SSM - Population Health 3 (2017) 767–786

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

Article

Disparities in children's vocabulary and height in relation to household wealth and parental schooling: A longitudinal study in four low- and middle-income countries

Sarah A. Reynolds[a,*], Chris Andersen[b], Jere Behrman[c], Abhijeet Singh[d], Aryeh D. Stein[e], Liza Benny[f], Benjamin T. Crookston[g], Santiago Cueto[h], Kirk Dearden[i], Andreas Georgiadis[f], Sonya Krutikova[j], Lia C.H. Fernald[a]

[a] School of Public Health, University of California, Berkeley, CA, USA
[b] Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, MA, USA
[c] School of Arts and Sciences, University of Pennsylvania, Philadelphia, PA, USA
[d] University College London, UK
[e] Rollins School of Public Health, Emory University, Atlanta, GA, USA
[f] Young Lives, Department of International Development, University of Oxford, UK
[g] College of Life Sciences, Brigham Young University, Provo, UT, USA
[h] Group for the Analysis of Development and Pontificia Universidad Católica del Perú, Lima, Peru
[i] IMA World Health, Dar es Salaam, Tanzania
[j] EDePo, Institute for Fiscal Studies, London, UK

ABSTRACT

Children from low socio-economic status (SES) households often demonstrate worse growth and developmental outcomes than wealthier children, in part because poor children face a broader range of risk factors. It is difficult to characterize the trajectories of SES disparities in low- and middle-income countries because longitudinal data are infrequently available. We analyze measures of children's linear growth (height) at ages 1, 5, 8 and 12y and receptive language (Peabody Picture Vocabulary Test) at ages 5, 8 and 12y in Ethiopia, India, Peru and Vietnam in relation to household SES, measured by parental schooling or household assets. We calculate children's percentile ranks within the distributions of height-for-age z-scores and of age- and language-standardized receptive vocabulary scores. We find that children in the top quartile of household SES are taller and have better language performance than children in the bottom quartile; differences in vocabulary scores between children with high and low SES are larger than differences in the height measure. For height, disparities in SES are present by age 1y and persist as children age. For vocabulary, SES disparities also emerge early in life, but patterns are not consistent across age; for example, SES disparities are constant over time in India, widen between 5 and 12y in Ethiopia, and narrow in this age range in Vietnam and Peru. Household characteristics (such as mother's height, age, and ethnicity), and community fixed effects explain most of the disparities in height and around half of the disparities in vocabulary. We also find evidence that SES disparities in height and language development may not be fixed over time, suggesting opportunities for policy and programs to address these gaps early in life.

Introduction

Optimal development in early childhood is associated with better health, cognitive and language development, and achievement, concurrently and later in life (Grantham-McGregor et al., 2007; Hoddinott, Alderman, Behrman, Haddad, & Horton, 2013; Martorell et al., 2010; Victora et al., 2008). More than 250 million children under 5y are at risk for not meeting their developmental potential due to living in extreme poverty and/or because they have experienced linear growth retardation (stunting) (Black et al., 2016; Lu, Black, & Richter, 2016); direct measures of cognitive child development have confirmed the magnitude of the problem (McCoy et al., 2016). Children living in poverty receive fewer household- and community-level investments (e.g., nutrition, health, education, and responsive stimulation) than children who do not live in poverty (Engle et al., 2011; Walker, Wachs et al. 2011). For these reasons, among others, the United Nations has

* Corresponding author.
E-mail address: sar48@berkeley.edu (S.A. Reynolds).

http://dx.doi.org/10.1016/j.ssmph.2017.08.008
Received 16 February 2017; Received in revised form 7 August 2017; Accepted 21 August 2017
2352-8273/

included reducing inequality within and among countries as a key Sustainable Development Goal (Nino, 2016).

Developmental disparities between children from lower and higher socio-economic status (SES) households persist into adulthood. In low- and middle-income countries, child height is associated with adult skills, marriage partner quality, and labor market outcomes (Hoddinott, Alderman et al., 2013, Hoddinott, Behrman et al., 2013a). Better early cognitive skills, including those related to language, are associated with higher labor market earnings and lower levels of risky behavior later in life (Gertler et al., 2014; Heckman, Stixrud, & Urzua, 2006; Walker, Chang, Vera-Hernández, & Grantham-McGregor, 2011). Thus, investing in children through a range of interventions can affect children's cognitive and physical development, and can have long-term implications in many other domains (Britto et al., 2016; Hoddinott, Maluccio, Behrman, Flores, & Martorell, 2008).

While the persistence of health and cognitive disparities has been well-documented in high-income countries (Bradley & Corwyn, 2002; Case, Lubotsky, & Paxson, 2002; Pavalko & Caputo, 2013), less longitudinal research has been done in low- or middle-income countries. Most literature to date has relied on cross-sectional data, requiring strong assumptions to be made in drawing inferences about changes with age. Moreover, existing studies often capture a limited age range (Fernald, Kariger, Hidrobo, & Gertler, 2012; Fernald, Weber, Galasso, & Ratsifandrihamanana, 2011; Ghuman, Behrman, Borja, Gultiano, & King, 2005; Paxson & Schady, 2007; Rubio-Codina, Attanasio, Meghir, Varela, & Grantham-McGregor, 2015a). Evidence from Colombia, the country with the widest age-range we found to have been studied cross-sectionally, supports the hypothesis that disparities in vocabulary initially widen with age but the supposed widening may halt in later childhood, as the disparities at 8.5y are of a similar magnitude to those at 4.5y (Bernal & Van Der Werf, 2011; Rubio-Codina, Attanasio, Meghir, Varela, & Grantham-McGregor, 2015b).

The limited available longitudinal research supports these cross-sectional findings. Data from Bangladesh (following children from age 0 until 5y) (Hamadani et al., 2014), Ecuador (following children from 3–5y until 10–12y) (Schady et al., 2015), Madagascar (following children 3–6y until 7–10y) (Galasso, Weber, & Fernald, 2017), Nicaragua (following children 3–6y until 6–9y) (Macours, Schady, & Vakis, 2012), and the Young Lives countries (Ethiopia, India, Peru, and Vietnam, following children from 5y until 8y) (Lopez Boo, 2016) provide some additional evidence that SES-related differences in cognitive child development scores increase throughout early childhood, flatten around 5–7y, and are constant through the remaining pre-pubertal years.

We are aware of only three studies that engage in cross-country comparisons. These studies apply the same method in differing contexts, an advantage over comparing multiple, individual-county studies. In one cross-sectional analysis looking at disparities in early child development in India, Indonesia, Peru and Senegal, within-country differences in length-for-age and child development scores by SES are evident as early as 3–23mo (Fernald et al., 2012). Findings from another study of children 3–6y in five Latin American countries (some with cross-sectional data and some with longitudinal data) align with the hypothesis that disparities in vocabulary widen at early ages, with little further change once children are in elementary school (Schady et al., 2015). A final longitudinal study examines children from the Young Lives Study Countries (Ethiopia, India, Peru and Vietnam) at 5 and 8y, and finds the magnitude of within-country SES differences in vocabulary to persist over time (Lopez Boo, 2016). Each paper finds consistent patterns but the sizes of the SES disparities vary by country.

The existing literature implies that vocabulary disparities attributable to SES widen in early childhood and persist into middle childhood, though this hypothesis has not been directly tested. Furthermore, most of the extant studies do not address disparities in height after early childhood. Stunting had been thought to be determined by 2–3y (Victora et al., 2008); however, recent research from the Young Lives Study indicates that HAZ may be influenced by SES as late as 8y (Lundeen et al., 2014; Schott, Crookston, Lundeen, Stein, & Behrman, 2013) and is associated with improved cognitive outcomes in children who experience growth recovery compared to children who are persistently stunted (Crookston et al., 2013). Data from rural Gambia further illustrates increases in HAZ in adolescence (Prentice et al., 2013). Variation in adult height is strongly predicted by growth in the first years of life (Stein et al., 2010), and there is limited evidence of potential for nutritional interventions to impact on linear growth when delivered after age 2y (Roberts & Stein, 2017). Thus identifying common underlying determinants of disparities in growth and cognitive achievement is of value because, while sharing some important inputs like nutrition, they are not perfectly correlated and height and vocabulary are both associated with schooling, economic productivity, health and other outcomes later in the life cycle (Britto et al., 2016).

Our study extends the existing research, in particular building on the cross-country Young Lives Study (Lopez Boo, 2016). Our objective is to contribute to the literature with a longitudinal description of childhood disparities in height and vocabulary (a measure of cognitive achievement) associated with two measures of SES (household wealth and parental schooling). Height data are available at 1, 5, 8 and 12y and vocabulary data are available at 5, 8, and 12y. We hypothesize that SES-related disparities in height will widen between 1 and 5y and that SES-related disparities in both height and vocabulary will remain constant from 5 to 12y. Since many studies confirm that household and community covariates account for much of these SES gaps (Fernald et al., 2012, 2011; Hamadani et al., 2014; Lopez Boo, 2014; Rubio-Codina et al., 2015a), in a non-causal analysis we describe the extent to which these covariates at age 1y account for the size of the SES-related disparities at 12y.

Methods

Data

We analyze data from the Young Lives Study, which recruited children in each of four countries (Ethiopia, India, Peru, and Vietnam) in 2002 (Barnett et al., 2013). The present analysis uses data from the younger cohort, who were between 6.0 and 17.9 months at recruitment (mean 11.7 months). Follow-up data were collected in 2006 (mean 5.3y), in 2009 (mean 7.9y), and in 2013 (mean 12.0y). We refer to the survey rounds as ages 1, 5, 8 and 12, respectively.

In each of the study countries, participants were selected through a multi-stage sampling process beginning with 20 sentinel sites that were purposively selected to reflect the Young Lives study's aims of examining the causes and consequences of childhood poverty and diversity of childhood experiences. In India, recruitment was restricted to the state of Andhra Pradesh, which subsequently divided into two states, Andhra Pradesh and Telangana. Within each sentinel site, approximately 100 children within the eligible age category were randomly sampled ("Young Lives methods guide," 2017). Less than 2% of selected households refused to participate. There was one study child per household. Comparisons with children in the nationally-representative Demographic and Health Surveys (DHS) found the Young Lives samples to cover a broad diversity of children within each country ("Young Lives methods guide," 2017).

Sample size and exclusions

The first Young Lives survey round (age 1y) included 1999 children in Ethiopia, 2011 children in India, 2052 children in Peru, and 2000 children in Vietnam. We limit the analytic sample to children for whom the following data are available: wealth index, parents' or caregiver's schooling, HAZ, and vocabulary test (and whether it was taken in the same major language at both 5 and 12y) (Table A1). Being a "major language" was defined as having at least 100 children take the test in that language in the 5 and 12y surveys. Because our analysis focuses on final outcomes at 12y, we do not restrict the sample used in the main analysis based on language of the test taken or availability of outcome data at 8y. Major languages by this definition are Amarigna (Amharic), Oromifa, and Tigrigna for Ethiopia; Telugu for India; Spanish for Peru; and Tiếng Việt for Vietnam. We include all major languages instead of official languages due to the large number of children in Ethiopia who took the vocabulary assessment in a range of languages. A robustness check considers only children who took the vocabulary assessment in Amarigna, the official language in Ethiopia. We drop observations with implausible values beyond six standard deviations for HAZ [Ethiopia N = 1; India N = 4; Peru N = 3; Vietnam N = 3]. Children in the analytic sample generally had higher measures of SES than those who were excluded (Table A2).

Variables used to characterize SES

The household wealth index variable, measured at 1y, is country-specific. Details regarding variables included for each country and their weights are available elsewhere (Alemu et al., 2003; Escobal et al., 2003; Galab et al., 2003; Tuan et al., 2003). The wealth index includes measures of housing quality, ownership of consumer durables, and access to services such as electricity, water and sanitation; these sub-indices are weighted equally in the composite index. We divide the analytical sample within each country into quartiles based on the wealth index. Although Peru and Vietnam are higher income countries than Ethiopia and India, not all components of the wealth index reflect this difference. For example, all countries have close to universal coverage of electricity in the top quartile, but India's lower quartile has higher electricity coverage than Peru's (Table A3).

Parental schooling was recorded when the child was 5y. We code parental formal schooling attainment according to country-specific thresholds of lower and upper primary and lower and upper secondary. Respondents who indicated that they were literate but had not participated in any formal schooling [Ethiopia N = 219; India N = 75; Peru N = 1; Vietnam N = 0] are assigned to the incomplete lower primary schooling level. Fig. A1 illustrates the distribution of parental schooling pairs and shows the schooling levels that are coded with integer values 0-9. Children with information on only one parent's schooling [Ethiopia N = 113; India N = 1; Peru N = 9; Vietnam N = 25] are assigned the schooling level of that parent. Children with no information on parental schooling [Ethiopia N = 4; India N = 0; Peru N = 0; Vietnam N = 1] are assigned the schooling level of the caregiver. One child in Ethiopia did not have information on parental or caregiver schooling, so questions from the previous survey round (1y) regarding whether the caregiver and caregiver's partner had completed primary or secondary school are used to assign parental levels of schooling. Using this average parental schooling index, we divide the analytical sample within each country, approximating quartiles as closely as possible.

Wealth refers directly to assets that are available, but parental schooling may also represent parental knowledge of good child development practices and the opportunity costs of time. In this study the correlation coefficients for household wealth and parental schooling are 0.64 for Ethiopia, 0.58 for India, 0.59 for Peru, and 0.65 for Vietnam.

Child outcomes: height and language development

Supine length (at 1y) and height (at ages 5, 8, and 12y) were measured to 1 mm using standardized length boards and stadiometers. Height-for-age Z scores (HAZ) were computed using the WHO Growth Standards (World Health Organization, 2006) for children $\leq$ 60mo and the WHO Growth References (de Onis et al., 2007) for children > 60 mo. Length-for-age was measured at 1y, but for consistency with later height measurements, we refer to the length-for-age z-score as HAZ. Because HAZ of infants is inversely correlated with age in many low- and middle-income countries (Victora, de Onis, Hallal, Blössner, & Shrimpton, 2010), the 1y HAZ measurements are adjusted to their predicted value at age 12mo by calculating the difference between each child's HAZ and the mean HAZ for children within 1 month of the child's age in the same country. This value is added to the mean HAZ for children aged 11–13mo. This adjustment is preferable to adding age as a covariate in the model because the adjustment does not assume a linear relationship between HAZ and age. This technique has been employed in previous analyses (Andersen et al., 2015; Crookston et al., 2013; Lundeen et al., 2014).

The Young Lives Study data set includes several measures of cognition including vocabulary, reading, writing, and math, but vocabulary is the only test used here because it was consistently administered as early as age 5 years. The vocabulary test has a sufficient range in difficulty to be applied at all ages, which allows for increased confidence in the longitudinal comparisons of child cognition. Children were administered the Peabody Picture Vocabulary Test (PPVT) version 3 (Dunn & Dunn, 1997) and, in Peru, the Spanish Version (Test de Vocabulario en Imágenes Peabody) (Dunn, Padilla, Lugo, & Dunn, 1986) at 5, 8, and 12y. Country- and round-specific details about the test, including selection of questions, implementation, and psychometric properties, can be found elsewhere (Cueto & Leon, 2012; Cueto, Leon, Guerrero, & Muñoz, 2009). To compare results over time, we age-normalized the raw scores within each survey round and language of administration. The means and standard deviations used to calculate the age and language standardized PPVT scores are generated applying a previously-used methodology: mean PPVT for the age in months is estimated with a cubic polynomial (Rubio-Codina et al., 2015a). For the age-conditional standard deviation, we square the residuals of the previous regression, and regress them on another cubic polynomial of age in months. This method allows for continuity in the standardized scores across months but still allows for flexibility by month of the mean and variance used in the standardization.

There is evidence that measures of child health and development vary in terms of how they are related to SES variables; for example, SES disparities in Madagascar are larger for vocabulary scores than for linear growth (Fernald et al., 2011). These comparisons are challenging because the growth and language processes are not often measured on the same scale. Thus we use percentiles, an approach used before in studies on skill comparison (Neal, 2006) and intergenerational mobility (Chetty, Hendren, Kline, & Saez, 2014; Zhang, Behrman, Fan, Wei, & Zhang, 2014). In order to compare the two outcomes, we compute the percentile rank of each child on HAZ and age- and language-standardized PPVT. We also provide analyses using the raw HAZ distribution in the Appendix A. Because there is no global standard for vocabulary, we do not include standardized cross-country comparisons for language.

We use the interchangeable terms 'disparity' and `gap' to refer to

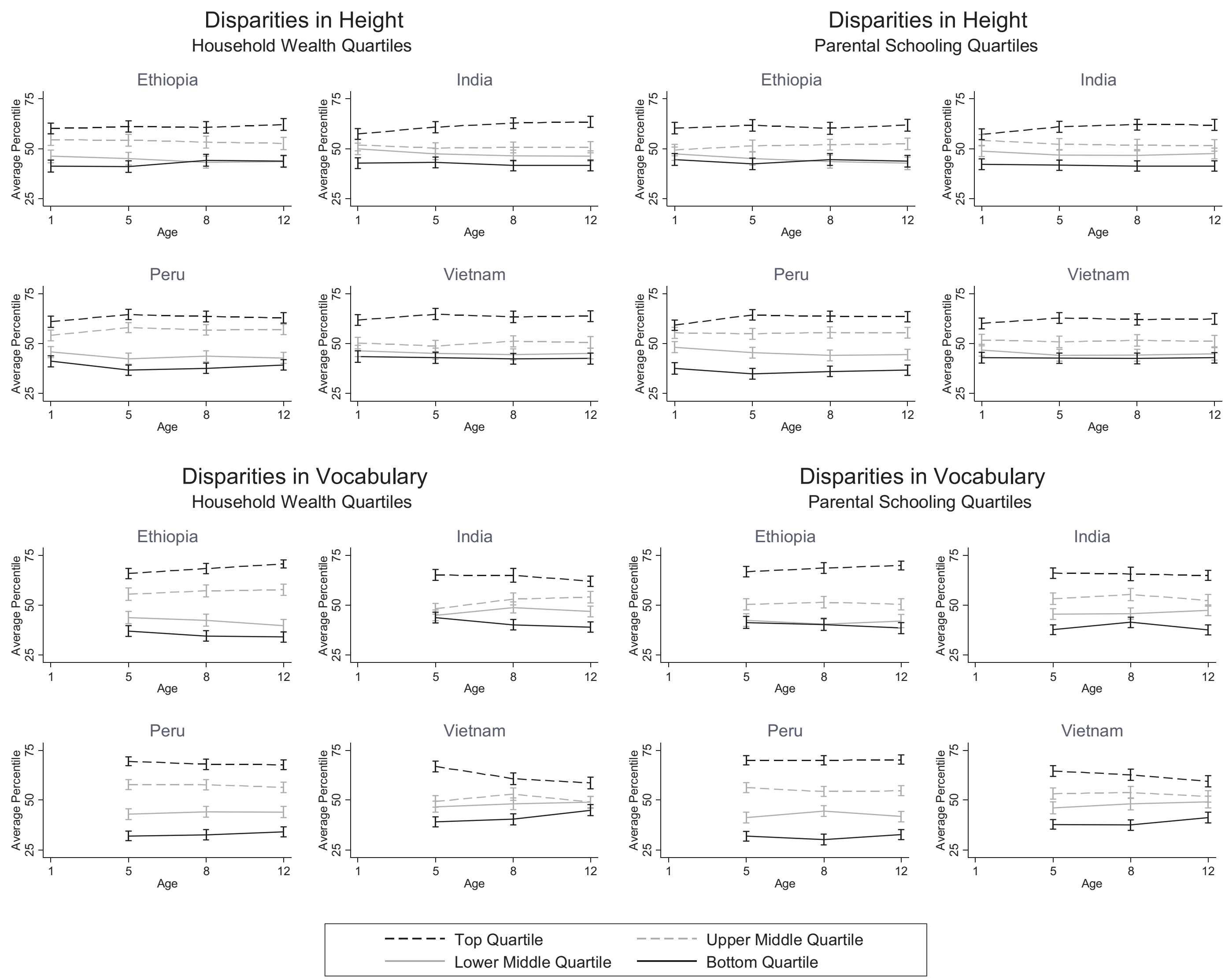

Fig. 1. Disparities in height and vocabulary scores from household wealth and parental schooling, Young Lives study. Vocabulary (PPVT) is standardized within country and language of administration.

differences in mean percentile rank of height or PPVT score between top and bottom quartiles of the household wealth or parental schooling indices. Larger gaps arise from stronger associations between SES and child outcomes, which could be interpreted as inequality.

Correlations between the standardized height and vocabulary outcomes range from 0.11 to 0.26; correlations between the percentile ranks of the two outcomes are slightly higher, ranging from 0.17 to 0.37.

Household covariates and community fixed effects

All covariates were recorded when children were 1y. Covariates include mother's height in centimeters, mother's age in years, ethnicity indicator variables,[1] and an indicator variable for whether the mother speaks the region's official language. We impute missing covariates (Table A4) using multivariate normal regression (20 repetitions; Stata command *mi impute mvn*). We use sentinel site location codes to generate community fixed effects. By 12y, 12% (Ethiopia), 14% (India), 75% (Peru) and 9% (Vietnam) of children no longer lived within the sentinel sites, thus we use the child's community from age 1y to define these fixed effects.

Statistical analyses

For each country (Ethiopia, India, Peru, Vietnam) measure of SES (wealth or parental schooling), and outcome (percentile height and percentile vocabulary), we graph the mean and 95% confidence intervals of each outcome at each age by SES quartile. We impute outcome variables missing at age 8y (Table A4) using multivariate normal regression (20 repetitions; Stata command *mi impute mvn*).

For each combination of country, SES measure, and outcome, we test for the presence of non-parallel linear trends in child age using the OLS regression

$$y_{it} = \beta_Q Q_{i1} + \sum_{\forall t \in j} \beta_a a_t + \beta_p Q_{i1} \bullet A_{it} + C + e_{it} \tag{1}$$

in which the outcome variable for each child i at age t is $y_{it.}Q_{i1}$ is an indicator variable for child i being in the top SES quartile in early childhood (age 1 for wealth, age 5 for parental schooling) versus being in the bottom quartile. Children in middle quartiles are not included in this analysis. The coefficient on this variable, β_Q, measures the size of

[1] Ethnicities are Amhara, Gurage, Hadiva, Oromo, Sidama, Tigrian, Wolavta, and other (Ethiopia); Scheduled Caste, Scheduled Tribe, Backward Class, and other (India); White, Mestizo including Andean Indigenous, and other (Peru); and H'mong, Kinh and other (Vietnam)

the disparity at the first age the outcome variable is measured, 1y for height and 5y for vocabulary. We control for time factors a that influence all children, measured by indicator variables for the age at each survey a_t. For HAZ, elements of j are 5, 8, and 12y; for vocabulary, elements of j are 8 and 12y. C is the mean outcome at the first age measured of the reference group, the children in the bottom quartile. To test for parallel trends, we examine β_p, the coefficient on the interaction between age and the variable that indicates the child was in the top SES quartile at age 1y. Age in the interaction term A_{it} is distinct from a_t, as A_{it} is continuous and a_t are indicators. We reject the null hypothesis of parallel trends if β_p is statistically distinct from 0. The error term is e_{it}. We cluster standard errors at the child level. In a robustness check, we test whether disparities change over time in comparison to the disparity present at 1y (i.e., do the differences between high and low SES become more or less pronounced at each age). In no cases do we reject the assumption of monotonicity of the differences over age, so we present the simpler specification. To test that parallel trends do not arise from worsening scores for both top and bottom quartiles, we test that, for the lowest quartile, slopes are not negative.

To consider the sensitivity of the height findings at 12y to puberty progression, which is associated with SES (Deardorff, Abrams, Ekwaru, & Rehkopf, 2014; James-Todd, Tehranifar, Rich-Edwards, Titievsky, & Terry, 2010), we calculate an expected increase in height within the top and bottom quartiles for those who, per self-report, did not yet have evidence of initiation of puberty (onset of menses in girls and voice-lowering in boys). We calculate mean percentile of HAZ by girls' menstruation onset status and boys' low voice status. Since research suggests that age of onset of puberty is not correlated or is weakly correlated with final height, we assume that children who did not yet exhibit these puberty markers would later achieve the mean height of those who did exhibit them (Limony, Kozieł, & Friger, 2015; Lundeen et al., 2016; Stein et al., 2016; Vizmanos, Martí-Henneberg, Clivillé, Moreno, & Fernández-Ballart, 2001). We calculate the differences in mean height and multiply these differences by the portion of boys and girls respectively in each quartile who had not yet exhibited the puberty marker. We weight these final sex-specific adjustments by the portion of boys and girls in the analytic sample and report this final adjustment as a percentage of the disparity at 12y.

We examine the extent to which controlling for household variables and community fixed effects, separately and together, changes the magnitude of the disparities. We perform the following analysis twice: when the outcomes were first measured (1y or 5y) and at 12y. In both cases Q_i refers to top quartile in wealth or parental schooling as measured in early childhood.

$$y_i = \beta_Q Q_i + C + v_i \tag{2}$$

The magnitude of the SES disparity at age t without any adjustment is given by β_Q , C is the mean outcome of the reference group, the bottom quartile, and the error term is v_i. This coefficient is adjusted for the SES variable not being used to define the disparity (e.g. education is included as a covariate for the wealth models and wealth is included as a covariate for the education models). The coefficient is also adjusted for household-level covariates described above. We also adjust separately for initial community-level fixed effects, with communities defined as the sentinel sites in the Young Lives sampling framework. We choose to use age 1y location for the community fixed effects in spite of some subsequent moves because of the emphasis in the literature on the early years as being the most critical for height and cognition (Martorell et al., 2010; Victora et al., 2008). Finally, we examine the size of the gap after adjusting for both maternal characteristics and community fixed effects. For all regressions including household characteristics, we use multiple imputation estimates. All analyses were performed in Stata 14.

Results

In all four samples at all ages, children living in households in the top quartile of SES are taller and have better language proficiency than those living in households in the bottom quartile of socio-economic status (Fig. 1). These results are consistent whether socio-economic status is defined by household wealth or by parental schooling (Table 1). On average, the difference in HAZ between a child from low and high SES households is about 1 SD; this translates into a 5cm height deficit for 5-year-old girls and a 7cm deficit for 12-year-old girls. The differences in average receptive vocabulary by top and bottom SES quartiles are approximately 1 standard deviation at both age 5 and age 12, with the exception of Vietnam, where the difference is around 0.4 standard deviations at age 12. These estimates cannot be converted to number of words known because there is not a cross-cultural, normative vocabulary scale, but they can give a general sense of effect size.

There are disparities in HAZ in all countries at 1y, and in the majority of cases, the size of the SES difference remains constant as children age (Table 2, Panel A). For Indian children, the height gap widens during childhood for both wealth and schooling, and for the Peruvian children the gap widens for schooling. At 5y, SES differences in vocabulary exist in all countries; in three cases for wealth and two for schooling, the disparity is not constant across age (Table 2, Panel B). The disparities in vocabulary widens with age in Ethiopia but narrows in Vietnam and Peru. The disparity in vocabulary from wealth also shrinks with age in Peru.

A supplementary analysis indicates similar findings when height is represented as height-for-age z-score, with a few key differences (Fig. A4). In Ethiopia, the disparities in percentile height are parallel, but the disparities in HAZ shrink as children age. In India, the disparities in percentile height widen with age, but the disparities in HAZ are parallel (Table A5). We perform a robustness check for Ethiopia using the smaller sample with only speakers of Amharic, the majority language in the sample (Table A6). Within this population, for all disparities assessed we do not reject the hypothesis of parallel trends. We confirm that parallelism emerges from the quartiles' mean scores staying constant rather than both increasing or—more concerning—worsening over time: by testing that the lowest quartiles' linear trends differ from zero, we find only two cases of decline with respect to wealth (PPVT for Ethiopia and India) and none with respect to parental schooling.

We do not find significant differences in vocabulary based on puberty marker status. Observations with data on absence or presence of puberty markers range from 93% (boys in Ethiopia) to 100% (girls in Peru). Adjusting for puberty status reduces the height gap at age 12 between 7% (Peru, parental schooling disparity) and 55% (India, parental schooling disparity), except in Ethiopia, where the low prevalence of puberty markers by age 12 (9%) makes this adjustment specious. In most cases, the fraction of children with puberty markers is higher in the top SES quartiles than the bottom SES quartiles (Table A7). These exceptions (males in Ethiopia & India) are found where small fractions of children exhibit puberty markers. Without exception, girls and boys with puberty makers are taller than children without puberty markers.

For most of the analyses, the disparity in height is no longer statistically significant when adjusting for the combination of mother characteristics and community fixed effects (Fig. 2a and Table A8). Household variables generally are more strongly associated with the disparities in height than community fixed effects, but these are not statistically distinct. The supplementary analysis indicates similar findings when height is represented as height-for-age z-score HAZ (Fig. A5). In contrast, the gaps in percentile vocabulary from wealth remain statistically significant in many cases when adjusting for household

Table 1

Panel A: Summary Statistics by Wealth Disparity		Ethiopia				India (AP & TG)[b]				Peru				Vietnam			
		Bottom Quartile		Top Quartile		Bottom Quartile		Top Quartile		Bottom Quartile		Top Quartile		Bottom Quartile		Top Quartile	
	Variables	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Disparities	Wealth Index	0.05	0.04	0.48***	0.09	0.16	0.06	0.68***	0.08	0.21	0.06	0.70***	0.05	0.19	0.08	0.72***	0.10
	Average Parental Schooling[a]	1.32	1.47	5.38***	2.69	1.77	2.22	6.34***	2.65	4.37	2.08	7.84***	1.40	3.59	1.87	6.81***	1.61
Outcomes	Age & language standardized PPVT score age 5	-0.42	0.69	0.43***	0.97	-0.19	0.87	0.51***	1.23	-0.59	0.84	0.65***	0.88	-0.40	0.75	0.56***	1.11
	Age & language standardized PPVT score age 8	-0.53	0.70	0.61***	0.94	-0.30	0.78	0.55***	1.17	-0.50	0.98	0.64***	0.76	-0.28	0.79	0.43***	1.07
	Age & language standardized PPVT score age 12	-0.41	0.87	0.69***	0.50	-0.25	0.91	0.45***	0.75	-0.37	0.84	0.69***	0.76	-0.02	0.87	0.34***	0.69
	Height-for-age z-score age 1 (adjusted)	-2.29	1.78	-1.26***	1.61	-1.65	1.47	-1.01***	1.28	-1.53	1.21	-0.72***	1.21	-1.42	1.33	-0.71***	1.12
	Height-for-age z-score age 5	-1.71	1.05	-0.98***	0.98	-1.88	0.96	-1.29***	0.98	-1.91	0.98	-0.88***	0.97	-1.55	0.95	-0.75***	1.04
	Height-for-age z-score age 8	-1.31	0.97	-0.74***	0.97	-1.69	1.19	-1.04***	1.11	-1.46	0.98	-0.57***	0.96	-1.32	0.96	-0.54***	1.09
	Height-for-age z-score age 12	-1.65	0.92	-01***	1.00	-1.75	0.92	-0.97***	1.06	-1.32	1.00	-0.44***	0.98	-1.25	1.01	-0.43***	1.10
Mother Variables	Mother Speaks Local Language Fluently	0.82	0.38	0.81	0.39	0.31	0.46	0.59***	0.49	0.11	0.32	0.08*	0.27	0.87	0.33	0.99***	0.09
	Mother's Age	28.33	6.78	26.89***	6.18	23.51	4.49	23.94	4.03	26.45	6.88	27.05	6.33	25.87	5.51	29.19***	5.78
	Mother's Height (cm)	157.69	5.95	159.49***	6.49	150.75	5.62	152.03*-**	5.21	149.06	5.70	151.99***	5.47	152.00	5.74	152.69*	5.49
	N	336		351		397		403		386		401		378		388	

Panel B: Summary Statistics by Parental Schooling Disparity		Ethiopia				India (AP & TG)[b]				Peru				Vietnam			
		Bottom Quartile		Top Quartile		Bottom Quartile		Top Quartile		Bottom Quartile		Top Quartile		Bottom Quartile		Top Quartile	
	Variables	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Disparities	Wealth Index	0.16	0.11	0.42***	0.15	0.29	0.15	0.58***	0.18	0.29	0.14	0.59***	0.15	0.30	0.18	0.63***	0.18
	Average Parental Schooling[a]	0.00	0.00	6.8***	1.23	0.00	0.00	7.92***	0.82	2.91	1.05	8.77***	0.25	2.71	1.21	7.62***	0.89
Standardized Outcomes	Age & language standardized PPVT score age 5	-0.30	0.81	0.49***	1.07	-0.37	0.64	0.56***	1.26	-0.60	0.81	0.67***	0.90	-0.42	0.76	0.51***	1.18
	Age & language standardized PPVT score age 8	-0.34	0.85	0.61***	0.94	-0.27	0.81	0.54***	1.13	-0.57	1.01	0.70***	0.74	-0.36	0.74	0.49***	1.06
	Age & language standardized PPVT score age 12	-0.29	0.95	0.66***	0.57	-0.31	0.94	0.53***	0.74	-0.43	0.86	0.76***	0.82	-0.12	0.90	0.36***	0.68
	Height-for-age z-score age 1 (adjusted)	-2.09	1.87	-1.26***	1.62	-1.71	1.60	-0.99***	1.47	-1.66	1.20	-0.8***	1.16	-1.44	1.19	-0.79***	1.23
	Height-for-age z-score age 5	-1.66	1.02	-0.94***	1.05	-1.94	0.88	-1.30***	1.03	-1.99	1.00	-0.89***	0.98	-1.56	0.90	-0.84***	1.03
	Height-for-age z-score age 8	-1.30	1.05	-0.76***	0.99	-1.75	0.95	-1.03***	1.10	-1.51	0.94	-0.58***	0.92	-1.31	1.00	-0.62***	1.06
	Height-for-age z-score age 12	-1.63	0.87	-1.02***	1.01	-1.76	0.95	-1.03***	1.06	-1.41	0.97	-0.44***	1.01	-1.25	1.03	-0.49***	1.11
Mother Variables	Mother Speaks Local Language Fluently	0.88	0.33	0.82**	0.39	0.29	0.45	0.63***	0.48	0.09	0.29	0.09	0.29	0.88	0.33	0.99***	0.09
	Mother's Age	29.24	7.31	26.03***	5.48	24.32	5.03	23.41***	3.40	28.50	7.63	27.49**	5.82	26.17	6.11	29.35***	5.36
	Mother's Height (cm)	158.44	5.64	159.11	6.66	150.85	5.61	152.52*-**	5.31	148.36	5.66	152.55***	5.16	151.78	5.70	152.81***	5.57
	N	332		344		406		430		405		371		403		420	

Means of the Top Quartile and Bottom Quartile are significantly different at *10% **5% ***1%
Mother ethnicity indicators not listed.
[a] Levels are from 0 - 8: (0) no education (1) incomeplete lower primary (2) complete lower primary….(8) complete upper secondary.
[b] Andhra Pradesh and Telangana.

Table 2
SES disparities between top and bottom quartiles & testing for parallel trends.

	Wealth Disparity				Schooling Disparity			
	Ethiopia	India (AP & TG)[a]	Peru	Vietnam	Ethiopia	India (AP & TG)[a]	Peru	Vietnam
Panel A **Percentile Height: Ages 1, 5, 8, & 12**	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Top Quartile Indicator Variable (SES Gap at Age 1)	19.106*** (2.01)	14.446*** (1.92)	22.567*** (1.92)	19.003*** (2.05)	16.394*** (2.04)	15.587*** (1.91)	23.963*** (1.91)	17.874*** (1.98)
Age 5 Indicator Variable	0.631 (1.24)	0.462 (1.02)	-1.066 (0.98)	0.636 (0.78)	-0.617 (1.16)	0.574 (0.98)	0.581 (0.98)	0.819 (0.80)
Age 8 Indicator Variable	2.229 (1.39)	-0.315 (1.20)	-1.479 (1.03)	-0.61 (1.05)	-0.441 (1.28)	0.113 (1.13)	0.209 (1.06)	0.185 (1.02)
Age 12 Indicator Variable	2.875 (1.76)	-1.36 (1.46)	-1.504 (1.32)	-0.9 (1.31)	-0.306 (1.56)	-0.978 (1.34)	-0.382 (1.32)	0.054 (1.27)
Top Quartile (Indicator) X Age (Continuous)	**-0.103 (0.22)**	**0.693*** (0.18)**	**0.274 (0.17)**	**0.252 (0.16)**	**0.12 (0.21)**	**0.517*** (0.17)**	**0.385** (0.16)**	**0.183 (0.16)**
Constant (Bottom Quartile at Age 1)	41.151*** (1.45)	42.552*** (1.36)	39.673*** (1.37)	43.047*** (1.45)	44.180*** (1.49)	41.699*** (1.32)	36.143*** (1.40)	42.487*** (1.35)
p-value of coefficient on Top Quartile X Age	0.634	0	0.108	0.113	0.561	0.003	0.019	0.251
N	2744	3197	3138	3053	2699	3341	3092	3284

	Wealth Disparity				Schooling Disparity			
	Ethiopia	India (AP & TG)[a]	Peru	Vietnam	Ethiopia	India (AP & TG)[a]	Peru	Vietnam
Panel B **Percentile Vocabulary: Ages 5, 8, & 12**	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Top Quartile Indicator Variable (SES Gap at Age 5)	24.175*** (2.90)	21.226*** (3.12)	40.028*** (2.39)	37.363*** (3.12)	21.287*** (3.12)	27.790*** (2.99)	39.242*** (2.53)	33.650*** (3.01)
Age 8 Indicator Variable	-1.62 (1.29)	-2.397* (1.37)	0.352 (0.97)	0.639 (1.29)	-0.872 (1.39)	2.094 (1.37)	-0.631 (1.02)	0.8 (1.30)
Age 12 Indicator Variable	-2.896* (1.62)	-4.626*** (1.65)	2.072* (1.23)	5.826*** (1.61)	-2.818 (1.85)	-0.291 (1.68)	0.942 (1.38)	3.511** (1.60)
Top Quartile (Indicator) X Age (Continuous)	**1.076*** (0.30)**	**0.201 (0.33)**	**-0.541** (0.24)**	**-2.021*** (0.34)**	**0.850** (0.33)**	**-0.106 (0.33)**	**-0.101 (0.26)**	**-1.250*** (0.33)**
Constant (Bottom Wealth Quartile at Age 5)	36.725*** (1.31)	43.311*** (1.36)	32.009*** (1.21)	39.330*** (1.26)	41.247*** (1.45)	38.236*** (1.19)	31.497*** (1.20)	37.440*** (1.21)
p-value of coefficient on Top Quartile X Age	0	0.536	0.023	0	0.01	0.743	0.697	0
N	2048	2244	2314	2241	2012	2340	2271	2415

N = number of children in top & bottom quartiles x number of rounds. Some children are missing outcomes in intermediate rounds.
Significant at *0.1 **0.05 ***0.01.
Standard errors clustered by child.
[a] Andhra Pradesh and Telangana.

characteristics and community fixed effects; the adjusted gap is around 50% of the size of the unadjusted gap (Fig. 2b and Table A8). In two cases (Ethiopia and Vietnam for vocabulary) disparities at first age measured and at 12y are significantly different. Yet when we include maternal characteristics and community fixed effects, the adjusted disparities at age first measured and at 12y are of a similar magnitude.

Discussion

We find that children living in households with more material resources and/or with parents who have more schooling are taller and perform better on a test of receptive vocabulary on average than children who live with less wealth or with parents who have attained fewer grades of schooling; these findings are consistent across four low- or middle-income countries at all ages measured. The differences in mean percentile height between children living in low and high SES households are established early in life and persist —and in a few cases they increase—between 1y and 12y. In contrast, disparities in vocabulary do not have consistent trends across ages from when they were first measured (5y) through to the final measurement (12y). The SES gaps in percentile vocabulary are larger in general than SES gaps in percentile height.

In contrast to our hypotheses, our results indicate that disparities in vocabulary between the first and fourth SES quartile on average may increase or decrease over time, depending on the context. This finding implies that policies may be able to influence vocabulary, which is a conclusion supported by the understanding of sensitive periods in the science of development in early and middle childhood (Adair, 1999; Behrman, 2015; Crookston et al., 2010, 2011, 2013; Georgiadis et al., 2016; Lundeen et al., 2014; Mani, 2012; Penny, Schott, Crookston, & Behrman, 2015; Prentice et al., 2013; Schott et al., 2013). Similarly, these findings support the understanding that cognition can be plastic for a longer period of time than linear growth. This result contrasts with the existing research in lower- and middle-income countries that suggests disparities in vocabulary stabilize during middle childhood (Galasso et al., 2017; Schady et al., 2015).

Disparities in height at first measurement and at 12y are of similar magnitude when adjusted for household covariates at age 1y and community fixed effects, suggesting that early life environments greatly

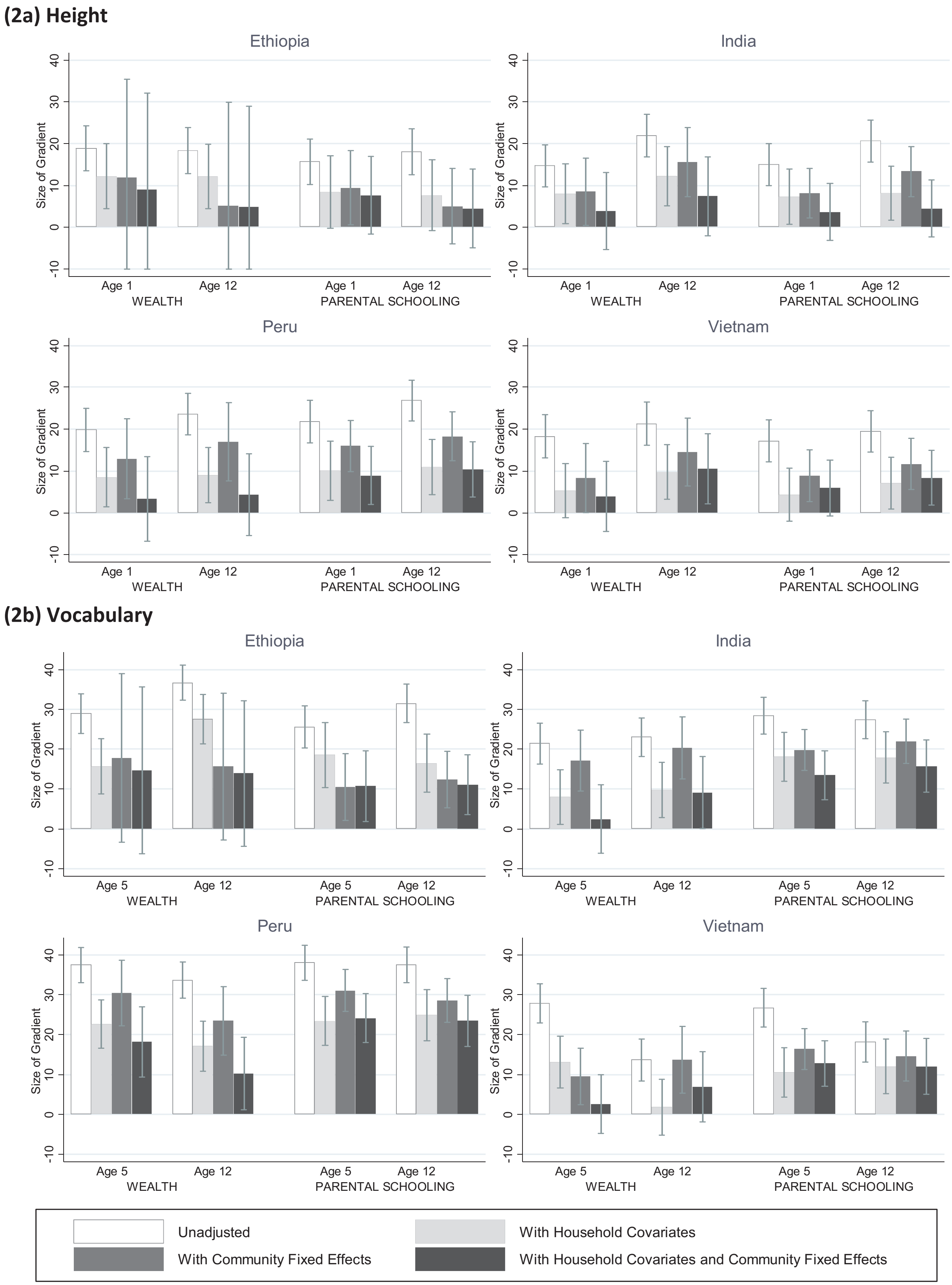

Fig. 2. Disparities in height and vocabulary from wealth and parental schooling at ages 1 and 12 y, with and without controls for household variables and community fixed effects, Young Lives study. Household covariates are mother's height in centimeters, mother's age in years, ethnicity indicator variables, and an indicator variable for the mother speaking the region's official language. The variable not defining the disparitiy is also included: the parental schooling index is included as a household covariate in the adjusted disparities from wealth and vice versa.). Community fixed effects are defined by location at age 1y. Confidence intervals are wide for community fixed effects in Ethiopia for the wealth disparity because 14 of 20 communities do not contain households in both top and bottom quartile. Confidence intervals for Ethiopian wealth disparities adjusted for community fixed effects and mother characteristics (height, age, ethnicity, and language) with community fixed effects are truncated at −10. Vocabulary (PPVT) is standardized within country and language of administration.

influence childhood trajectories. Since both household-level variables and community fixed effects reduce coefficients for the disparities in height and language, exposures at both the micro- and macro-levels influence childhood inequality early on in life. Conditions associated with poverty, such as low birth weight, stress-induced hormonal changes during pregnancy, and postnatal exposure to environmental stressors, are possible mechanisms for variations in development (Boyce & Ellis, 2005; Hertzman & Boyce, 2010). For these reasons, policy makers who prioritize equitable childhood development outcomes should integrate education and stimulation into early childhood interventions. Successful interventions are often implemented as multi-sectoral packages anchored in nurturing care and include parenting support, preschool participation, and responsive care, among others (Britto et al., 2016).

Disparities in vocabulary from SES were generally larger than disparities in height from SES, and were not fully explained by household covariates or community fixed effects. Patterns by which these covariates attenuated the height and vocabulary gaps were similar across countries. There are several mechanisms that connect household wealth and parental education with childhood growth and cognitive outcomes. A household with more wealth is more likely to purchase and provide adequate and nourishing food or cognitive stimulation for children (Black et al., 2016). Formal education may equip parents to successfully apply knowledge about health, sanitation, and responsive interaction when caring for their children (Fuchs, Pamuk, & Lutz, 2010). Interventions to improve family SES have proven helpful in improving child outcomes (Britto et al., 2016). Future research could explore a pathway analysis to understand the role of each variable (Prado et al., 2017) as well as considering how the outcomes influence each other; nutrition has been found to influence cognition in these populations (Georgiadis et al., 2016).

In spite of the strengths of our study, there are also some clear limitations. The data are not nationally-representative but over-represent the poor, and our analytic sample is generally wealthier than those omitted from the overall sample, likely due to exclusion of children who took the vocabulary test in one of the minority languages. Thus our estimates may be conservative. Our study is descriptive, with no effort to identify causal effects. Our measure of parental years of schooling is only available at child age 5y, so we may be mis-categorizing any parents who acquired schooling since child age 1y, though this is at most 2.5% of each country sample. We have data from a longer time period for height than for vocabulary, so we cannot comment on very early SES gaps in cognition. Though we examine height differences by puberty markers, this sensitivity analysis remains speculative, but it suggests that our main estimates of height disparities may be reduced by 23%, on average, after puberty growth. There is a large range of variables that were not collected at age 1y, such as parental stimulation, school quality, home environment, and consumption of nutritious foods, all of which are likely to be on the causal pathways connecting SES and health/development outcomes. We lack information on social or family violence and access to early childhood education, which may also influence cognitive stimulation and may explain disparities in vocabulary. Thus, we are limited in our ability to comment much on mechanistic pathways. Finally we focus on the average values for the first and fourth baseline SES quartiles, though there may be movement within these quartiles with some children improving and others faltering that is masked by the quartile averages.

In this study, we add to the existing literature by assessing disparities in height and vocabulary from SES across an extended period of childhood in four developing countries. The Young Lives study country samples represent the diversity of children in each context and provide an invaluable opportunity for examining these SES gaps in resource-poor settings. Our findings suggest that policy changes through interventions early in life to improve inequality can have large and generally persistent impacts, since basic patterns in SES gaps are established early, as supported by a large body of literature (Engle et al., 2007, 2011; Grantham-McGregor et al., 2007; Hoddinott, Alderman et al., 2013; Hoddinott, Behrman et al., 2013a, 2008; Maluccio et al., 2009; Martorell et al., 2010; Victora et al., 2008, 2010). Our study raises questions for further research. Longitudinal studies with data on cognitive development early in life are necessary to better document how and when vocabulary disparities emerge. Cultural, political, and historical research could help explain differences across contexts. While our data cover a long time span, they do not include adolescence and adulthood. More information about the transitions to adulthood will be necessary to determine if these disparities persist.

Acknowledgements

This work was supported by Grand Challenges Canada (Grant 0072-03), the Bill and Linda Gates Foundation (Grant OPP1032713), and the National Institute of Child Health and Human Development (NICHD R01 HD070993). The funders played no role in determining study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Appendix A

See Appendix Figs. A1–A5.

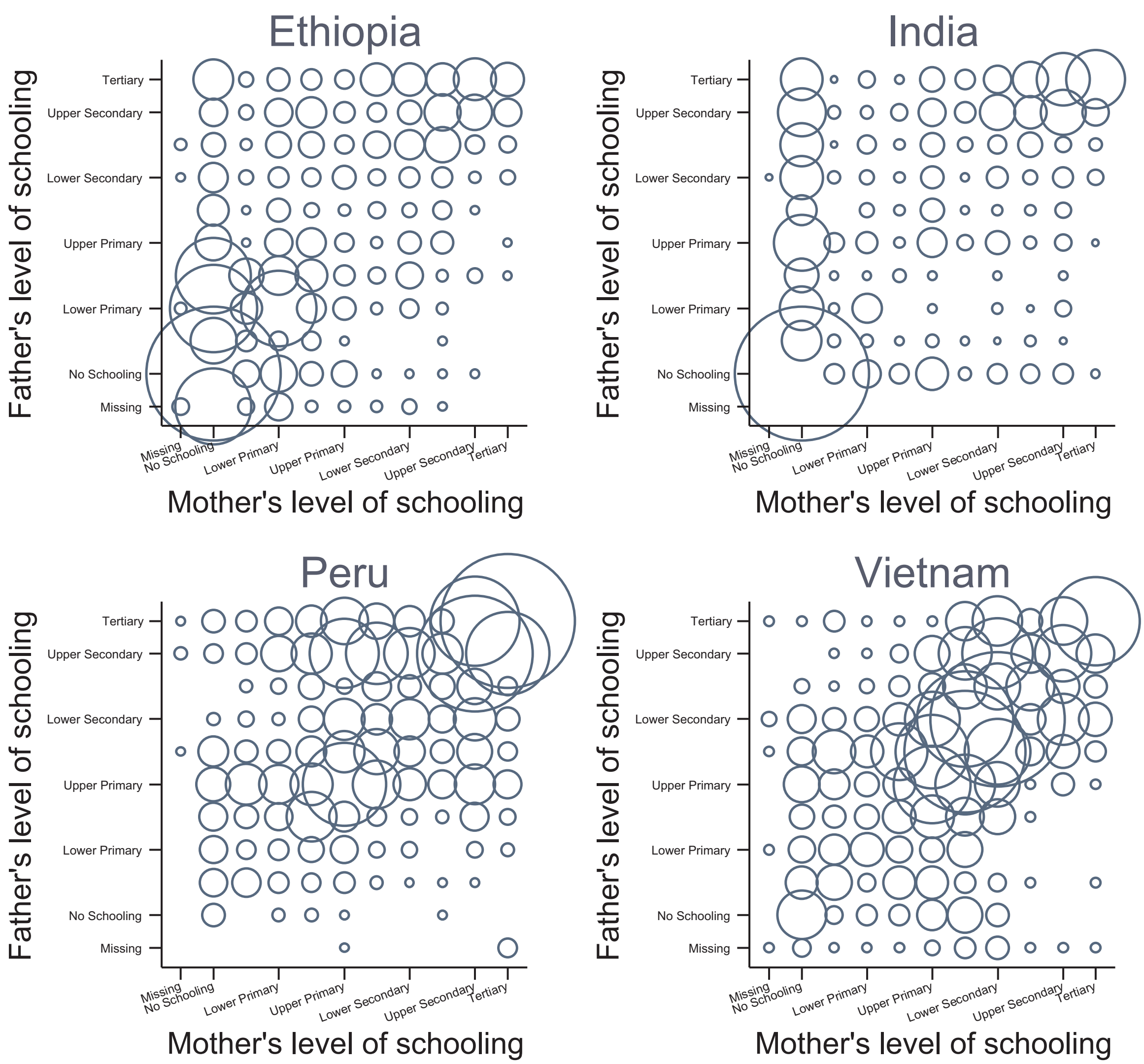

Fig. A1. Mothers' and Fathers' Paired Schooling Levels. Labeled values are completed levels; intermediate levels are incomplete. The size of the circles illustrates the number of children with parents with those schooling levels.

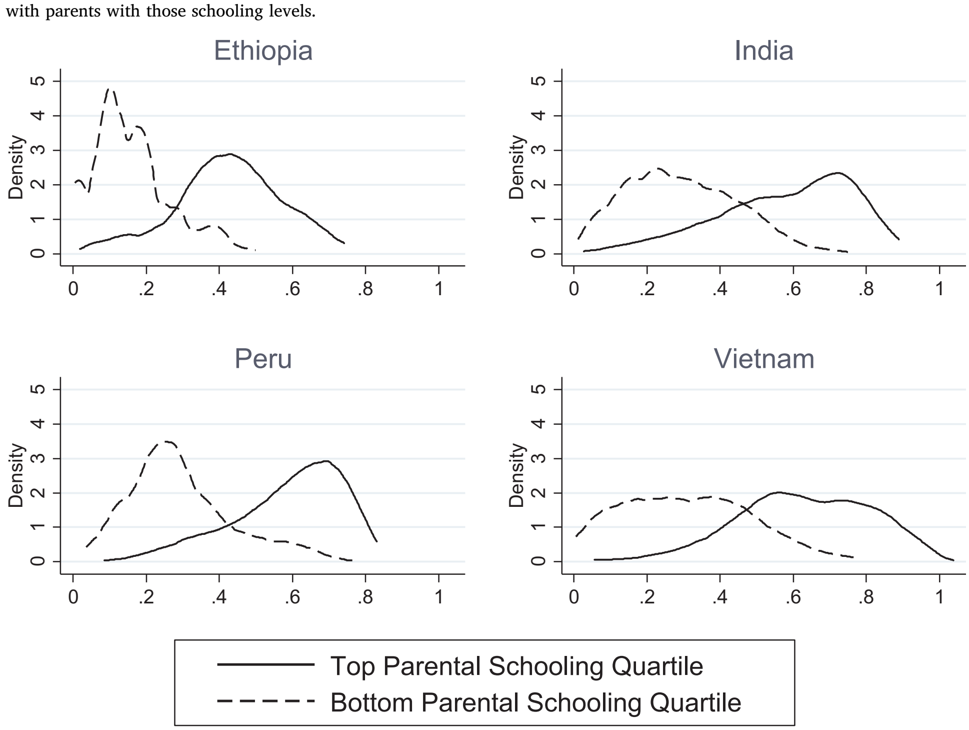

Fig. A2. Densities of Wealth Index by Average Parental Schooling.

Fig. A3. Densities of Average Parental Schooling by Wealth Quartile.

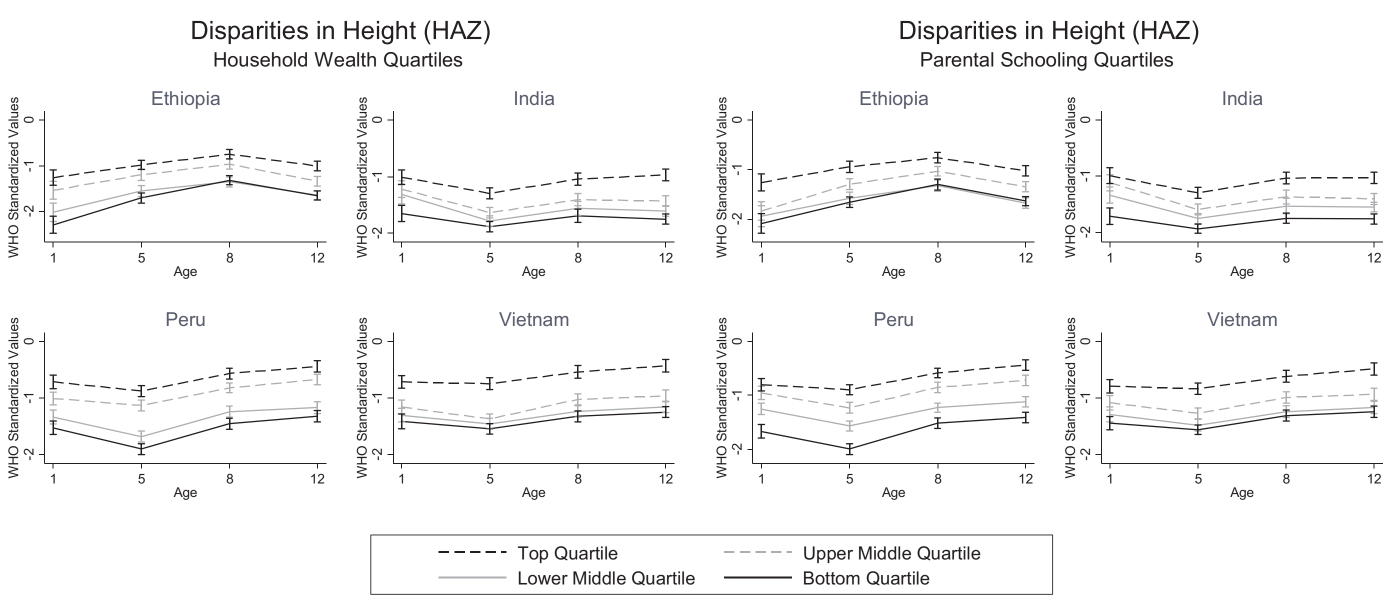

Fig. A4. Disparities in HAZ from household wealth and parental schooling are fairly parallel, Young Lives study. HAZ is standardized according to World Health Organization international norms.

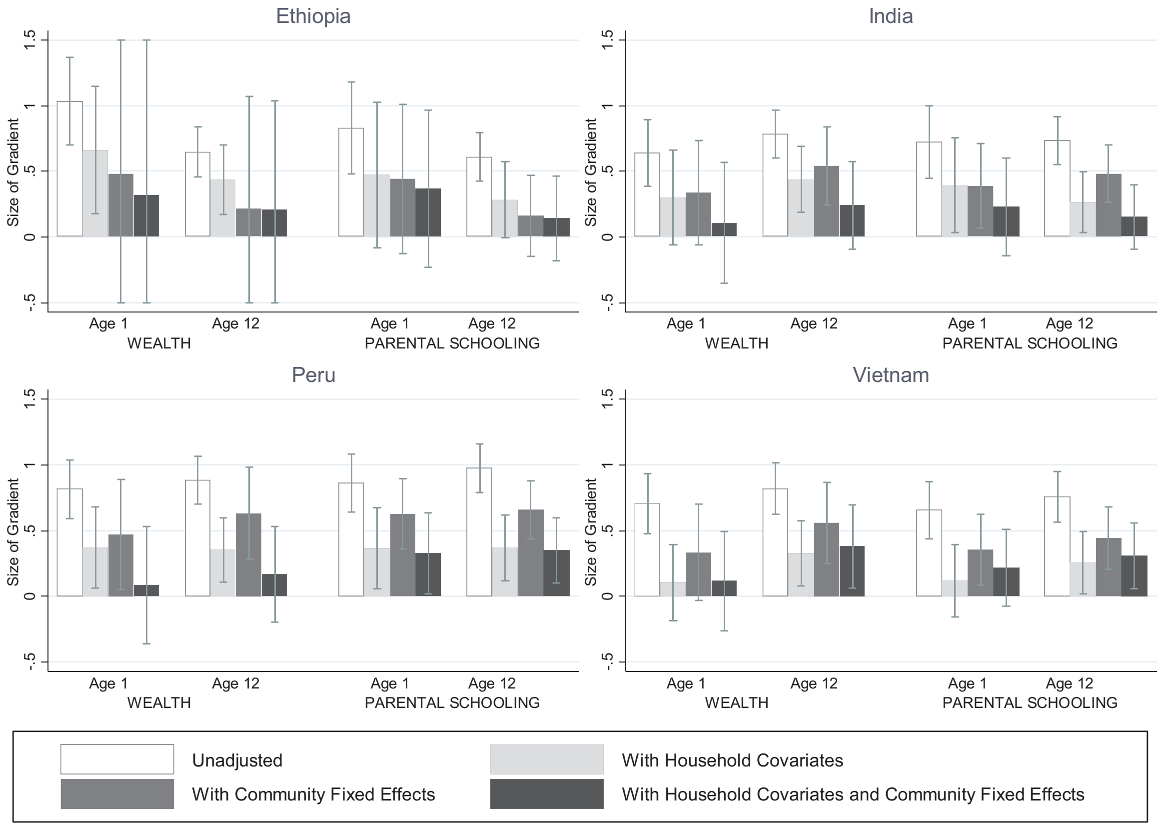

Fig. A5. Disparities in HAZ from wealth and parental schooling at ages 1 and 12 y, with and without controls for household variables and community fixed effects, Young Lives study. Household covariates are mother's height in centimeters, mother's age in years, ethnicity indicator variables, and an indicator variable for the mother speaking the region's official language. The variable not defining the disparitiy is also included: the parental schooling index is included as a household covariate in the adjusted disparities from wealth and vice versa.). Community fixed effects are defined by location at age 1y. Confidence intervals are wide for community fixed effects in Ethiopia for the wealth disparity because 14 of 20 communities do not contain households in both top and bottom quartile. Confidence intervals for Ethiopian wealth disparities adjusted for community fixed effects and mother characteristics (height, age, ethnicity, and language) with community fixed effects are truncated at −10 for height and vocabulary and are truncated at −0.5 and 1.5. HAZ is standardized according to World Health Organization Growth Standards/References (de Onis et al., 2007; World Health Organization, 2006).

See Appendix Tables A1–A8.

Table A1
Defining Analytic Sample.

	Original sample - N at age 1y		Analytic Sample	Analytic sample as a percentage of original sample	N in top or bottom quartile Wealth	N in top or bottom quartile Parental Schooling
Data on height and vocabulary in first & last rounds[a]		x	x			
PPVT in major languages first & last rounds			x			
Ethiopia	1986	1764	1345	68%	687	676
India (AP & TG)[b]	2011	1793	1604	80%	800	836
Peru	2052	1779	1574	77%	787	776
Vietnam	2000	1628	1514	76%	766	823

First rounds are age 1 year for HAZ and age 5 years for age and language standardized PPVT.
Last rounds are age 12 years for both HAZ and age and language standardized PPVT
In Ethiopia, 1999 children were surveyed, but only 1986 had wealth data. All children in other countries had complete wealth data.
Information on parental education was available for all children.
[a] Children not included if HAZ is beyond 6 S.D.
[b] Andhra Pradesh and Telangana

Table A2
In-analytic-sample and out-of-analytic-sample means.

		Ethiopia		India (AP & TG)[b]		Peru		Vietnam	
	Variables	in sample	out of sample	in sample	out of sample	in sample	out of sample	in sample	out of sample
Disparities	Wealth Index	0.24	0.15***	0.40	0.42	0.45	0.33***	0.46	0.39***
	Average Parental Schooling Level[a]	2.75	2.43	3.51	3.39	6.19	4.42***	5.22	4.1***
HAZ	Height-for-age z-score age 1 (adjusted)	-1.78	-1.91	-1.30	-1.30	-1.15	-1.91***	-1.15	-1.37***
	Height-for-age z-score age 5	-1.36	-1.67***	-1.65	-1.62	-1.40	-2.1***	-1.28	-1.53***
	Height-for-age z-score age 8	-1.09	-1.48***	-1.43	-1.45	-1.03	-1.62***	-1.03	-1.31***
	Height-for-age z-score age 12	-1.41	-1.6***	-1.44	-1.47	-0.90	-1.52***	-0.95	-1.32***
Mother Variables	Mother Speaks Local Language Fluently	0.82	0.86	0.43	0.35***	0.11	0.06	0.96	0.72***
	Mother's Age	27.41	27.26	23.57	24.10	26.62	27.35	27.21	27.07
	Mother's Height (cm)	158.77	158.63	151.54	151.81	150.23	148.96***	152.44	151.32***
Community Variables	Average Community Wealth Index (Excluding the child's)	0.24	0.15***	0.40	0.43***	0.45	0.35***	0.45	0.41***
	Rural	0.56	0.83***	0.77	0.66***	0.25	0.63***	0.81	0.78
	Community has Health Clinic or Hospital within 10K	0.87	0.83	0.53	0.52	0.69	0.72	0.63	0.54***
	Community has Secondary School or Higher within 10K	0.41	0.52***	0.38	0.40	0.60	0.59	0.98	0.86***
	N	1345	654	1604	407	1574	478	1514	486

Difference between means is statistically significant *p = 0.1 **p = 0.05 ***p = 0.01
PPVT summary statistics are not presented since language of the PPVT is the main limiter of being included in the sample
Missing values are imputed
[a] Levels are from 0 - 8: (0) no education (1) incomeplete lower primary (2) complete lower primary….(8) complete upper secondary.
[b] Andhra Pradesh and Telangana

Table A3
Top & bottom wealth quartiles' mean values for components of the wealth index at 1y.

		Ethiopia		India (AP & TG)[b]		Peru		Vietnam	
	Variables	Top Quartile	Bottom Quartile	Top Quartile	Bottom Quartile	Top Quartile	Bottom Quartile	Top Quartile	Bottom Quartile
Housing Quality	Crowding (rooms per person)	0.38	0.21	0.45	0.28	0.58	0.37	0.52	0.33
	Wall material satisfies quality norms	0.16	0.15	0.96	0.07	0.92	0.00	0.99	0.07
	Roof material satisfies quality norms	0.97	0.02	0.88	0.20	0.97	0.72	0.99	0.30
	Floor material satisfies quality norms	0.44	0.00	0.56	0.02	0.97	0.00	0.93	0.13
Consumer Durables[a]	Radio	0.83	0.07	0.32	0.12	0.90	0.59	0.64	0.36
	Refrigerator	0.03	0.00	0.17	0.01	0.56	0.00	0.35	0.01
	Bicycle	0.10	0.00	0.51	0.14	0.45	0.16	0.76	0.59
	Television	0.27	0.00	0.72	0.03	0.96	0.17	0.90	0.28
	Motorbicycle	0.00	0.00	0.30	0.00	0.07	0.00	0.85	0.16
	Car	0.02	0.00	0.01	0.00	0.15	0.00	0.03	0.00
	Mobile Phone	0.01	0.00	0.04	0.00	0.21	0.00	0.22	0.00
	Landline Phone	0.17	0.00	0.22	0.00	0.33	0.00	0.45	0.00
Services	Access to safe drinking water	0.93	0.27	0.96	0.73	0.87	0.15	0.37	0.00
	Access to sanitation	0.51	0.02	0.83	0.01	0.99	0.54	0.93	0.10
	Access to electricity	0.98	0.00	0.99	0.47	1.00	0.11	1.00	0.59
	Access to adequate fuels for cooking	0.37	0.00	0.77	0.00	0.95	0.06	0.73	0.02
	N	336	351	397	403	386	401	378	388

Difference between means is statistically significant *p = 0.1 **p = 0.05 ***p = 0.01
The subset of variables which are present in all countries' wealth index was selected to provide better conceptualization of wealth.
[a] Not all consumer durables listed; others different across countries.
[b] Andhra Pradesh and Telangana.

Table A4
Percentage of missing data in the top and bottom SES quartiles.

		Ethiopia		India (AP & TG)[a]		Peru		Vietnam	
	Variables	**Wealth**	**Parental Schooling**	**Wealth**	**Parental Schooling**	**Wealth**	**Parental Schooling**	**Wealth**	**Parental Schooling**
Disparities	Wealth Index	0%	0%	0%	0%	0%	0%	0%	0%
	Average Parental Schooling	0%	0%	0%	0%	0%	0%	0%	0%
Standardized Outcomes	Age & language standardized PPVT score age 5	0%	0%	0%	0%	0%	0%	0%	0%
	Age & language standardized PPVT score age 8	2%	2%	19%	20%	6%	7%	7%	7%
	Age & language standardized PPVT score age 12	0%	0%	0%	0%	0%	0%	0%	0%
	Height-for-age z-score age 1 (adjusted)	0%	0%	0%	0%	0%	0%	0%	0%
	Height-for-age z-score age 5	0%	0%	0%	0%	0%	0%	0%	0%
	Height-for-age z-score age 8	1%	1%	0%	0%	1%	1%	1%	1%
	Height-for-age z-score age 12	0%	0%	0%	0%	0%	0%	0%	0%
Mother Variables	Mother Speaks Local Language Fluently	1%	0%	0%	0%	0%	0%	0%	0%
	Mother's Age	4%	4%	1%	1%	1%	1%	0%	0%
	Mother's Ethnicity	0%	0%	0%	0%	0%	0%	0%	0%
	Mother's Height (cm)	10%	11%	2%	3%	5%	4%	1%	0%
	N	687	676	800	836	787	776	766	823

[a] Andhra Pradesh and Telangana

Table A5
SES Disparities in HAZ between Top and Bottom Quartiles & Testing for Parallel Trends.

	Wealth Disparity				Schooling Disparity			
	Ethiopia	**India (AP & TG)[a]**	**Peru**	**Vietnam**	**Ethiopia**	**India (AP & TG)[a]**	**Peru**	**Vietnam**
HAZ - WHO stand/ref: Ages 1, 5, 8, & 12	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Top Quartile Indicator Variable (SES Gap at Age 1)	0.980*** (0.11)	0.578*** (0.09)	0.888*** (0.08)	0.714*** (0.09)	0.817*** (0.12)	0.687*** (0.10)	0.928*** (0.08)	0.653*** (0.08)
Age 5 Indicator Variable	0.504*** (0.07)	-0.287*** (0.05)	-0.275*** (0.04)	-0.100*** (0.03)	0.420*** (0.07)	-0.269*** (0.05)	-0.218*** (0.04)	-0.099*** (0.03)
Age 8 Indicator Variable	0.872*** (0.08)	-0.085 (0.06)	0.101** (0.04)	0.100** (0.05)	0.725*** (0.07)	-0.05 (0.06)	0.164*** (0.04)	0.126*** (0.04)
Age 12 Indicator Variable	0.647*** (0.09)	-0.105 (0.07)	0.226*** (0.05)	0.172*** (0.06)	0.469*** (0.09)	-0.057 (0.07)	0.278*** (0.05)	0.206*** (0.05)
Top Quartile (Indicator) X Age (Continuous)	**-0.036*** (0.01)**	**0.013 (0.01)**	**0.003 (0.01)**	**0.01 (0.01)**	**-0.022** (0.01)**	**0.003 (0.01)**	**0.006 (0.01)**	**0.008 (0.01)**
Constant (Bottom Quartile at Age 1)	-2.245*** (0.09)	-1.624*** (0.07)	-1.568*** (0.06)	-1.427*** (0.06)	-2.073*** (0.09)	-1.697*** (0.07)	-1.700*** (0.06)	-1.448*** (0.06)
p-value of coefficient on Top Quartile X Age	0.001	0.101	0.72	0.148	0.036	0.753	0.399	0.214
N	2744	3197	3138	3053	2699	3341	3092	3284

N = number of children in top & bottom quartiles x number of rounds. Some children are missing outcomes in intermediate rounds
Significant at *0.1 **0.05 ***0.01
Standard errors clustered by child
[a] Andhra Pradesh and Telangana

Table A6
Robustness check for Ethiopia of SES disparities between top and bottom quartiles & testing for parallel trends.

Panel A **Percentile Height: Ages 1, 5, 8, & 12**	**Wealth Disparity Ethiopia** Coef./SE	**Schooling Disparity Ethiopia** Coef./SE
Top Quartile Indicator Variable (SES Gap at Age 1)	19.67*** (2.78)	20.53*** (2.80)
Age 5 Indicator Variable	0.4 (1.62)	0.41 (1.74)
Age 8 Indicator Variable	-1.18 (1.83)	1.15 (1.91)
Age 12 Indicator Variable	-2.34 (2.29)	0.57 (2.35)
Top Quartile (Indicator) X Age (Continuous)	**0.35** **(0.29)**	**-0.11** **(0.29)**
Constant (Bottom Quartile at Age 1)	40.04*** (1.96)	38.91*** (2.07)
p-value of coefficient on Top Quartile X Age	0.24	0.701
N	1474	1299

Panel B **Percentile Vocabulary: Ages 5, 8, & 12**	**Wealth Disparity Ethiopia** Coef./SE	**Schooling Disparity Ethiopia** Coef./SE
Top Quartile Indicator Variable (SES Gap at Age 5)	40.93*** (3.32)	36.36*** (3.89)
Age 8 Indicator Variable	-2.66* (1.51)	-0.16 (1.78)
Age 12 Indicator Variable	-5.27*** (1.65)	-0.57 (2.21)
Top Quartile (Indicator) X Age (Continuous)	**0.52** **(0.36)**	**0.23** **(0.43)**
Constant (Bottom Wealth Quartile at Age 5)	27.72*** (1.27)	31.63*** (1.68)
p-value of coefficient on Top Quartile X Age	0.152	0.592
N	1101	970

Panel C **HAZ - WHO stand/ref: Ages 1, 5, 8, & 12**	**Wealth Disparity Ethiopia** Coef./SE	**Schooling Disparity Ethiopia** Coef./SE
Top Quartile Indicator Variable (SES Gap at Age 1)	0.96*** (0.14)	0.99*** (0.16)
Age 5 Indicator Variable	0.60*** (0.09)	0.57*** (0.10)
Age 8 Indicator Variable	0.82*** (0.10)	0.86*** (0.11)
Age 12 Indicator Variable	0.52*** (0.12)	0.60*** (0.13)
Top Quartile (Indicator) X Age (Continuous)	**-0.02** **(0.01)**	**-0.03**** **(0.02)**
Constant (Bottom Quartile at Age 1)	-2.24*** (0.11)	-2.24*** (0.12)
p-value of coefficient on Top Quartile X Age	0.227	0.025
N	1474	1299

N = number of children in top & bottom quartiles x number of rounds. Some children are missing outcomes in intermediate rounds.
Significant at *0.1 **0.05 ***0.01.
Standard errors clustered by child.

Table A7

Panel A: Mean Height Percentile by Quartile & Puberty Marker

	Ethiopia				India - Andhra Pradesh and Telangana				Peru				Vietnam			
	Does not Menstruate	Menstruates	Voice has not lowered	Low voice	Does not Menstruate	Menstruates	Voice has not lowered	Low voice	Does not Menstruate	Menstruates	Voice has not lowered	Low voice	Does not Menstruate	Menstruates	Voice has not lowered	Low voice
Wealth	Girls (N = 307)		Boys (N = 377)		Girls (N = 371)		Boys (N = 429)		Girls (N = 386)		Boys (N = 401)		Girls (N = 388)		Boys (N = 381)	
Bottom Quartile	40.71	50.00	44.04	58.48	35.85	67.29	41.39	44.90	34.64	56.67	37.84	40.43	40.16	58.80	38.12	52.74
N	151	2	156	25	159	31	189	21	158	46	102	94	173	35	134	42
Top Quartile	64.10	77.50	60.73	52.50	53.88	78.89	64.88	68.33	56.20	72.61	62.64	63.51	50.00	70.48	59.27	74.71
N	143	6	160	10	125	53	196	18	111	71	89	115	75	95	105	93
Adjustments by sex		3.69		-20.19		-8.75		0.00		-7.05		-0.97		-6.47		-2.94
Gradient adjustment				-44%				-19%				-18%				-22%
Parents' Education	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**
	Girls (N = 303)		Boys (N = 374)		Girls (N = 365)		Boys (N = 471)		Girls (N = 377)		Boys (N = 399)		Girls (N = 400)		Boys (N = 425)	
Bottom Quartile	42.23	47.00	44.16	53.50	36.36	68.71	40.50	50.25	31.06	48.74	35.27	40.59	39.86	65.42	35.47	52.48
N	151	1	173	10	160	24	214	28	139	47	96	88	172	36	136	69
Top Quartile	63.90	83.60	59.75	57.38	55.41	75.89	60.72	60.18	56.53	75.05	61.08	64.93	52.81	69.32	56.69	74.58
N	140	5	157	13	112	61	202	22	116	75	93	121	106	81	114	95
Adjustments by sex		14.28		-11.02		-14.87		-9.11		-1.96		-1.10		-11.78		-1.53
Gradient adjustment				1%				-55%				-7%				-31%

Panel B: Mean HAZ by Quartile & Puberty Marker

	Ethiopia				India - Andhra Pradesh and Telangana				Peru				Vietnam			
	Does not Menstruate	Menstruates	Voice has not lowered	Low voice	Does not Menstruate	Menstruates	Voice has not lowered	Low voice	Does not Menstruate	Menstruates	Voice has not lowered	Low voice	Does not Menstruate	Menstruates	Voice has not lowered	Low voice
Wealth	Girls (N = 307)		Boys (N = 377)		Girls (N = 371)		Boys (N = 429)		Girls (N = 386)		Boys (N = 401)		Girls (N = 388)		Boys (N = 381)	
Bottom Quartile	-1.77	-1.42	-1.63	-1.15	-1.97	-0.88	-1.74	-1.59	-1.51	-0.67	-1.35	-1.29	-1.34	-0.68	-1.40	-0.84
N	151	2	156	25	159	31	189	21	158	46	102	94	173	35	134	42
Top Quartile	-0.90	-0.10	-1.09	-1.40	-1.35	-0.37	-0.91	-0.85	-0.73	-0.07	-0.47	-0.38	-0.96	-0.27	-0.60	0.07
N	143	6	160	10	125	53	196	18	111	71	89	115	75	95	105	93
Adjustments by sex		0.42		-0.71		-0.22		-0.08		-0.25		0.01		-0.24		-0.07
Gradient adjustment				-25%				-18%				-15%				-20%
Parents' Education	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**	**Does not Menstruate**	**Menstruates**	**Voice has not lowered**	**Low voice**
	Girls (N = 303)		Boys (N = 374)		Girls (N = 365)		Boys (N = 471)		Girls (N = 377)		Boys (N = 399)		Girls (N = 400)		Boys (N = 425)	
Bottom Quartile	-1.68	-1.5	-1.62	-1.35	-1.97	-0.85	-1.75	-1.45	-1.63	-0.95	-1.44	-1.27	-1.37	-0.39	-1.5	-0.89
N	151	1	173	10	160	24	214	28	139	47	96	88	172	36	136	69
Top Quartile	-0.96	0.17	-1.1	-1.24	-1.29	-0.51	-1.05	-1.15	-0.72	0.01	-0.53	-0.37	-0.87	-0.32	-0.7	0.08
N	140	5	157	13	112	61	202	22	116	75	93	121	106	81	114	95
Adjustments by sex		0.91		-0.38		-0.47		-0.36		-0.06		-0.02		-0.5		0.02
Gradient adjustment				26%				-53%				-5%				-30%

Adjustments by sex: for each quartile, the difference between the average percentile heights of those who have entered and those who have not entered puberty is calculated. This difference is multipled by the fraction of girls in the quartile who have not yet reached puberty, indicating how much growth we may expect to be added to the mean of the quartile. Then we take the difference between expected growth of the top and bottom quartiles.

The gradient adjustment: the average of the adjustments by sex weighted proportionally by boys and girls in the analytical sample, and divided by the total size of the gradient.

Note: some children are missing data on these puberty outcomes. We use weights based on all children in the analytical sample, not just those with puberty indicator data.

Table A8
Disparities & Adjusted Disparities with 99% Confidence Intervals.

	Disparities at first measurement*				Disparities at age 12y			
	Ethiopia							
	Unadjusted	Household Covariates	Community FE	Household + Comm. FE	Unadjusted	Household Covariates	Community FE	Household + Comm. FE
Height (percentile)								
Wealth disparity	18.8*** [13.4,24.2]	12.2*** [4.4,19.9]	11.9 [-11.6,35.5]	8.9 [-14.3,32.2]	18.5*** [13.0,24.0]	12.4*** [4.7,20.1]	5.2 [-19.5,29.9]	4.8 [-19.2,28.9]
Height (percentile)								
Schooling disparity	15.6*** [10.1,21.1]	8.5** [-0.2,17.1]	9.4*** [0.6,18.3]	7.6** [-1.7,16.9]	18.0*** [12.6,23.5]	7.7** [-0.8,16.2]	5 [-4.0,14.0]	4.5 [-5.0,13.9]
Vocabulary (percentile)								
Wealth disparity	25.5*** [20.2,30.7]	18.5*** [10.4,26.7]	10.5*** [2.1,18.8]	10.7*** [1.7,19.6]	31.4*** [26.6,36.2]	16.5*** [9.2,23.8]	12.4*** [5.3,19.4]	11.1*** [3.6,18.5]
Vocabulary (percentile)								
Schooling disparity	29.0*** [24.1,33.9]	15.9*** [9.0,22.8]	17.9** [-3.3,39.0]	14.8* [-6.2,35.7]	36.7*** [32.3,41.0]	27.6*** [21.4,33.7]	15.6** [-2.8,34.0]	13.9** [-4.3,32.1]

	Disparities at first measurement*				Disparities at age 12y			
	Ethiopia							
	Unadjusted	Household Covariates	Community FE	Household + Comm. FE	Unadjusted	Household Covariates	Community FE	Household + Comm. FE
Height (HAZ)								
Wealth disparity	0.8*** [0.5,1.2]	0.5** [-0.1,1.0]	0.4** [-0.1,1.0]	0.4 [-0.2,1.0]	0.6*** [0.4,0.8]	0.3** [-0.0,0.6]	0.2 [-0.1,0.5]	0.1 [-0.2,0.5]
Height (HAZ)								
Schooling disparity	1.0*** [0.7,1.4]	0.7*** [0.2,1.1]	0.5 [-1.0,2.0]	0.3 [-1.2,1.8]	0.7*** [0.5,0.8]	0.4*** [0.2,0.7]	0.2 [-0.6,1.1]	0.2 [-0.6,1.0]

	India - Andhra Pradesh and Telangana							
	Unadjusted	Household Covariates	Community FE	Household + Comm. FE	Unadjusted	Household Covariates	Community FE	Household + Comm. FE
Height (percentile)								
Wealth disparity	14.7*** [9.7,19.8]	8.0*** [0.8,15.2]	8.5*** [0.5,16.5]	3.9 [-5.4,13.2]	21.9*** [16.9,27.0]	12.3*** [5.2,19.4]	15.6*** [7.3,23.9]	7.4** [-2.0,16.8]
Height (percentile)								
Schooling disparity	15.0*** [10.0,20.0]	7.3*** [0.7,14.0]	8.2*** [2.2,14.1]	3.7 [-3.1,10.5]	20.7*** [15.7,25.7]	8.1*** [1.7,14.6]	13.3*** [7.3,19.4]	4.5* [-2.3,11.4]
Vocabulary (percentile)								
Wealth disparity	21.4*** [16.3,26.5]	8.0*** [1.1,14.9]	17.1*** [9.6,24.7]	2.5 [-6.1,11.1]	23.0*** [18.2,27.9]	9.8*** [2.9,16.7]	20.3*** [12.6,28.1]	9.1*** [0.1,18.1]
Vocabulary (percentile)								
Schooling disparity	28.4*** [23.8,33.1]	18.1*** [12.0,24.2]	19.8*** [14.6,25.0]	13.5*** [7.3,19.6]	27.4*** [22.7,32.1]	17.9*** [11.5,24.3]	22.0*** [16.4,27.5]	15.8*** [9.2,22.4]

	India - Andhra Pradesh and Telangana							
	Unadjusted	Household Covariates	Community FE	Household + Comm. FE	Unadjusted	Household Covariates	Community FE	Household + Comm. FE
Height (HAZ)								
Wealth disparity	0.6*** [0.4,0.9]	0.3** [-0.1,0.7]	0.3** [-0.1,0.7]	0.1 [-0.4,0.6]	0.8*** [0.6,1.0]	0.4*** [0.2,0.7]	0.5*** [0.2,0.8]	0.2* [-0.1,0.6]
Height (HAZ)								
Schooling disparity	0.7*** [0.4,1.0]	0.4*** [0.0,0.8]	0.4*** [0.1,0.7]	0.2 [-0.1,0.6]	0.7*** [0.6,0.9]	0.3*** [0.0,0.5]	0.5*** [0.3,0.7]	0.2 [-0.1,0.4]

(*continued on next page*)

Table A8 (*continued*)

	Disparities at first measurement*				Disparities at age 12y			
Peru								
	Unadjusted	**Household Covariates**	**Community FE**	**Household + Comm. FE**	**Unadjusted**	**Household Covariates**	**Community FE**	**Household + Comm. FE**
Height (percentile)								
Wealth disparity	19.8*** [14.7,25.0]	8.5*** [1.4,15.6]	12.9*** [3.4,22.5]	3.3 [-6.8,13.4]	23.6*** [18.7,28.5]	9.0*** [2.5,15.6]	17.0*** [7.7,26.3]	4.4 [-5.4,14.1]
Height (percentile)								
Schooling disparity	21.8*** [16.7,26.8]	10.1*** [3.0,17.2]	16.0*** [9.9,22.1]	8.9*** [2.0,15.8]	26.8*** [22.0,31.7]	10.9*** [4.3,17.6]	18.3*** [12.5,24.1]	10.4*** [3.8,17.0]
Vocabulary (percentile)								
Wealth disparity	37.5*** [33.1,41.9]	22.6*** [16.6,28.6]	30.4*** [22.2,38.7]	18.2*** [9.4,27.0]	33.7*** [29.1,38.2]	17.1*** [10.9,23.3]	23.4*** [14.9,32.0]	10.2*** [1.2,19.3]
Vocabulary (percentile)								
Schooling disparity	38.0*** [33.6,42.4]	23.4*** [17.3,29.6]	31.0*** [25.8,36.3]	24.1*** [18.0,30.3]	37.5*** [33.0,42.0]	24.9*** [18.5,31.3]	28.6*** [23.1,34.1]	23.4*** [17.0,29.9]
Vietnam								
	Unadjusted	**Household Covariates**	**Community FE**	**Household + Comm. FE**	**Unadjusted**	**Household Covariates**	**Community FE**	**Household + Comm. FE**
Height (percentile)								
Wealth disparity	18.2*** [13.0,23.4]	5.2** [-1.3,11.7]	7.8** [-0.5,16.1]	3.6 [-4.9,12.0]	21.4*** [16.3,26.6]	9.8*** [3.3,16.4]	14.8*** [6.6,23.0]	10.8*** [2.3,19.2]
Height (percentile)								
Schooling disparity	17.2*** [12.1,22.2]	4.3* [-2.0,10.6]	8.9*** [2.7,15.1]	5.9** [-0.8,12.6]	19.5*** [14.6,24.5]	7.1*** [0.9,13.3]	11.7*** [5.5,17.8]	8.3*** [1.8,14.8]
Vocabulary (percentile)								
Wealth disparity	27.7*** [22.8,32.6]	13.2*** [6.7,19.7]	9.5*** [2.3,16.6]	2.7 [-4.7,10.2]	13.4*** [8.2,18.7]	1.7 [-5.4,8.8]	13.6*** [5.1,22.0]	7.0** [-1.9,15.9]
Vocabulary (percentile)								
Schooling disparity	26.6*** [21.8,31.5]	10.5*** [4.3,16.7]	16.4*** [11.2,21.5]	12.7*** [7.0,18.5]	18.1*** [13.0,23.1]	12.1*** [5.3,18.9]	14.7*** [8.4,20.9]	12.1*** [5.1,19.1]

	Disparities at first measurement*				Disparities at age 12y			
Peru								
	Unadjusted	**Household Covariates**	**Community FE**	**Household + Comm. FE**	**Unadjusted**	**Household Covariates**	**Community FE**	**Household + Comm. FE**
Height (HAZ)								
Wealth disparity	0.8*** [0.6,1.0]	0.4*** [0.1,0.7]	0.5*** [0.1,0.9]	0.1 [-0.4,0.5]	0.9*** [0.7,1.1]	0.4*** [0.1,0.6]	0.6*** [0.3,1.0]	0.2 [-0.2,0.5]
Height (HAZ)								
Schooling disparity	0.9*** [0.6,1.1]	0.4*** [0.1,0.7]	0.6*** [0.4,0.9]	0.3*** [0.0,0.6]	1.0*** [0.8,1.2]	0.4*** [0.1,0.6]	0.7*** [0.4,0.9]	0.3*** [0.1,0.6]
Vietnam								
	Unadjusted	**Household Covariates**	**Community FE**	**Household + Comm. FE**	**Unadjusted**	**Household Covariates**	**Community FE**	**Household + Comm. FE**
Height (HAZ)								
Wealth disparity	0.7*** [0.5,0.9]	0.1 [-0.2,0.4]	0.3** [-0.1,0.7]	0.1 [-0.3,0.5]	0.8*** [0.6,1.0]	0.3*** [0.1,0.6]	0.6*** [0.3,0.9]	0.4*** [0.1,0.7]
Height (HAZ)								
Schooling disparity	0.7*** [0.4,0.9]	0.1 [-0.2,0.4]	0.4*** [0.1,0.6]	0.2* [-0.1,0.5]	0.8*** [0.6,1.0]	0.3*** [0.0,0.5]	0.4*** [0.2,0.7]	0.3*** [0.1,0.6]

*First measurement is age 1 year for height and age 5 years for vocabulary
Each estimate is the coefficient indicating the size of the disparity in a separate regression including the covariates &/or fixed effects
Statistically distinct from 0 at * 0.1 **0.5 ***0.01
Confidence intervals are wide for Community FE in Ethiopia for the wealth disparity because 14 out of 20 communities do not contain households in both top and bottom quartile; communities are more mixed with respect to parental schooling.

References

Adair, L. S. (1999). Filipino children exhibit catch-up growth from age 2 to 12 years. *The Journal of Nutrition, 129*(6), 1140–1148.

Alemu, T., Asgedom, G., Liebenberg, J., Mekonnen, A., Seager, J., Tefera, B., & Woldehanna, T. (2003). Young Lives Preliminary Country Report: Ethiopia. Retrieved from 〈http://www.younglives.org.uk/sites/www.younglives.org.uk/files/YL-CR1-Ethiopia-2003-revised.pdf〉.

Andersen, C. T., Reynolds, S. A., Behrman, J., Crookston, B. T., Dearden, K. A., Escobal, J. A., ... Fernald, L. C. H. (2015). Participation in the Juntos conditional cash transfer program in Peru is associated with changes in child anthropometric status but not language development or school achievement. *Journal of Nutrition*.

Barnett, I., Ariana, P., Petrou, S., Penny, M. E., Duc, L. T., Galab, S., ... Boyden, J. (2013). Cohort profile: The Young Lives Study. *International Journal of Epidemiology, 42*(3), 701–708. http://dx.doi.org/10.1093/ije/dys082.

Behrman, J. R. (2015). Growth faltering in the first thousand days after conception and catch-up growth. In J. Komlos, & I. R. Kelly (Eds.). *The Oxford handbook of economics and human biology*(1st ed.). Oxford University Press. (Retreived from) 〈http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199389292.001.0001/oxfordhb-9780199389292〉.

Bernal, R., & Van Der Werf, C. (2011). Situación de la infancia en Colombia. In Colombia en movimiento: Un análisis descriptivo basado en la encuesta longitudinal colombiana de la Universidad de los Andes (pp. 101–117). Bogota: Universidad de Los Andes: Centro de Estudios Sobre Desarrollo Economico - CEDE. Retrieved from 〈http://elca-colombiaenmovimiento.uniandes.edu.co/libro/ColombiaEnMovimiento-Cap6.pdf〉.

Black, M. M., Walker, S. P., Fernald, L. C. H., Andersen, C. T., DiGirolamo, A. M., Lu, C., ... Grantham-McGregor, S. (2016). Early childhood development coming of age: Science through the life course. *The Lancet*. http://dx.doi.org/10.1016/S0140-6736(16)31389-7.

Boyce, W. T., & Ellis, B. J. (2005). Biological sensitivity to context: I. An evolutionary–developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology, 17*(02), 271–301.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53*(1), 371–399. http://dx.doi.org/10.1146/annurev.psych.53.100901.135233.

Britto, P. R., Lye, S. J., Proulx, K., Yousafzai, A. K., Matthews, S. G., Vaivada, T., ... Bhutta, Z. A. (2016). Nurturing care: Promoting early childhood development. *The Lancet*. http://dx.doi.org/10.1016/S0140-6736(16)31390-3.

Case, A., Lubotsky, D., & Paxson, C. (2002). Economic status and health in childhood: The origins of the gradient. *American Economic Review, 92*(5), 1308–1334. http://dx.doi.org/10.1257/000282802762024520.

Chetty, R., Hendren, N., Kline, P., & Saez, E. (2014). *Where is the land of opportunity? The geography of intergenerational mobility in the United States.* National Bureau of Economic Research. (Retrieved from) 〈http://www.nber.org/papers/w19843〉.

Crookston, B. T., Dearden, K. A., Alder, S. C., Porucznik, C. A., Stanford, J. B., Merrill, R. M., ... Penny, M. E. (2011). Impact of early and concurrent stunting on cognition. *Maternal Child Nutrition, 7*(4), 397–409. http://dx.doi.org/10.1111/j.1740-8709.2010.00255.x.

Crookston, B. T., Penny, M. E., Alder, S. C., Dickerson, T. T., Merrill, R. M., Stanford, J. B., ... Dearden, K. A. (2010). Children who recover from early stunting and children who are not stunted demonstrate similar levels of cognition. *The Journal of Nutrition, 140*(11), 1996–2001. http://dx.doi.org/10.3945/jn.109.118927.

Crookston, B. T., Schott, W., Cueto, S., Dearden, K. A., Engle, P., Georgiadis, A., ... Behrman, J. R. (2013). Postinfancy growth, schooling, and cognitive achievement: Young Lives. *The American Journal of Clinical Nutrition, 98*(6), 1555–1563.

Cueto, S., & Leon, J. (2012). Psychometric characteristics of cognitive development and achievement instruments in Round 3 of Young Lives. *Young Lives Technical Note*, *15*. (Retrieved from) 〈http://www.grade.org.pe/upload/publicaciones/Archivo/download/pubs/NDMtn25.pdf〉.

Cueto, S., Leon, J., Guerrero, G., & Muñoz, I. (2009). Psychometric characteristics of cognitive development and achievement instruments in Round 2 of Young Lives. *Young Lives Technical Notes*, *15*. Retrieved from 〈https://www.researchgate.net/profile/Ismael_G_Munoz/publication/43438721_Psychometric_characteristics_of_cognitive_development_and_achievement_instruments_in_Round_2_of_Young_Lives/links/554fa6f308ae12808b37a748.pdf〉.

de Onis, M., Onyango, A. W., Borghi, E., Siyam, A., Nishida, C., & Siekmann, J. (2007). Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization, 85*(09), 660–667. http://dx.doi.org/10.2471/BLT.07.043497.

Deardorff, J., Abrams, B., Ekwaru, J. P., & Rehkopf, D. H. (2014). Socioeconomic status and age at menarche: An examination of multiple indicators in an ethnically diverse cohort. *Annals of Epidemiology, 24*(10), 727–733. http://dx.doi.org/10.1016/j.annepidem.2014.07.002.

Dunn, L. M., & Dunn, L. M. (1997). *PPVT-III: Peabody picture vocabulary test.* MN: American Guidance Service Circle Pines.

Dunn, L. M., Padilla, E. R., Lugo, D. E., & Dunn, L. M. (1986). *Manual del examinador para el Test de Vocabulario en Imágenes Peabody.* Circle Pines: American Guidance Service.

Engle, P. L., Black, M. M., Behrman, J. R., Cabral de Mello, M., Gertler, P. J., Kapiriri, L., ... International Child Development Steering Group (2007). Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *Lancet, 369*(9557), 229–242. http://dx.doi.org/10.1016/S0140-6736(07)60112-3.

Engle, P. L., Fernald, L. C. H., Alderman, H., Behrman, J., O'Gara, C., Yousafzai, A., ... Global Child Development Steering Group (2011). Strategies for reducing inequalities and improving developmental outcomes for young children in low-income and middle-income countries. *Lancet, 378*(9799), 1339–1353. http://dx.doi.org/10.1016/S0140-6736(11)60889-1.

Escobal, J., Lanata, C., Madrid, S., Penny, M., Saavedra, J., Suárez, P., … Huttly, S. (2003). Young Lives Preliminary Country Report: Peru. Retrieved from 〈http://www.younglives.org.uk/sites/www.younglives.org.uk/files/YL-CR1-Peru-2003_revised.pdf〉.

Fernald, L. C. H., Kariger, P., Hidrobo, M., & Gertler, P. J. (2012). Socioeconomic gradients in child development in very young children: Evidence from India, Indonesia, Peru, and Senegal. *Proceedings of the National Academy of Sciences of the United States of America, 109*(*Suppl 2*), 17273–17280. http://dx.doi.org/10.1073/pnas.1121241109.

Fernald, L. C. H., Weber, A., Galasso, E., & Ratsifandrihamanana, L. (2011). Socioeconomic gradients and child development in a very low income population: Evidence from Madagascar. *Developmental Science, 14*(4), 832–847. http://dx.doi.org/10.1111/j.1467-7687.2010.01032.x.

Fuchs, R., Pamuk, E., & Lutz, W. (2010). Education or wealth: Which matters more for reducing child mortality in developing countries? *Vienna Yearbook of Population Research, 8*, 175–199.

Galab, S., Gopinath Reddy, M., Antony, P., McCoy, A., Ravi, C., Sreerama Raju, D., … Prudhivikar Reddy, P. (2003). Young Lives Preliminary Country Report: Andhra Pradesh, India. Retrieved from 〈http://www.younglives.org.uk/sites/www.younglives.org.uk/files/YL-CR1-India-2003.pdf〉.

Galasso, E., Weber, A., & Fernald, L. C. H. (2017). Dynamics of child development: Analysis of a longitudinal cohort in a very low income country. *World Bank Economic Review* 〈http://onlinelibrary.wiley.com/doi/10.1111/j.1467-7687.2010.01032.x/epdf〉.

Georgiadis, A., Benny, L., Crookston, B. T., Duc, L. T., Hermida, P., Mani, S., ... Behrman, J. R. (2016). Growth trajectories from conception through middle childhood and cognitive achievement at age 8 years: Evidence from four low- and middle-income countries. *Social Science Medicine : Population Health, 2*, 43–54. http://dx.doi.org/10.1016/j.ssmph.2016.01.003.

Gertler, P., Heckman, J., Pinto, R., Zanolini, A., Vermeersch, C., Walker, S., ... Grantham-McGregor, S. (2014). Labor market returns to an early childhood stimulation intervention in Jamaica. *Science, 344*(6187), 998–1001.

Ghuman, S., Behrman, J. R., Borja, J. B., Gultiano, S., & King, E. M. (2005). Family background, service providers, and early childhood development in the Philippines: Proxies and interactions. *Economic Development and Cultural Change, 54*(1), 129–164. http://dx.doi.org/10.1086/431258.

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., & Strupp, B. (2007). Developmental potential in the first 5 years for children in developing countries. *The Lancet, 369*(9555), 60–70.

Hamadani, J. D., Tofail, F., Huda, S. N., Alam, D. S., Ridout, D. A., Attanasio, O., & Grantham-McGregor, S. M. (2014). Cognitive deficit and poverty in the first 5 years of childhood in Bangladesh. *Pediatrics, 134*(4), e1001–e1008. http://dx.doi.org/10.1542/peds.2014-0694.

Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. *Journal of Labor Economics, 24*(3), 411–482.

Hertzman, C., & Boyce, T. (2010). How experience gets under the skin to create gradients in developmental health. *Annual Review of Public Health, 31*, 329–347.

Hoddinott, J., Alderman, H., Behrman, J. R., Haddad, L., & Horton, S. (2013a). The economic rationale for investing in stunting reduction. *Maternal Child Nutrition, 9*(Suppl. 2), 69–82. http://dx.doi.org/10.1111/mcn.12080.

Hoddinott, J., Behrman, J. R., Maluccio, J. A., Melgar, P., Quisumbing, A. R., Ramirez-Zea, M., ... Martorell, R. (2013b). Adult consequences of growth failure in early childhood. *The American Journal of Clinical Nutrition, 98*(5), 1170–1178. http://dx.doi.org/10.3945/ajcn.113.064584.

Hoddinott, J., Maluccio, J. A., Behrman, J. R., Flores, R., & Martorell, R. (2008). Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *Lancet, 371*(9610), 411–416. http://dx.doi.org/10.1016/S0140-6736(08)60205-6.

James-Todd, T., Tehranifar, P., Rich-Edwards, J., Titievsky, L., & Terry, M. B. (2010). The impact of socioeconomic status across early life on age at menarche among a racially diverse population of girls. *Annals of Epidemiology, 20*(11), 836–842. http://dx.doi.org/10.1016/j.annepidem.2010.08.006.

Limony, Y., Kozieł, S., & Friger, M. (2015). Age of onset of a normally timed pubertal growth spurt affects the final height of children. *Pediatric Research, 78*(3), 351–355. http://dx.doi.org/10.1038/pr.2015.104.

Lopez Boo, F. (2014). Socioeconomic status and early childhood cognitive skills: Is Latin America different? Retrieved from 〈http://lacer.lacea.org/handle/123456789/12564〉.

Lopez Boo, F. (2016). Socio-economic status and early childhood cognitive skills: A mediation analysis using the Young Lives panel. *International Journal of Behavioral Development, 40*(6), 500–508. http://dx.doi.org/10.1177/0165025416644689.

Lu, C., Black, M. M., & Richter, L. M. (2016). Risk of poor development in young children in low-income and middle-income countries: an estimation and analysis at the global, regional, and country level. *The Lancet Global Health*. 〈http://www.sciencedirect.com/science/article/pii/S2214109X16302662〉.

Lundeen, E. A., Behrman, J. R., Crookston, B. T., Dearden, K. A., Engle, P., Georgiadis, A., ... Stein, A. D. (2014). Growth faltering and recovery in children aged 1–8 years in four low-and middle-income countries: Young Lives. *Public Health Nutrition, 17*(09), 2131–2137.

Lundeen, E. A., Norris, S. A., Martorell, R., Suchdev, P. S., Mehta, N. K., Richter, L. M., &

Stein, A. D. (2016). Early life growth predicts pubertal development in South African adolescents. *The Journal of Nutrition, 146*(3), 622–629. http://dx.doi.org/10.3945/jn.115.222000.
Macours, K., Schady, N., & Vakis, R. (2012). Cash transfers, behavioral changes, and cognitive development in early childhood: Evidence from a randomized experiment. *American Economic Journal: Applied Economics, 4*(2), 247–273. http://dx.doi.org/10.1257/app.4.2.247.
Maluccio, J. A., Hoddinott, J., Behrman, J. R., Martorell, R., Quisumbing, A. R., & Stein, A. D. (2009). The impact of improving nutrition during early childhood on education among Guatemalan adults. *The Economic Journal, 119*(537), 734–763. http://dx.doi.org/10.1111/j.1468-0297.2009.02220.x.
Mani, S. (2012). Is there complete, partial, or no recovery from childhood malnutrition? – Empirical evidence from Indonesia. *Oxford Bulletin of Economics and Statistics, 74*(5), 691–715. http://dx.doi.org/10.1111/j.1468-0084.2011.00670.x.
Martorell, R., Horta, B. L., Adair, L. S., Stein, A. D., Richter, L., Fall, C. H. D., ... Consortium on Health Orientated Research in Transitional Societies Group (2010). Weight gain in the first two years of life is an important predictor of schooling outcomes in pooled analyses from five birth cohorts from low- and middle-income countries. *The Journal of Nutrition, 140*(2), 348–354. http://dx.doi.org/10.3945/jn.109.112300.
McCoy, D. C., Peet, E. D., Ezzati, M., Danaei, G., Black, M. M., Sudfeld, C. R., ... Fink, G. (2016). Early childhood developmental status in low-and middle-income countries: National, regional, and global prevalence estimates using predictive modeling. *PLoS Med, 13*(6), e1002034.
Neal, D. (2006). Why has black–white skill convergence stopped? *Handbook of the Economics of Education, 1*, 511–576.
Nino, F.S. (2016). Reduce inequality within and among countries. Retrieved May 1, 2016, from ⟨http://www.un.org/sustainabledevelopment/inequality/⟩.
Pavalko, E. K., & Caputo, J. (2013). Social inequality and health across the life course. *American Behavioral Scientist*. http://dx.doi.org/10.1177/0002764213487344.
Paxson, C., & Schady, N. (2007). Cognitive development among young children in Ecuador: The roles of wealth, health, and parenting. *The Journal of Human Resources, 42*(1), 49–84.
Penny, M.E., Schott, W., Crookston, B.T., & Behrman, J.R. (2015). Catch-up growth: What, how, when, why, and does it matter? *Ma, Peru: Instituto de Investigación Nutricional*.
Prado, E. L., Abbeddou, S., Adu-Afarwuah, S., Arimond, M., Ashorn, P., Ashorn, U., et al. (2017). Predictors and pathways of language and motor development in four prospective cohorts of young children in Ghana, Malawi, and Burkina Faso. *Journal of Child Psychology and Psychiatry* (Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/jcpp.12751/full).
Prentice, A. M., Ward, K. A., Goldberg, G. R., Jarjou, L. M., Moore, S. E., Fulford, A. J., & Prentice, A. (2013). Critical windows for nutritional interventions against stunting. *The American Journal of Clinical Nutrition, 97*(5), 911–918. http://dx.doi.org/10.3945/ajcn.112.052332.
Roberts, J. L., & Stein, A. D. (2017). The impact of nutritional interventions beyond the first 2 years of life on linear growth: A systematic review and meta-analysis. *Advances in Nutrition: An International Review Journal, 8*(2), 323–336.
Rubio-Codina, M., Attanasio, O., Meghir, C., Varela, N., & Grantham-McGregor, S. (2015a). The socioeconomic gradient of child development: Cross-sectional evidence from children 6–42 months in Bogota. *Journal of Human Resources, 50*(2), 464–483.
Rubio-Codina, M., Attanasio, O., Meghir, C., Varela, N., & Grantham-McGregor, S. (2015b). The socioeconomic gradient of child development: Cross-sectional evidence from children 6–42 months in Bogota. *Journal of Human Resources, 50*(2), 464–483.
Schady, N., Behrman, J., Araujo, M. C., Azuero, R., Bernal, R., Bravo, D., et al. (2015). Wealth gradients in early childhood cognitive development in five Latin American countries. *Journal of Human Resources, 50*(2), 446–463.
Schott, W. B., Crookston, B. T., Lundeen, E. A., Stein, A. D., & Behrman, J. R. (2013). Periods of child growth up to age 8 years in Ethiopia, India, Peru and Vietnam: Key distal household and community factors. *Social Science Medicine, 1982*, *97*. http://dx.doi.org/10.1016/j.socscimed.2013.05.016.
Stein, A. D., Lundeen, E. A., Martorell, R., Suchdev, P. S., Mehta, N. K., Richter, L. M., & Norris, S. A. (2016). Pubertal development and prepubertal height and weight jointly predict young adult height and body mass index in a prospective study in South Africa. *The Journal of Nutrition, 146*(7), 1394–1401. http://dx.doi.org/10.3945/jn.116.231076.
Stein, A. D., Wang, M., Martorell, R., Norris, S. A., Adair, L. S., Bas, I., ... Victora, C. G. (2010). Growth patterns in early childhood and final attained stature: Data from five birth cohorts from low- and middle-income countries. *American Journal of Human Biology, 22*(3), 353–359. http://dx.doi.org/10.1002/ajhb.20998.
Tuan, T., Lan, P.T., Harpham, T., Huong, N.T., Thach, T.D., Tod, B., … Ha, N.T.V. (2003). Young Lives Preliminary Country Report: Vietnam. Retrieved from ⟨http://www.younglives.org.uk/sites/www.younglives.org.uk/files/YL-CR1-Vietnam-2003.pdf⟩.
Victora, C., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008). Maternal and child undernutrition: Consequences for adult health and human capital. *The Lancet, 371*(9609), 340–357.
Victora, C., de Onis, M., Hallal, P. C., Blössner, M., & Shrimpton, R. (2010). Worldwide timing of growth faltering: Revisiting implications for interventions. *Pediatrics, 125*(3), e473–e480. http://dx.doi.org/10.1542/peds.2009-1519.
Vizmanos, B., Martí-Henneberg, C., Clivillé, R., Moreno, A., & Fernández-Ballart, J. (2001). Age of pubertal onset affects the intensity and duration of pubertal growth peak but not final height. *American Journal of Human Biology, 13*(3), 409–416. http://dx.doi.org/10.1002/ajhb.1065.
Walker, S. P., Chang, S. M., Vera-Hernández, M., & Grantham-McGregor, S. (2011a). Early childhood stimulation benefits adult competence and reduces violent behavior. *Pediatrics, 127*(5), 849–857. http://dx.doi.org/10.1542/peds.2010-2231.
Walker, S. P., Wachs, T. D., Grantham-McGregor, S., Black, M. M., Nelson, C. A., Huffman, S. L., et al. (2011b). Inequality in early childhood: Risk and protective factors for early child development. *The Lancet, 378*(9799), 1325–1338.
World Health Organization (2006). WHO Child Growth Standards: Methods and development. EN technical report. Retrieved from ⟨http://www.who.int/childgrowth/standards/technical_report/en/⟩.
Young Lives methods guide: sampling (2017). Oxford Department of International Development. Retrieved from younglives.org.uk.
Zhang, H., Behrman, J. R., Fan, C. S., Wei, X., & Zhang, J. (2014). Does parental absence reduce cognitive achievements? Evidence from rural China. *Journal of Development Economics, 111*, 181–195. http://dx.doi.org/10.1016/j.jdeveco.2014.09.004.