468*
(Round 1)	(0.016)	(0.619)	(0.020)	(0.404)	(0.028)	(0.816)
Observations	1,804	1,804	990	990	814	814
Number of communities	82	82	50	50	77	77
R-squared	0.155		0.125		0.191	
Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%						

Turning to the Early Grade Reading Assessment, Table XVII compares community fixed effects and instrumental variables for the full sample, urban areas, and rural areas.[16] Both weight for height and height for age in the first round is significant at the 1% level for all three subsets using the community fixed effects estimation. Using instrumental variables approach, none of the coefficients on the child health variables are significant. While the size of the coefficient increased substantially, the large increase in the standard errors suggests that there are weak instruments and led to statistical insignificance. Comparing weight for height and height for age, the size of the coefficients on height for age are much larger than the coefficients on weight for height.

[16] The full table of regression results can be found in Appendix 16.

Table XVII: Comparison of CFE and IV for EGRA using WHZ & HAZ Round 1

EGRA	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Weight for Height Z-Scores (Round 1)	0.045***	-0.691	0.008	0.041	0.097***	0.021
	(0.017)	(1.120)	(0.022)	(0.273)	(0.028)	(0.475)
Height for Age Z-Scores (Round 1)	0.100***	0.965	0.065***	0.265	0.141***	0.996
	(0.019)	(0.949)	(0.023)	(0.349)	(0.033)	(0.847)
Observations	1,706	1,706	1,008	1,008	698	698
Number of communities	82	82	49	49	77	77
R-squared	0.108		0.085		0.141	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Focusing on the Math Achievement Exam scores, Table XVIII compares community fixed effects and instrumental variables.[17] Weight for height in the first round is significant at the 1% level in both the full sample and for rural areas. Similar to the previous results, height for age during the first round is significant at the 1% level for all three subsets of the data. Using instrumental variables approach, neither weight for height nor height for age are significant in any of the regressions. Again, these results could be the consequence of poor instruments.

[17] The full table of regression results can be found in Appendix 17.

Table XVIII: Comparison of CFE and IV for Math Scores using WHZ & HAZ Round 1

Math	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Weight for Height Z-Scores		-0.351	0.030	0.507		-0.176
(Round 1)	0.052***				0.080***	
	(0.016)	(0.750)	(0.022)	(0.352)	(0.024)	(0.362)
Height for Age Z-Scores		1.057		0.534		0.612
(Round 1)	0.110***		0.086***		0.123***	
	(0.017)	(0.669)	(0.023)	(0.440)	(0.027)	(0.580)
Observations	1,845	1,845	1,009	1,009	836	836
Number of communities	82	82	50	50	77	77
R-squared	0.176		0.170		0.180	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Tables XVI, XVII, and XVIII compared results from community fixed effects and instrumental variables over the full sample, urban areas, and rural areas. Using community fixed effects, height for age was significant at the 1% level for all of the educational achievement indicators, the PPVT, EGRA and Math Achievement scores. However, there were mixed findings using instrumental variables approach and the results were even more inconclusive when focusing on the weight for height measure of childhood malnutrition. A conclusion from the findings in this section is that weight for height Z-scores are not working well, even after correcting with the use of instruments. For this reason, weight for height is not included in the subsequent analysis.

IV. Comparing Estimates from CFE and IV using HAZ Round 3

The next set of analysis concentrates on the impact of height for age, or stunting, during the third round of data collection on educational achievement and whether this impacts the various measures of cognitive ability differently. The results for the PPVT, EGRA, and Math

Achievement scores are presented in Tables XIX, XX, and XXI respectively. This analysis looks at how chronic malnourishment in school-age children impacts their educational achievement.

The results in table XIX show the differences between community fixed effects and instrumental variables methods in estimating the impact of stunting on PPVT scores.[18] Height for age in the third round is significant at the 1% level in both the CFE and IV estimates for the full sample and rural areas, but only for the community fixed effects model in urban areas. For the full sample and rural areas, both CFE and IV have the same level of significance. The results suggest that IV methods give a more correct estimate of the impact of child health on educational achievement. The size of the coefficients using IV methods are between three and six times larger than those using CFE, indicating a significant underestimation when using ordinary least squares.

Table XIX: Comparison of CFE and IV for PPVT using Round 3 HAZ

PPVT	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Height for Age	0.151***	0.870***	0.150***	0.464	0.124***	0.885***
Z-Scores (Round 3)	(0.020)	(0.190)	(0.024)	(0.292)	(0.036)	(0.227)
Observations	1,811	1,811	995	995	816	816
Number of communities	82	82	51	51	77	77
R-squared	0.163		0.145		0.182	
Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%						

Turning to the results from the Early Grade Reading Assessment, the findings are outlined in Table XX[19]. The results show that height for age in round three is significant at the 1% level in the full sample, urban areas and rural areas using community fixed effects. Using instrumental variables, the coefficient on height for age is significant at the 1% level using the

[18] The full table of regression results can be found in Appendix 18.
[19] The full table of regression results can be found in Appendix 19.

full sample, at the 10% level in urban areas, and not significant in rural areas. In the full sample, the magnitude of the estimate on height for age is almost four times as large as the coefficient estimated by community fixed effects.

Table XX: Comparison of CFE and IV for EGRA using Round 3 HAZ

EGRA	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Height for Age Z-Scores (Round 3)	0.133***	0.467***	0.100***	0.574*	0.182***	0.127
	(0.024)	(0.175)	(0.029)	(0.341)	(0.042)	(0.191)
Observations	1,713	1,713	1,013	1,013	700	700
Number of communities	82	82	50	50	77	77
R-squared	0.108		0.088		0.134	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Finally, the findings from the analysis on Math Achievement scores are outlined in Table XXI[20]. Similar to the results for the PPVT and EGRA, the coefficient on height for age is significant at the 1% level using all three subsets - the full sample, urban areas and rural areas. The estimates from instrumental variables are significant across all subsets as well, but to varying degrees of significance. Using the full sample, the IV estimate on height for age is significant at the 1% level. With the urban areas only, the coefficient on height for age estimated by IV is significant at the 5% level and in rural areas only, at the 10% level. There are dramatic differences in the size of coefficients between those estimated by community fixed effects and those by instrumental variables, with the IV estimates significantly larger.

[20] The full table of regression results can be found in Appendix 20.

Table XXI: Comparison of CFE and IV for Math Scores using Round 3 HAZ

Math	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Height for Age Z-Scores (Round 3)	0.159***	0.669***	0.145***	0.964**	0.158***	0.312*
	(0.022)	(0.178)	(0.029)	(0.406)	(0.035)	(0.178)
Observations	1,852	1,852	1,014	1,014	838	838
Number of communities	82	82	51	51	77	77
R-squared	0.179		0.179		0.173	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

This section analyzed how chronic malnourishment in school-age children impacts their educational achievement. The results show that height for age is positively related to PPVT, EGRA and Math Achievement scores. The findings from this section also support the conclusion that without correcting for endogeneity and measurement error using instrumental variables, the estimates of the impact of stunting on educational achievement will be incorrect. The estimates using instrumental variables are several times larger than the estimates from community fixed effects, indicating that measurement error must have a stronger effect than endogeneity.

V. Comparing Estimates from CFE and IV using HAZ Round 1 & 3, by Region

This section compares the estimates of community fixed effects and instrumental variables using height for age in both rounds one and three. Tables XXII, XXIII, and XXIV show the results from the analysis on PPVT, EGRA, and Math Achievement scores respectively. Each table shows estimates from the full sample, urban areas, and rural areas. The purpose of this analysis is to determine which stage of childhood, during the first year of life or school-age, malnutrition has the largest impact on educational achievement.

The findings on PPVT scores using both height for age in round one and in round three are presented in Table XXII.[21] The results show that using the full sample, the fixed effects estimates are significant at the 1% level. However, in urban areas, only height for age in round three is significant. In rural areas, height for age in round one is significant at the 5% level and in round three at the 10% level. None of the estimates using instrumental variables are statistically significant. This finding suggests that the predicted values of height for age in round one are highly correlated with the predicated value of height for age in round three, indicating that the instruments are not strong enough to be able to instrument two height for age variables.

Table XXII: Impact of HAZ Round 1 and HAZ Round 3 on PPVT Scores

PPVT	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Height for Age Z-Score	0.049***	-0.637	0.021	0.619	0.070**	0.729
(Round 1)	(0.019)	(1.375)	(0.023)	(0.450)	(0.033)	(0.889)
Height for Age Z-Score	0.116***	1.292	0.135***	0.163	0.073*	0.485
(Round 3)	(0.024)	(0.953)	(0.028)	(0.438)	(0.043)	(0.559)
Observations	1,802	1,802	991	991	811	811
Number of communities	82	82	51	51	77	77
R-squared	0.166		0.145		0.186	
Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%						

Turning to the Early Grade Reading Assessment, findings suggest that height for age in the third round is statistically significant in all three subsets of the data, but height for age in round one is only significant for the full sample. The results from this analysis are presented in Table XXIII.[22] Height for age in round one is significant at the 5% level in the full sample, but at the 1% level in the third round. When isolating rural and urban areas, height for age in round one

[21] The full table of regression results can be found in Appendix 21.
[22] The full table of regression results can be found in Appendix 22.

is not significant in either region. Height for age in round three is significant at the 5% level in urban areas and at the 1% level in rural areas. None of the estimates from the instrumental variables approach are significant, which signals that the instruments used may not be strong enough for instrumenting two variables that may be highly correlated.

Table XXIII: Impact of HAZ Round 1 and HAZ Round 3 on EGRA Scores

EGRA	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Height for Age Z-Score	0.054**	-1.158	0.034	0.020	0.061	-0.320
(Round 1)	(0.022)	(1.667)	(0.027)	(0.420)	(0.040)	(0.522)
Height for Age Z-Score		1.248		0.521		0.301
(Round 3)	0.093***		0.073**		0.137***	
	(0.028)	(1.169)	(0.034)	(0.385)	(0.051)	(0.341)
Observations	1,705	1,705	1,009	1,009	696	696
Number of communities	82	82	50	50	77	77
R-squared	0.110		0.089		0.135	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Focusing on the Math Achievement scores, Table XXIV presents the results of stunting measures from rounds one and three.[23] The results from community fixed effects are statistically significant in all cases, with the exception of height for age in round one in urban areas. In urban areas, the coefficient on height for age in round three is statistically significant at the 10% level. The coefficient on height for age in round three using instrumental variables is almost seven times as large as the coefficient on height for age in round three using community fixed effects in urban areas.

[23] The full table of regression results can be found in Appendix 23.

Table XXIV: Impact of HAZ Round 1 and HAZ Round 3 on Math Scores

Math	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Height for Age Z-Score	0.051**	-0.182	0.033	0.221	0.060*	0.506
(Round 1)	(0.020)	(0.895)	(0.027)	(0.512)	(0.032)	(0.506)
Height for Age Z-Score		0.787				0.083
(Round 3)	0.122***		0.121***	0.842*	0.112***	
	(0.026)	(0.607)	(0.034)	(0.480)	(0.042)	(0.311)
Observations	1,843	1,843	1,010	1,010	833	833
Number of communities	82	82	51	51	77	77
R-squared	0.181		0.179		0.175	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

The findings from this section are limited by the weaknesses of the instrumental variables. It appears that height for age in round one and height for age in round three are highly correlated, as one might expect, and this indicates that the instruments are not good enough to instrument both variables. Focusing on the results from community fixed effects, there are various significance levels, but the size of the coefficients on the height for age in round three is larger than the coefficient on height for age in round one for all scenarios. The height for age variable in round three is capturing what happened to the child's chronic nutrition level between when the first and third round were collected. The finding that the coefficients are larger on the third round variables suggests that the nutritional level of the child between the first and third round has a larger impact on educational achievement than the level of stunting of the child during the first round.

VI. Comparing Estimates from CFE and IV using HAZ Round 1 & 3, by Age Group

Finally, this last set of analysis attempts to tease apart the findings from section five to see if there are difference among the children who were 6-12 months during the first round of data collection and those who were 12 -18 months at this time. There are 1,018 children who were 12 months old or younger during the first round of surveying and 1,034 children who were older than 12 months. These two age groups were separated using the full sample and the analysis from section five repeated using this new distinction. The results from the PPVT, EGRA, and Math Achievement scores are presented in Tables XXV, XXVI, and XXVII respectively.

The results analyzing the impact of the first and third round of height for age measures on the Peabody Picture Vocabulary Test are shown in Table XXV.[24] Height for age in the third round is significant at the 1% level using community fixed effects and for the first round at the 10% level for the younger children and at the 5% level for older children at the time of the first round. Similar to the results found in section five, the estimates using instrumental variables are not significant, except for the case of height for age in the third round for those children who were 12 months or younger during the first round.

Table XXV: Impact of HAZ Round 1 and HAZ Round 3 on PPVT

PPVT	$Age\ in\ Round\ 1 \leq 12\ Months$		$Age\ in\ Round\ 1 > 12\ Months$	
	CFE	CFE IV	CFE	CFE IV
Height for Age	0.044*	-0.668	0.064**	0.108
Z-Score (Round 1)	(0.024)	(1.071)	(0.032)	(0.424)
Height for Age	0.106***	0.804*	0.109***	0.758
Z-Score (Round 3)	(0.033)	(0.440)	(0.038)	(0.465)
Observations	894	894	908	908
Number of communities	78	78	81	81
R-squared	0.174		0.120	
Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%				

[24] The full table of regression results can be found in Appendix 24.

Turning to the Early Grade Reading Assessment, Table XXVI shows the results from height for age during rounds one and three.[25] Height for age was only significant during round three and using community fixed effects. The size of the coefficient is greater for the children who were older than 12 months during the first round than for those who were younger than one year of age. None of the estimates from the instrumental variables approach or for the height for age variable in round one were significant.

Table XXVI: Impact of HAZ Round 1 and HAZ Round 3 on EGRA

EGRA	$Age\ in\ Round\ 1 \leq 12\ Months$		$Age\ in\ Round\ 1 > 12\ Months$	
	CFE	CFE IV	CFE	CFE IV
Height for Age Z-Score	0.046	0.029	0.048	0.040
(Round 1)	(0.030)	(0.762)	(0.036)	(0.406)
Height for Age Z-Score	0.084**	0.482	0.105**	0.280
(Round 3)	(0.040)	(0.417)	(0.043)	(0.450)
Observations	837	837	868	868
Number of communities	78	78	80	80
R-squared	0.135		0.077	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Finally, Table XXVII presents the results from the Math Achievement scores.[26] For children who were under 12 months of age in the first round of data collection, height for age in round three was significant at the 1% level using community fixed effects and at the 10% level using instrumental variables. The coefficient on height for age in round three is almost eight times larger using instrumental variables than with community fixed effects. This finding points to the underestimation of the impact of height for age on the child's mathematics skill assessment. For children who were older than 12 months in the first round, height for age in the first round is

[25] The full table of regression results can be found in Appendix 25.
[26] The full table of regression results can be found in Appendix 26.

significant at the 1% level and height for age in the third round at the 5% level using community fixed effects.

Table XXVII: Impact of HAZ Round 1 and HAZ Round 3 on Math Scores

Math	$Age\ in\ Round\ 1 \leq 12\ Months$		$Age\ in\ Round\ 1 > 12\ Months$	
	CFE	CFE IV	CFE	CFE IV
Height for Age Z-Score	0.016	-0.816	0.096***	-0.133
(Round 1)	(0.026)	(1.102)	(0.033)	(0.397)
Height for Age Z-Score	0.122***	0.958*	0.104**	0.591
Round 3)	(0.035)	(0.504)	(0.040)	(0.447)
Observations	914	914	929	929
Number of communities	80	80	81	81
R-squared	0.133		0.153	
Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%				

The results from the analysis in this paper suggest several important findings using the Peruvian Young Lives longitudinal study. When analyzed individually, the results from the first section show height for age as significant at the 1% level during all three rounds of data collection. It appears that weight for height, a measure of wasting, only has a significant impact during the first round of data collection, when the child is between 6 and 18 months old. In the third section, weight for height and height for age in the first round were included together to look at the impact of the different anthropometric measures during the first year of life on educational achievement at school-age. This analysis showed that the weight for height Z-scores were not working well, even after correcting with the use of instruments. The fourth section included measures of child stunting at the same time in which they took the educational assessment. The results from this section show that where instrumental variables estimates were statistically significant, they were dramatically larger than the estimates from community fixed effects. This finding suggests that failure to account for measurement error leads to an underestimation of the impact of child health on educational achievement. Finally, the last couple sections compare height for age in round one with height for age in round three. These findings show that for the various regional subsections and also split by age group during the first round, height for age in the third round has a larger impact than during the first round. As a whole, the results from this study point to how different anthropometric measures, collected at various stages of childhood, impact educational achievement outcomes.

Conclusion

This study reveals several important results and implications from the analysis of the impacts of different measures of childhood malnutrition on educational achievement scores. The focus of this analysis was on the following research questions. How does child nutrition in the first year of life affect educational assessments when children are school-aged? Which anthropometric measure of malnutrition has the largest impact on educational achievement? At what stage of childhood (infancy, early childhood, or school-aged) does malnutrition most affect educational achievement?

The use of community fixed effects instrumental variables estimates indicates that the results are robust to correlations between child anthropometric measures and unobserved child characteristics. Additionally, instrumenting for childhood nutrition more correctly estimates the impact on educational achievement by accounting for measurement error in the anthropometric variables. Using community fixed effects allows one to account for unobservable factors at the community level that impact both educational achievement and childhood malnutrition.

Using community fixed effects without correcting for the endogeneity of childhood nutrition and measurement error in anthropometric variables would lead to incorrect coefficients. Where instrumental variables estimates were statistically significant, they were dramatically larger than the estimates from community fixed effects. Due to the increase in the standard errors in conjunction with the increase in the size of the coefficients, many of the estimates using instrumental variables were insignificant. Addressing a potential problem in some of the previous studies, this study uses community fixed effects instrumental variables to offer more correct estimate of the impact of childhood nutrition on educational achievement. However, future studies should improve upon the estimation strategy by identifying improved instruments to use in the analysis.

A policy implication arising from this study is that policies aiming to increase the health and nutrition of children may also improve their educational outcomes. The results from this study suggest that stunting, or chronic malnourishment, has the largest impact at the time of the cognitive assessment due to the long-term impact that malnutrition can have on a child. Findings also suggest that wasting, or acute malnutrition, is of the most importance when the child is around one year of age or younger. These findings strengthen the argument that childhood malnutrition has an important role in the development of cognitive abilities and later educational achievement of children by using a longitudinal study in Peru.

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Appendix

Table A1: Frequencies of Mother and Father Education Levels

	Mother's Education Level			Father's Education Level		
	Frequency	Percent	Cumulative Percent	Frequency	Percent	Cumulative Percent
none	171	8.77	8.77	26	1.37	1.37
1	52	2.67	11.44	23	1.21	2.58
2	73	3.74	15.18	50	2.63	5.21
3	116	5.95	21.13	86	4.52	9.73
4	81	4.15	25.28	50	2.63	12.36
5	77	3.95	29.23	85	4.47	16.83
6	304	15.59	44.82	331	17.41	34.25
7	69	3.54	48.36	53	2.79	37.03
8	92	4.72	53.08	99	5.21	42.24
9	116	5.95	59.03	109	5.73	47.97
10	70	3.59	62.62	67	3.52	51.5
11	368	18.87	81.49	517	27.2	78.7
Incomplete Technical College	101	5.18	86.67	75	3.95	82.64
Complete Technical College	161	8.26	94.92	178	9.36	92
Incomplete University	34	1.74	96.67	44	2.31	94.32
Complete University	63	3.23	99.9	108	5.68	100
Adult Literacy Program	2	0.1	100			

Table A2: Correlation Table of Wealth Indices over Rounds of Data Collection

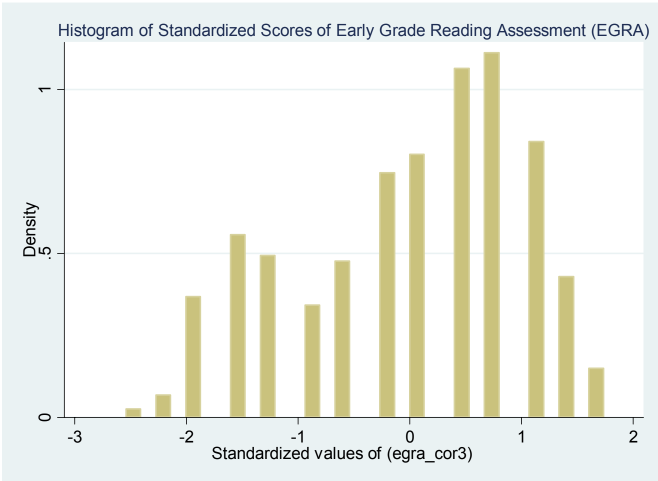
	Wealth Index (Round 1)	Wealth Index (Round 2)	Wealth Index (Round 3)
Wealth Index (Round 1)	1.00		
Wealth Index (Round 2)	0.78	1.00	
Wealth Index (Round 3)	0.71	0.83	1.00

Table A3: Correlation Table of Medical Professionals Present at Birth

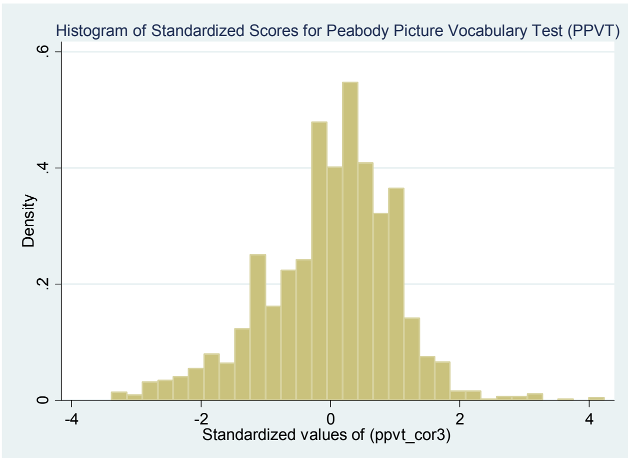
	Doctor Present at Birth	Nurse Present at Birth	Midwife Present at Birth
Doctor Present at Birth	1.00		

Nurse Present at Birth	0.48	1.00	
Midwife Present at Birth	0.33	0.53	1.00

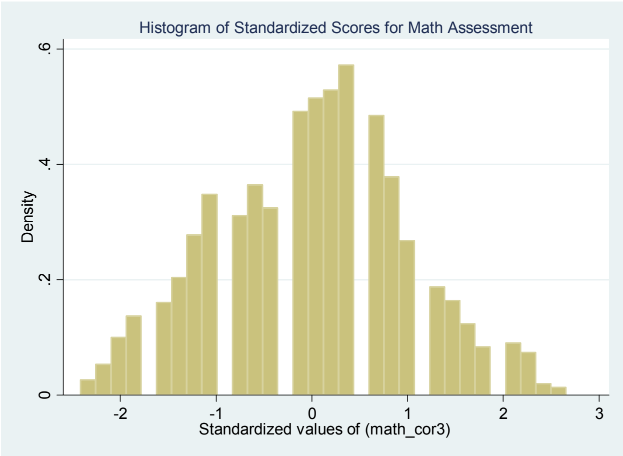
Table A4: Histograms of Education Assessment Indicators



(a) Early Grade Reading Assessment (EGRA)



(b) Peabody Picture Vocabulary Test (PPVT)



(c) Math Achievement Exam

Table A5: Descriptive Statistics for the Child Health Measures

	Weight for Height Z-Score (Round 1)	Weight for Height Z-Score (Round 2)	Height for Age Z-Score (Round 1)	Height for Age Z-Score (Round 2)	Height for Age Z-Score (Round 3)
N	2,039	533	2, 040	1, 954	1, 937
Mean	0.648	0.692	-1.301	-1.557	-1.167
Standard Deviation	1.308	0.884	1.358	1.157	1.063

Table A6: Scatter Plot of Height for Age Z-scores by Age

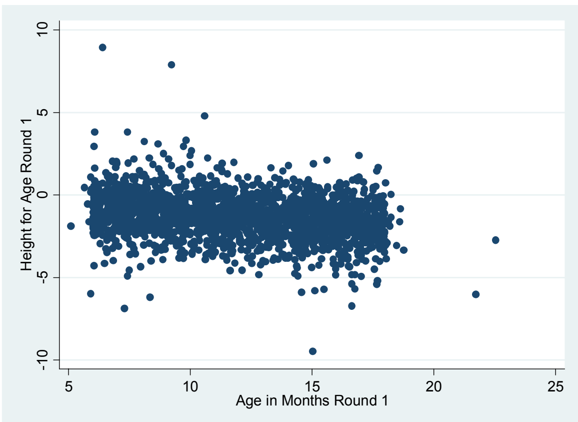
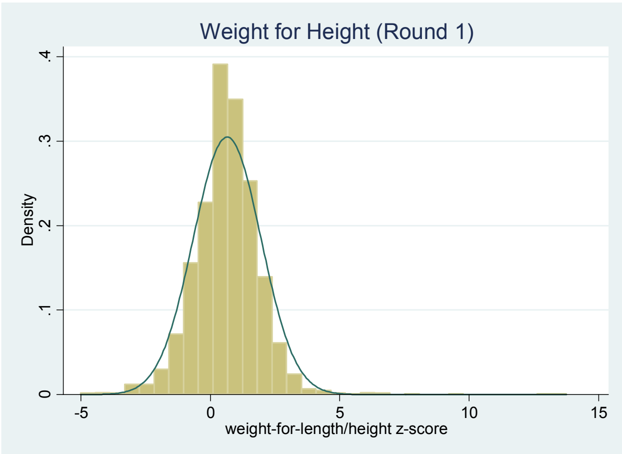
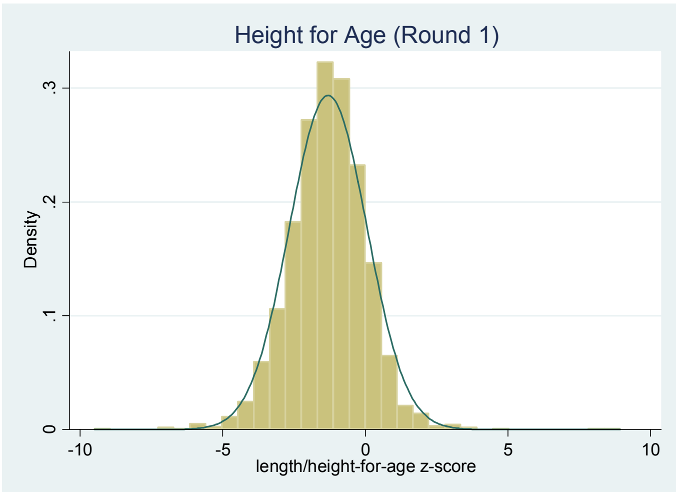


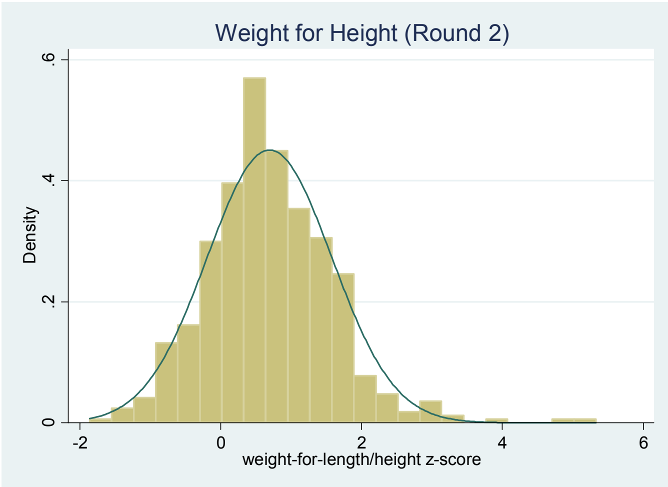
Table A7: Densities of the Child Health Measures



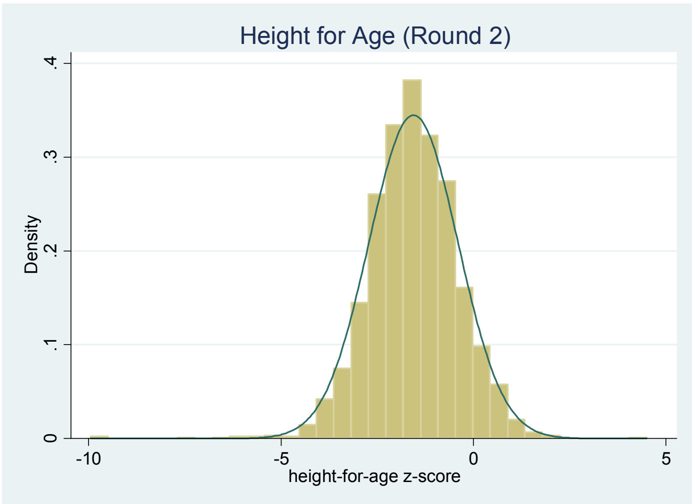
(a) Weight for Height (Round 1)



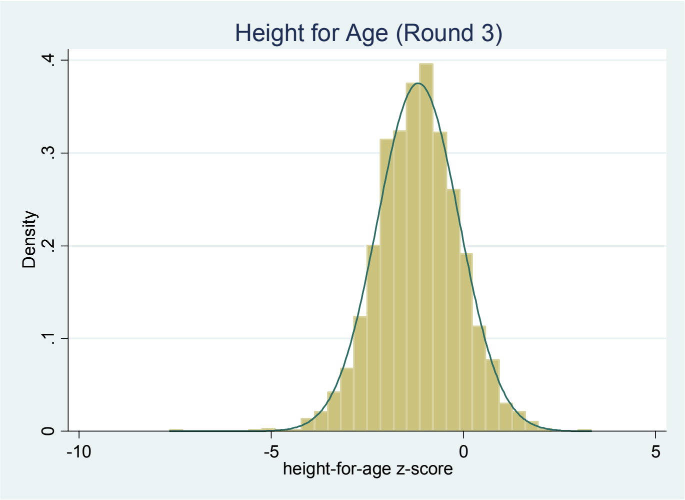
(b) Height for Age (Round 1)



(c) Weight for Height (Round 2)



(d) Height for Age (Round 2)



(e) Height for Age (Round 3)

Table A8: Comparison of Ordinary Least Squares and Community Fixed Effects

	PPVT Z-Scores		EGRA Z-Scores		Math Z-Scores	
	OLS	CFE	OLS	CFE	OLS	CFE
Sex	-0.097***	-0.096***	0.025	0.036	-0.143***	-0.137***
	(0.037)	(0.036)	(0.043)	(0.042)	(0.039)	(0.038)
Age in Months	0.046***	0.046***	0.039***	0.037***	0.070***	0.070***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Mother Fluent in Spanish	0.233***	0.229***	0.228***	0.217**	0.066	0.156*
	(0.072)	(0.076)	(0.082)	(0.088)	(0.076)	(0.081)
Father Fluent in Spanish	0.041	0.031	0.009	-0.091	0.133*	0.058
	(0.073)	(0.075)	(0.086)	(0.088)	(0.077)	(0.08)
Female Head of Household	-0.025	-0.074	-0.006	-0.013	-0.009	-0.024
	(0.057)	(0.056)	(0.065)	(0.064)	(0.06)	(0.059)
Father's Education Level	-0.001	-0.001	0.001	0.001	0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Mother's Education Level	0.018***	0.015***	0.019***	0.018***	0.018***	0.017***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Wealth Index	1.874***	1.267***	1.484***	1.160***	1.707***	1.404***
	(0.121)	(0.136)	(0.137)	(0.155)	(0.127)	(0.143)
Jungle	-0.006		0.101		0.034	
	(0.059)		(0.066)		(0.062)	
Mountain	0.067		0.081		0.036	
	(0.048)		(0.054)		(0.051)	
Electricity Access	0.168***	0.177***	0.119*	0.130*	-0.049	0.055
	(0.057)	(0.065)	(0.068)	(0.077)	(0.059)	(0.069)
Height-for-Age Z-Score (Round 1)	0.095***	0.094***	0.080***	0.090***	0.099***	0.099***
	(0.016)	(0.016)	(0.018)	(0.018)	(0.017)	(0.017)
Constant	-1.808***	-1.410***	-1.750***	-1.405***	-1.693***	-1.601***
	(0.117)	(0.116)	(0.136)	(0.137)	(0.122)	(0.123)
Observations	1,805	1,805	1,707	1,707	1,846	1,846
Number of Communities		82		82		82
R-squared	0.389	0.175	0.235	0.12	0.313	0.194

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A9: Comparing Height-for-Age across Three Rounds of Data Collection using Community Fixed Effects

	PPVT Z-Scores			EGRA Z-Scores			Math Z-Scores		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Sex	-0.096***	-0.062*	-0.078**	0.036	0.067	0.054	-0.137***	-0.102***	-0.115***
	(0.036)	(0.036)	(0.036)	(0.042)	(0.042)	(0.042)	(0.038)	(0.038)	(0.038)
Age in Months	0.046***	0.037***	0.039***	0.037***	0.028***	0.030***	0.070***	0.061***	0.062***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Mother Fluent in Spanish	0.229***	0.241***	0.235***	0.217**	0.224**	0.224**	0.156*	0.169**	0.162**
	(0.076)	(0.076)	(0.075)	(0.088)	(0.088)	(0.088)	(0.081)	(0.082)	(0.081)
Father Fluent in Spanish	0.031	0.000	0.012	-0.091	-0.099	-0.092	0.058	0.043	0.047
	(0.075)	(0.075)	(0.074)	(0.088)	(0.088)	(0.088)	(0.08)	(0.08)	(0.079)
Female Head of Household	-0.074	-0.066	-0.066	-0.013	-0.01	-0.011	-0.024	-0.015	-0.02
	(0.056)	(0.055)	(0.055)	(0.064)	(0.064)	(0.064)	(0.059)	(0.059)	(0.059)
Father's Education Level	-0.001	0.000	0.000	0.001	0.001	0.001	-0.001	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Mother's Education Level	0.015***	0.015***	0.014***	0.018***	0.017***	0.017***	0.017***	0.017***	0.017***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Wealth Index	1.267***	1.232***	1.180***	1.160***	1.116***	1.083***	1.404***	1.347***	1.290***
	(0.136)	(0.137)	(0.138)	(0.155)	(0.156)	(0.157)	(0.143)	(0.145)	(0.145)
Electricity Access	0.177***	0.178***	0.171***	0.130*	0.124	0.124	0.055	0.068	0.061
	(0.065)	(0.065)	(0.065)	(0.077)	(0.077)	(0.077)	(0.069)	(0.069)	(0.069)

Height-for-Age Z-Scores (Round 1)	0.094***			0.090***			0.099***		
	(0.016)			(0.018)			(0.017)		
Height-for-Age Z-Scores (Round 2)		0.117***			0.110***			0.109***	
		(0.019)			(0.022)			(0.02)	
Height-for-Age Z-Scores (Round 3)			0.131***			0.114***			0.138***
			(0.02)			(0.024)			(0.022)
Constant	-1.410***	-1.257***	-1.259***	-1.405***	-1.260***	-1.281***	-1.601***	-1.489***	-1.448***
	(0.116)	(0.123)	(0.122)	(0.137)	(0.145)	(0.145)	(0.123)	(0.131)	(0.13)
Observations	1,805	1,807	1,811	1,707	1,708	1,713	1,846	1,848	1,852
Number of communities	82	82	82	82	82	82	82	82	82
R-Squared	0.175	0.178	0.18	0.12	0.122	0.121	0.194	0.192	0.198

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A10: Comparing Weight-for-Height across Two Rounds of Data Collection using Community Fixed Effects

	PPVT Z-Scores		EGRA Z-Scores		Math Z-Scores	
	(1)	(2)	(1)	(2)	(1)	(2)
Sex	-0.078**	-0.184**	0.049	-0.066	-0.120***	-0.144*
	(0.037)	(0.075)	(0.042)	(0.094)	(0.039)	(0.076)
Age in Months	0.038***	0.035*	0.030***	0.015	0.063***	0.037*
	(0.005)	(0.02)	(0.006)	(0.026)	(0.005)	(0.021)
Mother Fluent in Spanish	0.249***	0.1	0.235***	0.153	0.174**	0.039
	(0.077)	(0.136)	(0.089)	(0.168)	(0.082)	(0.14)
Father Fluent in Spanish	0.032	0.089	-0.087	-0.055	0.063	0.128
	(0.076)	(0.127)	(0.089)	(0.162)	(0.08)	(0.13)
Female Head of Household	-0.059	-0.101	0.003	-0.052	-0.005	0.079
	(0.056)	(0.12)	(0.064)	(0.147)	(0.059)	(0.122)
Father's Education Level	0.000	0.000	0.001	-0.004	0.000	0.001
	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.003)
Mother's Education Level	0.015***	0.061***	0.018***	0.071***	0.017***	0.076***
	(0.003)	(0.013)	(0.004)	(0.016)	(0.003)	(0.013)
Wealth Index	1.339***	0.960***	1.213***	0.881***	1.462***	1.014***
	(0.137)	(0.274)	(0.155)	(0.33)	(0.144)	(0.279)
Electricity Access	0.189***	0.251**	0.146*	0.189	0.072	0.13
	(0.066)	(0.108)	(0.078)	(0.137)	(0.07)	(0.111)
Weight-for-Height Z-Scores (Round 1)	0.014		0.033*		0.039**	
	(0.015)		(0.017)		(0.016)	
Weight-for-Height Z-Scores (Round 2)		-0.017		0.004		-0.051
		(0.044)		(0.055)		(0.044)

Constant	-1.541***	-1.551***	-1.540***	-1.434***	-1.758***	-1.619***
	(0.116)	(0.254)	(0.137)	(0.323)	(0.122)	(0.259)
Observations	1,804	501	1,706	440	1,845	516
Number of communities	82	72	82	73	82	74
R-squared	0.159	0.212	0.109	0.159	0.181	0.22

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A11: First Stage Regression Equations for the Instrumental Variables - Full Sample

	Weight-for-Height Z-Scores (Round 1)	Height-for-Age Z-Scores (Round 1)	Height-for-Age Z-Score (Round 3)
Sex	0.158***	0.235***	0.056
	(0.057)	(0.053)	(0.042)
Age in Months	-0.042***	-0.096***	-0.008
	(0.008)	(0.007)	(0.006)
Mother Fluent in Spanish	0.082	0.372***	0.303***
	(0.112)	(0.104)	(0.083)
Father Fluent in Spanish	-0.034	0.089	0.065
	(0.115)	(0.106)	(0.084)
Female Head of Household	-0.191**	0.110	0.045
	(0.088)	(0.081)	(0.065)
Father's Education Level	0.002	0.003	-0.001
	(0.002)	(0.002)	(0.002)
Mother's Education Level	0.017***	0.010**	0.016***
	(0.005)	(0.005)	(0.004)
Wealth Index	0.921***	1.164***	1.041***
	(0.301)	(0.278)	(0.257)
Jungle	-0.638***	-0.273***	-0.123*
	(0.094)	(0.087)	(0.069)
Mountain	-0.147**	-0.569***	-0.252***
	(0.074)	(0.069)	(0.056)
Electricity Access	0.022	0.054	0.094
	(0.090)	(0.083)	(0.066)
Access to Sanitation	-0.176*	0.005	0.089
	(0.090)	(0.083)	(0.066)
Piped Water	0.108	0.050	0.038
	(0.071)	(0.066)	(0.053)
Doctor at Birth	0.112*	0.121*	0.134***
	(0.067)	(0.062)	(0.050)
Nurse at Birth	-0.033	0.119*	0.137**
	(0.071)	(0.066)	(0.057)
Cement Floor			0.177***
			(0.061)
Midwife at Birth			0.052
			(0.053)
Constant	0.698***	-1.172***	-2.110***
	(0.182)	(0.168)	(0.135)
Observations	1,951	1,952	1,910
R-squared	0.084	0.253	0.258

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table A12 First Stage Regression Equations for Instrumental Variables for Rural Areas

	Weight-for-Height Z-Scores (Round 1)	Height-for-Age Z-Scores (Round 1)	Height-for-Age Z-Score (Round 3)
Sex	0.245***	0.329***	0.061
	(0.088)	(0.081)	(0.060)
Age in Months	-0.052***	-0.105***	-0.011
	(0.012)	(0.011)	(0.008)
Mother Fluent in Spanish	0.075	0.331***	0.200**
	(0.136)	(0.125)	(0.094)
Father Fluent in Spanish	-0.034	0.176	0.148
	(0.138)	(0.127)	(0.094)
Female Head of Household	-0.051	-0.066	-0.061
	(0.151)	(0.139)	(0.105)
Father's Education Level	0.002	0.004	-0.002
	(0.003)	(0.003)	(0.002)
Mother's Education Level	0.022***	0.003	0.008*
	(0.006)	(0.006)	(0.004)
Wealth Index	-0.066	1.638**	0.529
	(0.696)	(0.640)	(0.484)
Jungle	-0.775***	-0.647***	-0.583***
	(0.259)	(0.238)	(0.180)
Mountain	-0.419*	-0.894***	-0.570***
	(0.249)	(0.229)	(0.174)
Electricity Access	0.112	0.059	0.116*
	(0.100)	(0.092)	(0.070)
Access to Sanitation	-0.226**	0.013	0.038
	(0.100)	(0.092)	(0.072)
Cement Floor	0.185	0.154	0.376***
	(0.179)	(0.165)	(0.124)
Piped Water			-0.088
			(0.070)
Doctor at Birth			0.109
			(0.080)
Nurse at Birth			0.139*
			(0.079)
Midwife at Birth			0.088
			(0.080)
Constant	1.126***	-0.887***	-1.564***
	(0.346)	(0.318)	(0.240)
Observations	872	872	859
R-squared	0.067	0.193	0.158

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table A13 First Stage Regression Equations for Instrumental Variables for Urban Areas

	Weight-for-Height Z-Scores (Round 1)	Height-for-Age Z-Scores (Round 1)	Height-for-Age Z-Score (Round 3)
Sex	0.105	0.144**	0.031
	(0.075)	(0.070)	(0.058)
Age in Months	-0.034***	-0.083***	0.000
	(0.011)	(0.010)	(0.008)
Mother Fluent in	0.188	0.368*	0.471***
Spanish	(0.207)	(0.194)	(0.163)
Father Fluent in	-0.123	-0.174	-0.172
Spanish	(0.212)	(0.199)	(0.165)
Female Head of	-0.269**	0.208**	0.092
Household	(0.107)	(0.100)	(0.083)
Father's Education	-0.003	0.003	0.001
Level	(0.005)	(0.005)	(0.004)
Mother's Education	0.006	0.025***	0.036***
Level	(0.009)	(0.008)	(0.007)
Wealth Index	1.323***	0.690**	1.024***
	(0.361)	(0.338)	(0.279)
Jungle	-0.861***	-0.129	0.126
	(0.128)	(0.120)	(0.098)
Mountain	-0.109	-0.562***	-0.244***
	(0.089)	(0.084)	(0.070)
Electricity Access	0.261	-0.103	0.099
	(0.252)	(0.236)	(0.202)
Piped Water	0.302***	0.119	0.119
	(0.099)	(0.093)	(0.082)
Doctor at Birth	0.160**	0.177**	0.140**
	(0.079)	(0.074)	(0.064)
Access to Sanitation			0.289**
			(0.142)
Nurse at Birth			0.119
			(0.078)
Constant	0.083	-0.775**	-2.436***
	(0.332)	(0.311)	(0.273)
Observations	1,079	1,080	1,051
R-squared	0.100	0.151	0.135

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table A14: Community Fixed Effects OLS Using Round 2 PPVT Scores

	PPVT Z-Scores (Round 2)			
	(1)	(2)	(3)	(4)
Sex	-0.023	-0.011	-0.004	-0.032
	(0.033)	(0.033)	(0.033)	(0.055)
Age in Months	0.052***	0.047***	0.047***	0.015
	(0.005)	(0.005)	(0.005)	(0.015)
Mother Fluent in Spanish	0.181**	0.193***	0.159**	-0.037
	(0.071)	(0.071)	(0.07)	(0.1)
Father Fluent in Spanish	0.006	0.007	-0.001	0.04
	(0.07)	(0.07)	(0.069)	(0.094)
Female Head of Household	0.031	0.041	0.033	0.121
	(0.05)	(0.051)	(0.05)	(0.09)
Father's Education Level	0.001	0.001	0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)
Mother's Education Level	0.015***	0.016***	0.015***	0.061***
	(0.003)	(0.003)	(0.003)	(0.01)
Wealth Index	1.435***	1.477***	1.376***	0.690***
	(0.123)	(0.123)	(0.122)	(0.198)
Electricity Access	0.025	0.033	0.021	-0.068
	(0.06)	(0.06)	(0.059)	(0.079)
Height-for-Age Z-Scores (Round 1)	0.062***			
	(0.014)			
Weight-for-Height Z-Scores (Round 1)		0.011		
		(0.013)		
Height-for-Age Z-Scores (Round 2)			0.110***	
			(0.017)	
Weight-for-Height (Round 2)				0.025
				(0.032)
Constant	-1.595***	-1.682***	-1.412***	-1.369***
	(0.106)	(0.105)	(0.111)	(0.189)
Observations	1845	1844	1853	502
Number of communities	81	81	81	74
R-Squared	0.196	0.188	0.209	0.181

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A15: Impact of WHZ Round 1 and HAZ Round 1 on PPVT Z-Scores

PPVT	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	-0.094**	-0.320**	-0.015	-0.081	-0.211***	-0.717**
	(0.037)	(0.127)	(0.045)	(0.080)	(0.062)	(0.316)
Age in Months	0.048***	0.140***	0.040***	0.092**	0.062***	0.196**
	(0.005)	(0.044)	(0.007)	(0.037)	(0.009)	(0.078)
Mother Fluent in	0.257***	0.025	-0.132	-0.323	0.360***	0.219
Spanish	(0.077)	(0.186)	(0.126)	(0.221)	(0.104)	(0.234)
Father Fluent in Spanish	0.045	0.029	0.151	0.205	0.052	-0.091
	(0.076)	(0.151)	(0.129)	(0.202)	(0.099)	(0.225)
Female Head of	-0.067	-0.235	0.056	-0.100	-0.263**	-0.249
Household	(0.056)	(0.212)	(0.065)	(0.173)	(0.105)	(0.224)
Father's Education Level	-0.000	-0.005	0.003	0.000	-0.001	-0.009
	(0.002)	(0.004)	(0.003)	(0.005)	(0.002)	(0.006)
Mother's Education	0.016***	0.011	0.026***	0.009	0.010**	0.012
Level	(0.003)	(0.011)	(0.005)	(0.013)	(0.004)	(0.018)
Wealth Index	1.386***	0.154	1.124***	0.750	1.944***	-1.908
	(0.218)	(0.748)	(0.234)	(0.622)	(0.526)	(2.492)
Electricity Access	0.340***	0.120	0.089	0.187	0.270***	0.118
	(0.062)	(0.233)	(0.163)	(0.264)	(0.078)	(0.212)
Weight for Height Z-	0.026*	-0.119	0.009	0.005	0.065***	0.193
Scores (Round 1)	(0.015)	(0.702)	(0.019)	(0.350)	(0.024)	(0.583)
Height for Age Z-Scores	0.101***	1.170*	0.077***	0.684*	0.113***	1.468*
(Round 1)	(0.016)	(0.619)	(0.020)	(0.404)	(0.028)	(0.816)
Constant	-1.306***	0.178	-0.738***	-0.350	-1.555***	0.943
	(0.118)	(1.183)	(0.212)	(0.432)	(0.181)	(1.705)
Observations	1,804	1,804	990	990	814	814
Number of communities	82	82	50	50	77	77
R-squared	0.155		0.125		0.191	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Doctor at Birth, Nurse at Birth
Rural Areas: Access to Sanitation, Cement Floor, Doctor at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation.

Table A16: Impact of WHZ Round 1 and HAZ Round 1 on EGRA Z-Scores

EGRA	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	0.039	-0.036	0.123**	0.097	-0.106	-0.341
	(0.043)	(0.131)	(0.052)	(0.069)	(0.074)	(0.264)
Age in Months	0.040***	0.086	0.032***	0.050*	0.056***	0.133*
	(0.006)	(0.053)	(0.008)	(0.030)	(0.011)	(0.078)
Mother Fluent in Spanish	0.240***	0.093	-0.050	-0.116	0.295**	0.210
	(0.089)	(0.235)	(0.146)	(0.186)	(0.119)	(0.199)
Father Fluent in Spanish	-0.074	-0.160	0.061	0.089	-0.147	-0.280
	(0.089)	(0.215)	(0.148)	(0.168)	(0.117)	(0.230)
Female Head of Household	-0.004	-0.211	0.067	0.025	-0.179	-0.168
	(0.064)	(0.285)	(0.075)	(0.140)	(0.124)	(0.183)
Father's Education Level	0.000	-0.004	0.003	0.002	-0.001	-0.008
	(0.002)	(0.006)	(0.003)	(0.004)	(0.003)	(0.008)
Mother's Education Level	0.019***	0.026	0.023***	0.017	0.016***	0.022
	(0.004)	(0.016)	(0.006)	(0.011)	(0.005)	(0.016)
Wealth Index	1.239***	1.049	1.058***	0.864*	1.456**	-0.246
	(0.248)	(0.794)	(0.273)	(0.520)	(0.610)	(1.914)
Electricity Access	0.286***	-0.008	0.352*	0.377*	0.250***	0.094
	(0.073)	(0.388)	(0.191)	(0.224)	(0.091)	(0.222)
Weight for Height Z-Scores	0.045***	-0.691	0.008	0.041	0.097***	0.021
(Round 1)	(0.017)	(1.120)	(0.022)	(0.273)	(0.028)	(0.475)
Height for Age Z-Scores	0.100***	0.965	0.065***	0.265	0.141***	0.996
(Round 1)	(0.019)	(0.949)	(0.023)	(0.349)	(0.033)	(0.847)
Constant	-1.326***	0.248	-1.219***	-1.096***	-1.343***	0.127
	(0.139)	(1.896)	(0.248)	(0.380)	(0.217)	(1.602)
Observations	1,706	1,706	1,008	1,008	698	698
Number of communities	82	82	49	49	77	77
R-squared	0.108		0.085		0.141	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Doctor at Birth, Nurse at Birth
Rural Areas: Access to Sanitation, Cement Floor, Doctor at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation.

Table A17: Impact of WHZ Round 1 and HAZ Round 1 on Math Z-Scores

Math	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	-0.137***	-0.318**	-0.076	-0.165*	-0.209***	-0.334
	(0.039)	(0.133)	(0.052)	(0.089)	(0.061)	(0.233)
Age in Months	0.073***	0.143***	0.075***	0.129***	0.073***	0.104*
	(0.006)	(0.045)	(0.008)	(0.039)	(0.009)	(0.059)
Mother Fluent in	0.184**	0.011	0.006	-0.197	0.222**	0.214
Spanish	(0.082)	(0.186)	(0.146)	(0.239)	(0.103)	(0.147)
Father Fluent in Spanish	0.079	0.034	0.179	0.334	0.053	-0.026
	(0.081)	(0.158)	(0.148)	(0.216)	(0.098)	(0.154)
Female Head of	-0.014	-0.210	0.048	0.052	-0.185*	-0.233
Household	(0.060)	(0.222)	(0.074)	(0.179)	(0.105)	(0.144)
Father's Education Level	-0.001	-0.004	-0.001	-0.002	-0.000	-0.002
	(0.002)	(0.004)	(0.003)	(0.005)	(0.002)	(0.004)
Mother's Education	0.018***	0.018	0.031***	0.015	0.012***	0.021*
Level	(0.003)	(0.011)	(0.006)	(0.014)	(0.004)	(0.011)
Wealth Index	1.467***	0.641	1.198***	0.154	1.857***	0.627
	(0.232)	(0.756)	(0.273)	(0.669)	(0.513)	(1.686)
Electricity Access	0.244***	0.024	0.347*	0.283	0.165**	0.079
	(0.066)	(0.243)	(0.191)	(0.289)	(0.076)	(0.128)
Weight for Height Z-	0.052***	-0.351	0.030	0.507	0.080***	-0.176
Scores (Round 1)	(0.016)	(0.750)	(0.022)	(0.352)	(0.024)	(0.362)
Height for Age Z-Scores	0.110***	1.057	0.086***	0.534	0.123***	0.612
(Round 1)	(0.017)	(0.669)	(0.023)	(0.440)	(0.027)	(0.580)
Constant	-1.497***	0.026	-1.613***	-1.501***	-1.434***	-0.324
	(0.124)	(1.321)	(0.247)	(0.489)	(0.176)	(1.162)
Observations	1,845	1,845	1,009	1,009	836	836
Number of communities	82	82	50	50	77	77
R-squared	0.176		0.170		0.180	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Doctor at Birth, Nurse at Birth
Rural Areas: Access to Sanitation, Cement Floor, Doctor at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation.

Table A18: Impact of HAZ Round 3 on PPVT Z-Scores

PPVT	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	-0.070*	-0.107**	-0.005	-0.011	-0.164***	-0.224***
	(0.036)	(0.049)	(0.044)	(0.048)	(0.061)	(0.080)
Age in Months	0.039***	0.044***	0.033***	0.035***	0.050***	0.055***
	(0.005)	(0.007)	(0.006)	(0.007)	(0.009)	(0.011)
Mother Fluent in	0.262***	0.125	-0.159	-0.273	0.377***	0.316**
Spanish	(0.076)	(0.106)	(0.125)	(0.171)	(0.104)	(0.134)
Father Fluent in	0.020	-0.046	0.154	0.173	0.023	-0.125
Spanish	(0.075)	(0.100)	(0.127)	(0.139)	(0.099)	(0.133)
Female Head of	-0.064	-0.121	0.054	0.012	-0.259**	-0.260*
Household	(0.056)	(0.075)	(0.064)	(0.079)	(0.106)	(0.135)
Father's Education	0.000	-0.001	0.003	0.002	-0.000	-0.001
Level	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
Mother's Education	0.016***	0.006	0.023***	0.012	0.011**	0.008
Level	(0.003)	(0.005)	(0.005)	(0.012)	(0.004)	(0.006)
Wealth Index	1.333***	0.363	1.026***	0.702*	2.150***	1.084
	(0.217)	(0.382)	(0.230)	(0.390)	(0.524)	(0.736)
Electricity Access	0.311***	0.126	0.044	-0.029	0.243***	0.083
	(0.062)	(0.095)	(0.161)	(0.187)	(0.079)	(0.110)
Height for Age	0.151***	0.870***	0.150***	0.464	0.124***	0.885***
Z-Scores (Round 3)	(0.020)	(0.190)	(0.024)	(0.292)	(0.036)	(0.227)
Constant	-1.121***	0.352	-0.488**	0.143	-1.479***	0.201
	(0.122)	(0.418)	(0.214)	(0.628)	(0.191)	(0.547)
Observations	1,811	1,811	995	995	816	816
Number of communities	82	82	51	51	77	77
R-squared	0.163		0.145		0.182	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A19: Impact of HAZ Round 3 on EGRA Z-Scores

EGRA	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	0.064	0.045	0.136***	0.121**	-0.051	-0.046
	(0.042)	(0.046)	(0.052)	(0.060)	(0.073)	(0.075)
Age in Months	0.029***	0.031***	0.027***	0.028***	0.038***	0.038***
	(0.006)	(0.006)	(0.007)	(0.009)	(0.010)	(0.010)
Mother Fluent in Spanish	0.250***	0.175*	-0.061	-0.235	0.316***	0.322***
	(0.088)	(0.101)	(0.146)	(0.207)	(0.119)	(0.121)
Father Fluent in Spanish	-0.083	-0.100	0.064	0.100	-0.165	-0.156
	(0.088)	(0.094)	(0.148)	(0.169)	(0.116)	(0.120)
Female Head of Household	-0.008	-0.037	0.068	0.003	-0.184	-0.183
	(0.064)	(0.070)	(0.074)	(0.096)	(0.125)	(0.125)
Father's Education Level	0.001	0.000	0.003	0.002	0.000	0.000
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)
Mother's Education Level	0.019***	0.014***	0.021***	0.004	0.017***	0.018***
	(0.004)	(0.005)	(0.006)	(0.014)	(0.005)	(0.005)
Wealth Index	1.205***	0.745**	0.979***	0.423	1.586***	1.644**
	(0.248)	(0.355)	(0.272)	(0.503)	(0.611)	(0.642)
Electricity Access	0.256***	0.164*	0.322*	0.218	0.209**	0.223**
	(0.073)	(0.091)	(0.191)	(0.228)	(0.092)	(0.103)
Height for Age Z-Scores (Round 3)	0.133***	0.467***	0.100***	0.574*	0.182***	0.127
	(0.024)	(0.175)	(0.029)	(0.341)	(0.042)	(0.191)
Constant	-1.156***	-0.459	-1.066***	-0.089	-1.131***	-1.250***
	(0.145)	(0.392)	(0.254)	(0.757)	(0.229)	(0.465)
Observations	1,713	1,713	1,013	1,013	700	700
Number of communities	82	82	50	50	77	77
R-squared	0.108		0.088		0.134	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A20: Impact of HAZ Round 3 on Math Z-Scores

Math	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	-0.108***	-0.138***	-0.065	-0.093	-0.153**	-0.167***
	(0.039)	(0.046)	(0.052)	(0.072)	(0.060)	(0.063)
Age in Months	0.062***	0.066***	0.068***	0.071***	0.058***	0.059***
	(0.005)	(0.006)	(0.007)	(0.010)	(0.008)	(0.009)
Mother Fluent in Spanish	0.192**	0.094	-0.018	-0.319	0.246**	0.234**
	(0.082)	(0.100)	(0.146)	(0.248)	(0.104)	(0.106)
Father Fluent in Spanish	0.059	0.013	0.171	0.232	0.029	-0.003
	(0.080)	(0.093)	(0.147)	(0.202)	(0.098)	(0.106)
Female Head of Household	-0.018	-0.059	0.042	-0.069	-0.186*	-0.188*
	(0.060)	(0.070)	(0.074)	(0.114)	(0.106)	(0.107)
Father's Education Level	0.000	-0.001	-0.002	-0.003	0.001	0.001
	(0.002)	(0.002)	(0.003)	(0.005)	(0.002)	(0.002)
Mother's Education Level	0.018***	0.011**	0.029***	-0.000	0.014***	0.013***
	(0.003)	(0.005)	(0.006)	(0.016)	(0.004)	(0.004)
Wealth Index	1.417***	0.682*	1.109***	0.142	2.010***	1.803***
	(0.233)	(0.368)	(0.271)	(0.602)	(0.514)	(0.571)
Electricity Access	0.219***	0.089	0.309	0.128	0.141*	0.108
	(0.066)	(0.088)	(0.190)	(0.273)	(0.077)	(0.086)
Height for Age Z-Scores (Round 3)	0.159***	0.669***	0.145***	0.964**	0.158***	0.312*
	(0.022)	(0.178)	(0.029)	(0.406)	(0.035)	(0.178)
Constant	-1.297***	-0.229	-1.365***	0.329	-1.294***	-0.953**
	(0.131)	(0.398)	(0.253)	(0.902)	(0.187)	(0.430)
Observations	1,852	1,852	1,014	1,014	838	838
Number of communities	82	82	51	51	77	77
R-squared	0.179		0.179		0.173	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A21: Impact of HAZ Round 1 and HAZ 3 on PPVT Z-Scores

PPVT	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	-0.084**	0.020	-0.010	-0.075	-0.191***	-0.459
	(0.037)	(0.282)	(0.044)	(0.079)	(0.062)	(0.296)
Age in Months	0.043***	-0.012	0.035***	0.087**	0.055***	0.119
	(0.005)	(0.120)	(0.007)	(0.039)	(0.009)	(0.081)
Mother Fluent in	0.249***	0.185	-0.161	-0.360	0.365***	0.270
Spanish	(0.076)	(0.189)	(0.125)	(0.237)	(0.104)	(0.170)
Father Fluent in	0.032	-0.071	0.153	0.208	0.039	-0.113
Spanish	(0.075)	(0.142)	(0.127)	(0.186)	(0.100)	(0.164)
Female Head of	-0.069	-0.071	0.050	-0.106	-0.257**	-0.249
Household	(0.056)	(0.140)	(0.064)	(0.137)	(0.106)	(0.165)
Father's Education	-0.000	0.002	0.003	0.000	-0.001	-0.004
Level	(0.002)	(0.005)	(0.003)	(0.004)	(0.002)	(0.005)
Mother's Education	0.016***	0.004	0.023***	0.006	0.011**	0.012
Level	(0.003)	(0.006)	(0.005)	(0.016)	(0.004)	(0.009)
Wealth Index	1.315***	0.591	1.029***	0.625	1.984***	-0.451
	(0.217)	(0.687)	(0.231)	(0.531)	(0.527)	(2.033)
Electricity Access	0.315***	0.145	0.052	0.141	0.251***	0.083
	(0.062)	(0.115)	(0.162)	(0.274)	(0.079)	(0.135)
Height for Age Z-Score	0.049***	-0.637	0.021	0.619	0.070**	0.729
(Round 1)	(0.019)	(1.375)	(0.023)	(0.450)	(0.033)	(0.889)
Height for Age Z-Score	0.116***	1.292	0.135***	0.163	0.073*	0.485
Round 3)	(0.024)	(0.953)	(0.028)	(0.438)	(0.043)	(0.559)
Constant	-1.115***	0.400	-0.500**	-0.065	-1.430***	0.736
	(0.122)	(0.509)	(0.215)	(0.842)	(0.191)	(0.910)
Observations	1,802	1,802	991	991	811	811
Number of communities	82	82	51	51	77	77
R-squared	0.166		0.145		0.186	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A22: Impact of HAZ Round 1 and HAZ Round 3 on EGRA Z-Scores

EGRA	Full Sample		Urban Areas		Rural Areas	
	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	0.050	0.240	0.126**	0.116	-0.068	0.033
	(0.043)	(0.294)	(0.052)	(0.074)	(0.074)	(0.157)
Age in Months	0.034***	-0.072	0.030***	0.030	0.043***	0.007
	(0.006)	(0.148)	(0.008)	(0.036)	(0.011)	(0.050)
Mother Fluent in	0.235***	0.278	-0.066	-0.224	0.302**	0.327**
Spanish	(0.089)	(0.231)	(0.146)	(0.213)	(0.120)	(0.134)
Father Fluent in	-0.083	-0.130	0.061	0.094	-0.169	-0.142
Spanish	(0.089)	(0.159)	(0.148)	(0.169)	(0.117)	(0.134)
Female Head of	-0.012	0.047	0.063	0.005	-0.183	-0.193
Household	(0.064)	(0.167)	(0.074)	(0.123)	(0.125)	(0.135)
Father's Education	0.001	0.007	0.003	0.002	-0.000	0.003
Level	(0.002)	(0.010)	(0.003)	(0.004)	(0.003)	(0.005)
Mother's Education	0.019***	0.011	0.021***	0.006	0.018***	0.015**
Level	(0.004)	(0.008)	(0.006)	(0.015)	(0.005)	(0.006)
Wealth Index	1.209***	0.965	1.005***	0.478	1.465**	2.047**
	(0.248)	(0.654)	(0.272)	(0.511)	(0.613)	(1.018)
Electricity Access	0.262***	0.185	0.333*	0.234	0.217**	0.242**
	(0.074)	(0.150)	(0.191)	(0.250)	(0.092)	(0.113)
Height for Age Z-Score	0.054**	-1.158	0.034	0.020	0.061	-0.320
(Round 1)	(0.022)	(1.667)	(0.027)	(0.420)	(0.040)	(0.522)
Height for Age Z-Score	0.093***	1.248	0.073**	0.521	0.137***	0.301
Round 3)	(0.028)	(1.169)	(0.034)	(0.385)	(0.051)	(0.341)
Constant	-1.157***	-0.234	-1.085***	-0.174	-1.098***	-1.370**
	(0.145)	(0.712)	(0.254)	(0.752)	(0.229)	(0.568)
Observations	1,705	1,705	1,009	1,009	696	696
Number of communities	82	82	50	50	77	77
R-squared	0.110		0.089		0.135	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A23: Impact of HAZ Round 1 and HAZ Round 3 on Math Z-Scores

	Full Sample		Urban Areas		Rural Areas	
Math	CFE	CFE IV	CFE	CFE IV	CFE	CFE IV
Sex	-0.123***	-0.103	-0.071	-0.114	-0.180***	-0.342*
	(0.039)	(0.191)	(0.052)	(0.093)	(0.061)	(0.180)
Age in Months	0.066***	0.049	0.070***	0.088**	0.063***	0.105**
	(0.006)	(0.079)	(0.008)	(0.044)	(0.009)	(0.047)
Mother Fluent in	0.177**	0.101	-0.018	-0.339	0.226**	0.193
Spanish	(0.082)	(0.132)	(0.145)	(0.264)	(0.104)	(0.124)
Father Fluent in	0.068	0.014	0.175	0.251	0.039	-0.018
Spanish	(0.081)	(0.101)	(0.147)	(0.211)	(0.099)	(0.125)
Female Head of	-0.020	-0.041	0.038	-0.106	-0.185*	-0.201
Household	(0.060)	(0.107)	(0.074)	(0.150)	(0.105)	(0.124)
Father's Education	-0.000	0.000	-0.002	-0.004	0.000	-0.002
Level	(0.002)	(0.004)	(0.003)	(0.005)	(0.002)	(0.003)
Mother's Education	0.018***	0.010**	0.028***	-0.003	0.014***	0.016***
Level	(0.003)	(0.005)	(0.006)	(0.018)	(0.004)	(0.006)
Wealth Index	1.418***	0.760	1.137***	0.124	1.878***	0.716
	(0.232)	(0.523)	(0.271)	(0.637)	(0.515)	(1.235)
Electricity Access	0.216***	0.087	0.321*	0.193	0.141*	0.099
	(0.066)	(0.090)	(0.190)	(0.311)	(0.077)	(0.099)
Height for Age Z-	0.051**	-0.182	0.033	0.221	0.060*	0.506
Score	(0.020)	(0.895)	(0.027)	(0.512)	(0.032)	(0.506)
(Round 1)						
Height for Age Z-	0.122***	0.787	0.121***	0.842*	0.112***	0.083
Score	(0.026)	(0.607)	(0.034)	(0.480)	(0.042)	(0.311)
Round 3)						
Constant	-1.284***	-0.202	-1.386***	0.230	-1.245***	-0.462
	(0.130)	(0.406)	(0.253)	(0.937)	(0.187)	(0.660)
Observations	1,843	1,843	1,010	1,010	833	833
Number of communities	82	82	51	51	77	77
R-squared	0.181		0.179		0.175	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A24: Impact of HAZ Round 1 and HAZ Round 3 on PPVT Z-Scores by Age Group

PPVT	$Age\ in\ Round\ 1 \leq 12\ Months$		$Age\ in\ Round\ 1 > 12\ Months$	
	CFE	CFE IV	CFE	CFE IV
Sex	-0.100*	-0.021	-0.058	-0.078
	(0.052)	(0.191)	(0.053)	(0.135)
Age in Months	0.026*	-0.024	0.014	0.024
	(0.015)	(0.094)	(0.015)	(0.028)
Mother Fluent in Spanish	0.219*	0.231	0.305***	0.225
	(0.112)	(0.301)	(0.110)	(0.146)
Father Fluent in Spanish	0.161	0.187	-0.149	-0.242
	(0.114)	(0.184)	(0.106)	(0.162)
Female Head of	0.022	0.031	-0.108	-0.080
Household	(0.082)	(0.256)	(0.080)	(0.110)
Father's Education Level	0.001	0.003	-0.003	-0.005
	(0.002)	(0.005)	(0.002)	(0.003)
Mother's Education Level	0.025***	0.020	0.009**	0.004
	(0.005)	(0.013)	(0.004)	(0.006)
Wealth Index	1.045***	0.830	1.432***	0.292
	(0.303)	(0.805)	(0.322)	(0.601)
Electricity Access	0.417***	0.329**	0.210**	-0.004
	(0.090)	(0.143)	(0.092)	(0.145)
Height for Age Z-Score	0.044*	-0.668	0.064**	0.108
(Round 1)	(0.024)	(1.071)	(0.032)	(0.424)
Height for Age Z-Score	0.106***	0.804*	0.109***	0.758
Round 3)	(0.033)	(0.440)	(0.038)	(0.465)
Constant	-1.158***	-0.591	-0.462*	0.921
	(0.201)	(0.812)	(0.279)	(0.639)
Observations	894	894	908	908
Number of communities	78	78	81	81
R-squared	0.174		0.120	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A25: Impact of HAZ Round 1 and HAZ Round 3 on EGRA Z-Scores by Age Group

EGRA	$Age\ in\ Round\ 1 \leq 12\ Months$		$Age\ in\ Round\ 1 > 12\ Months$	
	CFE	CFE IV	CFE	CFE IV
Sex	0.027	0.003	0.069	0.068
	(0.063)	(0.109)	(0.060)	(0.119)
Age in Months	0.010	0.018	0.022	0.023
	(0.018)	(0.071)	(0.017)	(0.027)
Mother Fluent in Spanish	0.230*	0.094	0.291**	0.268**
	(0.136)	(0.250)	(0.124)	(0.131)
Father Fluent in Spanish	0.002	-0.002	-0.162	-0.179
	(0.142)	(0.155)	(0.122)	(0.140)
Female Head of Household	0.053	-0.051	-0.077	-0.071
	(0.097)	(0.177)	(0.089)	(0.096)
Father's Education Level	-0.003	-0.003	0.003	0.003
	(0.003)	(0.005)	(0.003)	(0.004)
Mother's Education Level	0.033***	0.025***	0.010**	0.008
	(0.006)	(0.009)	(0.005)	(0.006)
Wealth Index	1.210***	0.758	0.932***	0.624
	(0.357)	(0.476)	(0.358)	(0.570)
Electricity Access	0.393***	0.328**	0.149	0.097
	(0.111)	(0.128)	(0.106)	(0.131)
Height for Age Z-Score (Round 1)	0.046	0.029	0.048	0.040
	(0.030)	(0.762)	(0.036)	(0.406)
Height for Age Z-Score Round 3)	0.084**	0.482	0.105**	0.280
	(0.040)	(0.417)	(0.043)	(0.450)
Constant	-1.210***	-0.459	-0.729**	-0.394
	(0.246)	(0.523)	(0.318)	(0.574)
Observations	837	837	868	868
Number of communities	78	78	80	80
R-squared	0.135		0.077	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.

Table A26: Impact of HAZ Round 1 and HAZ Round 3 on Math Z-Scores by Age Group

Math	$Age\ in\ Round\ 1 \leq 12\ Months$		$Age\ in\ Round\ 1 > 12\ Months$	
	CFE	CFE IV	CFE	CFE IV
Sex	-0.135**	-0.040	-0.127**	-0.068
	(0.056)	(0.208)	(0.056)	(0.126)
Age in Months	0.037**	-0.026	0.063***	0.053*
	(0.016)	(0.102)	(0.016)	(0.028)
Mother Fluent in Spanish	0.222*	0.239	0.146	0.113
	(0.120)	(0.314)	(0.117)	(0.130)
Father Fluent in Spanish	0.102	0.133	0.043	-0.025
	(0.122)	(0.205)	(0.112)	(0.138)
Female Head of Household	0.140	0.155	-0.124	-0.088
	(0.087)	(0.261)	(0.084)	(0.101)
Father's Education Level	-0.001	0.002	-0.001	-0.000
	(0.002)	(0.005)	(0.002)	(0.003)
Mother's Education Level	0.026***	0.020	0.012***	0.009
	(0.006)	(0.013)	(0.004)	(0.006)
Wealth Index	0.777**	0.547	1.938***	1.413**
	(0.322)	(0.848)	(0.342)	(0.579)
Electricity Access	0.274***	0.165	0.159	0.070
	(0.095)	(0.160)	(0.097)	(0.128)
Height for Age Z-Score (Round 1)	0.016	-0.816	0.096***	-0.133
	(0.026)	(1.102)	(0.033)	(0.397)
Height for Age Z-Score Round 3)	0.122***	0.958*	0.104**	0.591
	(0.035)	(0.504)	(0.040)	(0.447)
Constant	-1.050***	-0.345	-1.157***	-0.587
	(0.213)	(0.819)	(0.292)	(0.578)
Observations	914	914	929	929
Number of communities	80	80	81	81
R-squared	0.133		0.153	

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
Instrumental Variables for 2SLSFE (two-stage least squares with community fixed effects) are:
Full Sample: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Rural Areas: Access to Sanitation, Piped Water, Cement Floor, Doctor at Birth, Nurse at Birth, Midwife at Birth.
Urban Areas: Piped Water, Doctor at Birth, Access to Sanitation, Nurse at Birth.