Maternal education gradients in early life height: A comparative study of eight Latin American countries

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Abstract

Background

More than 20% of the children around the world were stunted in 2018. The situation is not any better in Latin American countries, even though stunting prevalence has been declining since 2000. Stunting has adverse consequences on children: severe short- and long-term health and functional effects, poor cognition and educational performance, low adult wages, and productivity loss.

Methods

This study compares maternal education gradients in height-for-age z-scores (HAZs) and stunting prevalence in children between two and four years of age from eight different Latin American countries: Chile, Uruguay, Costa Rica, Paraguay, Mexico, El Salvador, Nicaragua, and Peru.

Results

Results show that the prevalence of stunting varies widely across Latin American countries. Having a mother with tertiary education increases HAZs in every country (except Paraguay), compared to having a mother with primary education or less. In some countries, there is also a difference in HAZs associated with secondary versus primary maternal education. With regard to stunting, maternal education is a crucial determinant to decrease the odds of being stunted in early years in countries with the highest stunting prevalence (≈ 20%); however, this is not the case for countries where the prevalence is low (< 5%).

Conclusions

We found that maternal education is associated with height and stunting in preschool-aged children in our sampled Latin American countries. The association's magnitude is higher for LMICs than for countries with a higher income per capita in the zone (i.e., Chile and Uruguay). These results suggest that future policies aiming to increase maternal education will improve children's height-for-age and decrease their risk of stunting.

Introduction

Favorable physical growth, particularly in the early years of life, has been shown to have an extensive impact on population health, enhancing cognitive and socioemotional skills, allowing people to live longer in a healthy condition (Dewey & Begum, 2011; Grantham-McGregor et al., 2007; Guerrant et al., 2013; Martorell, 1999; Reynolds et al., 2017; Stevens et al., 2012; Walker et al., 2007). According to the latest report of the World Health Organization (WHO), childhood nutrition is essential for proper growth

(WHO, 2020). The worldwide prevalence of stunting in children under 5 years of age, defined as being two standard deviations (SDs) below the WHO child growth standard median, has decreased by 12% in the last 20 years (De Onis et al., 2019). However, the trend remains dissimilar in low- and middle-income countries (LMICs), where poverty, sanitation, and hygiene levels are still a social concern of population health (Perkins et al., 2017; Prendergast & Humphrey, 2014).

Recent studies have depicted that inappropriate child growth—stunting—results from a complex interaction among household, environmental, socioeconomic, and cultural influences (Stewart et al., 2013). Consequently, it might have severe short- and long-term health and functional consequences, including poor cognition and educational performance, low adult wages, and productivity loss (De Onis & Branca, 2016). Studies from LMICs from Latin America have shown that children's cognitive, physical, communicational, and socio-emotional development is shaped by the family's socioeconomic status (SES) (Araujo et al., 2015; Dekker et al., 2010; Lee et al., 2012; Schady et al., 2015; Segretin et al., 2016). Diversely from high-income countries (HICs), in LMICs this relationship can be derived from poor nutrition and lack of access to clean water, inadequate psychosocial stimulation, and the presence of repetitive infections causing impaired development in children under the age of 5 years living in low SES environments (Bradley & Corwyn, 2002; Ngure et al., 2014). Moreover, the high inequality in stunting levels between and within Latin America's LMICs has led to pay special attention to family's socioeconomic background to understand, and therefore tackle, the existing disparities while improving children's health.

The following study compares height-for-age z-scores (HAZs) and stunting prevalence in children between 2 and 4 years of age from eight different Latin American countries: Chile, Uruguay, Costa Rica, Paraguay, Mexico, El Salvador, Nicaragua, and Peru, focusing on maternal educational gradients. The paper aims to shed light on how socioeconomic and family background could enhance children's development from a comparative perspective. This research provides a cross-country comparison in the child, maternal, and household determinants of height-for-age and stunting prevalence by comparing the maternal education component's importance in the association with height-for-age and stunting.

Context

According to the 2018 Global Nutrition Report, the percentage of children under the age of 5 years who were stunted in Latin American countries was 9.6% (Fanzo et al., 2018). Furthermore, chronic undernutrition in Latin America and the Caribbean can vary widely; some countries face medium (10–20%), high (20–30%), or very high stunting rates (>30%) (Keeley et al., 2019).

The vast disparities within the region are represented in our sample of Latin American countries. Table 1 shows the mean and SD of the HAZ index by country (appendix, Figure A1), whereas Figure 1 shows the prevalence of stunted children by country (appendix, Figure A2). The prevalence of stunted children varies widely across countries. Chile and Uruguay have the lowest percentage of stunted children (2.8 and 3.8%, respectively), while other countries range between 10 and 15% (Costa Rica, Paraguay, Mexico, and El Salvador) and the most extreme countries are bordering 20% (Nicaragua and Peru).

In terms of demographic indicators, Table 2 shows economic and public health parameters for each country closer to the year of our infant data (2013) to understand the demographic and economic contexts of the different countries. Table 2 shows that countries with higher health expenditures have lower stunting prevalence. Yet, other indicators, such as infant mortality rate, are also aligned to the prior. The more investment the government puts into health, the better the outcomes for children.

The disparities in HAZs and stunting prevalence have been explained by different factors (del Pilar Flores-Quispe et al., 2019; Frongillo et al., 1997), but we want to pay close attention to a specific aspect: maternal educational gradients and their role in explaining the HAZs and stunting prevalence across countries. Figure 2 shows maternal education by country, and Figure 3 displays stunted children's prevalence by maternal educational and country. Secondary education is the most frequent maternal education level in most countries, while primary education remains the most prevalent level in countries like Costa Rica and Nicaragua. When looking at both maternal education level and stunting prevalence, a negative correlation is seen in every country (e.g., if education increases, stunting prevalence decreases).

Therefore, these figures raise new questions about how relevant maternal education is in determining HAZs and stunting prevalence in children under the age of 5 years. This paper explores how maternal education gradients affect HAZs and stunting prevalence and how these gradients differ by nation.

Data And Methods

Data

This paper uses the "Latin American – Center for Advanced Studies on Educational Justice" data project (LATAM-CJE), which is a multi-sectoral effort aiming to merge early childhood datasets from different countries in Latin America. The main goal of the project is to generate regionally comparative research on child development outcomes. Thus far, the project has included eight Latin American countries. Data were extracted from four surveys. First, early childhood data from Mexico and El Salvador were obtained from the Multiple Indicator Cluster Surveys (MICS), an international project carried out in LMICs by UNICEF that collects information about children and their households every five years (UNICEF, 2016). Second, data from Costa Rica, Nicaragua, Paraguay, and Peru were accessed through the Regional Project on Child Development Indicators (PRIDI), which was led by the Inter-American Development Bank (IDB) in 2013 (Verdisco et al., 2016). They measured child development indicators in children between 24 and 59 months of age. Third and fourth, data from Chile and Uruguay were extracted from their country-specific early childhood longitudinal studies: the Longitudinal Survey on Early Childhood Development (ELPI), and the Nutrition, Child Development, and Health Survey (ENDIS), respectively (Chilean Ministry of Social Development and Family, 2020; Uruguayan Ministry of Social Development, 2020).

We restricted our sample to children aged between 2 and 4 years (24 to 48 months old) for the present analysis. The chosen range represents a crucial developmental stage for the height-for-age marker. Full sample sizes and analytical sample sizes are shown in Appendix Table 1.

Measures

Two dependent variables were used in the models: HAZs and stunting prevalence. Height was objectively measured in each survey using a measuring tape from the floor to the children to get their full size in centimeters. For our analysis, we standardized height-for-age based on WHO standards for age and sex. Stunting is defined as a HAZ of less than or equal to two height-for-age standard deviations (SDs) from the WHO Child Growth Standards (WHO, 2006).

The main independent variable is maternal education level, which we divided into three categories: primary or less, secondary, and tertiary education level. The exact definition of each of these categories varies depending on the country. Primary education is defined as six years of formal schooling in all countries[1]. In terms of secondary level, Chile, El Salvador, Mexico, Paraguay, and Uruguay have six years of secondary school, while Costa Rica, Nicaragua, and Peru have five years of secondary school. Any years of education after secondary education were categorized as tertiary education.

Independent variables incorporated as covariates included characteristics of the mother, child, and household. Mother characteristics were age (in years) and ethnicity (which indicates whether the mother spoke indigenous language). Child characteristics included age in months, gender, and whether they were breastfed. Household characteristics contained three different variables: the number of people living in the household, the total number of additional children living at home, and wealth or income terciles (computed based on different scales and measures depending on the survey). Finally, to capture parenting style, we added two childhood stimulation variables: whether the parents stimulated their child by singing them a song and whether they regularly told their child stories (both presented as dichotomous variables). Table 3 depicts the descriptive statistics of our sample by country. The table shows that levels of stunting and levels of maternal education differ by country (also shown in Fig. 1 and Fig. 2). In terms of maternal age, the samples are quite similar, with means from 27.5 years in Costa Rica through 32.5 years in El Salvador. Ethnicity and rurality are characteristics that vary greatly between countries: ethnicity ranges from 0.7% in Costa Rica through 37.1% in Paraguay, and rurality ranges from 10.6% in Chile through 43% in El Salvador. Children characteristics are quite similar across countries: age in months, sex, and if they were breastfed.

To understand each national context, we compare our sample of mothers, whose children were 2 to 4 years old, with the standard socio-economic survey of each country to contrast our main independent variable: maternal education level. The results from this exercise are shown in appendix, section B. Our sampled mothers are in general much more educated for all countries than in the whole population. The main explanation behind this is that this is a relatively young section of the population—it represents a younger cohort born mainly after primary and secondary education became universal in these countries.

Thus, we should bear in mind that we work with a non-random sample of a much more educated population than what is observed in the whole population.

Methods

In the first set of analyses, we run linear regression models for the HAZ separately by country, as indicated in equation (1). The dependent variable corresponds to the height-for-age for the child *i*, and the main independent variable are dummies for maternal educational level (), where the first category—primary or less—is omitted. Therefore, an interpretation of the coefficients is made in comparison to this category. is a matrix of "j" observed child characteristics, including mother and household characteristics, and is the error term.

See formulas 1 and 2 in the supplementary files.

[1] Paraguay adopted a reform establishing 9 years for primary education, but we used 6 years for primary and 6 years for secondary according to the international equivalent educational standards of the United Nations Educational, Scientific, and Cultural Organization (UNESCO; UNESCO, 2013, 2015).

Results

Results from the first set of analyses indicate the importance of maternal education for HAZs among children between 24 and 48 months. Figure 4 shows the coefficients estimated for maternal secondary and tertiary education graphically by country compared to primary or less. Table 4 displays the coefficient estimates by country for the full model. For almost all countries, children of mothers with tertiary education had higher HAZs, compared to children of mothers with primary education or less. The exception is Paraguay, where there is no clear association between maternal educational level and HAZs. The maternal educational gradient varies by country: the smallest tertiary–primary gap was estimated for Chile at 0.2 SDs, i.e., children of mothers with tertiary education in Chile were 0.2 SDs taller than were children of mothers with primary education. Countries like Uruguay, Mexico, El Salvador, and Peru had a gradient ranging between 0.3 and 0.4 SDs. In contrast, countries like Costa Rica and Nicaragua show a maternal educational gradient from at least half a SD in height for age. The differences are less consistent when comparing children from mothers with secondary education versus primary or less. There is only a difference in HAZs in some countries between children of mothers with secondary and primary education: Uruguay, Mexico, El Salvador, and Peru.

With regard to other covariates, mother's age is relevant to explain HAZs in children under 5 years, but only in some countries: Chile, Mexico, El Salvador, and Peru. Nonetheless, the magnitude of the coefficient is small. Ethnicity was a relevant predictor in countries like Mexico, El Salvador, and Peru. The coefficients were 0.4 SDs for Mexico and El Salvador and 0.8 for Peru, which was of a higher relevance than the maternal educational gradient. Similarly, household wealth terciles were significant predictors of HAZs for all countries. The gradient in HAZs between belonging to the wealthier tercile and the poorer tercile varies between countries, being more important for countries like Paraguay (0.7 SDs), El Salvador (0.6 SDs), and Peru (0.5 SDs) and less important for countries like Chile (0.2 SDs) and Uruguay, where the coefficient did not present any meaningful variation.

Table 5 and Figure 5 depict the results for the models for stunting. Maternal education level is a crucial predictor for countries with a higher current stunting prevalence. Countries like Chile and Uruguay, where the prevalence is less than 4%, exhibited no differences in their respective stunting prevalence by mother's primary, secondary, or tertiary education level. Costa Rica, which has a prevalence of stunted children of 9%, did not display a maternal education gradient either. Notwithstanding, Paraguay (12% stunting prevalence) showed that mothers with tertiary education have almost a 50% lesser chance of having a stunted child than mothers with primary education level or less. The gradient is well observed in Mexico, where the odds for children of mothers with secondary education are 35% lower than they were for children of mothers with primary education or less. Meanwhile, having tertiary education increases these odds in about 50%. The maternal educational gradient is even more exacerbated in countries like El Salvador, Nicaragua, and Peru, where the stunting prevalence is the highest of our sampled countries (≈15%). Lower odds of stunting prevalence were seen if the mother had a higher education level. With regard to other covariates, an important finding is that with Nicaragua's exception, wealth terciles are vital determinants in predicting stunting prevalence, being even stronger than maternal educational gradients in some of our sampled countries.

Finally, we did an exploratory analysis by looking at the differences by child's gender and urban/rural residence. Even though for some countries sample sizes are small, Tables C1 and C2 in the appendix demonstrate these results. For boys, there is no clear pattern for all countries, but for girls, we see secondary and tertiary education being an important determinant of HAZs in those countries with a higher prevalence of stunting: Mexico, El Salvador, Nicaragua, and Peru. We saw no clear pattern for rurality, and the most important significant finding was found for Peru, where we observed a difference between urban and rural residency. For urban residency, the maternal educational gradient is important at the secondary and tertiary educational levels; however, maternal educational level was not a clear driver of children's HAZs in the rural zone.

Conclusions

This research article examined the association between height-for-age and stunting and maternal educational level among children between 2 and 4 years old from eight different Latin American countries. Our results evidence that children whose mothers have tertiary education had an increased HAZ in every country—except for Paraguay—compared to children whose mothers have primary education or less. In addition, maternal education was a crucial determinant in decreasing the odds of stunting in countries with a high stunting prevalence (Mexico, El Salvador, Nicaragua, and Peru), but not in countries where the prevalence of stunting was low (Chile, Uruguay, Costa Rica, and Paraguay). We view these maternal educational gradients as capturing cultural capital rather than economic resources, as we control for wealth terciles.

Our results are consistent with the previous literature on socioeconomic characteristics and how they affect stunting prevalence in the early years in LMICs (Black et al., 2013; Lu et al., 2016). For Latin American countries, studies have found that children with illiterate primary caregivers were 5 times more likely to be stunted compared with their counterparts with literate primary caregivers in Guatemala (Sereebutra et al., 2006), and maternal stature, low body mass index (BMI), low education, and poverty were also predictors of stunting in Uruguay (Bove et al., 2012). For Colombia, child stunting is associated with lower socioeconomic and maternal nutritional statuses (Dekker et al., 2010). To our knowledge, this is the first study to examine the influence of maternal education on HAZs and stunting across a range of Latin American countries.

This paper has some limitations. First, we do not have information on nutritional aspects for each country; this could explain some of the heterogeneous results we are finding across countries. Second, as with many comparative papers, we have to limit the number of controls in the estimations to those available in each survey. This may limit the analysis by introducing a potential omitted variable bias. Third, even though our analyses used several Latin American countries, our results do not necessarily represent other countries across the zone, because of either missing studies or data availability. Fourth, we lacked data on other environmental characteristics affecting early height and stunting, such as a lack of solid waste disposal, a lack of sanitation, solid fuels in the household, and dirt floor and material deprivation, although we did use socioeconomic measures to proxy for these differences.

Despite these limitations, this study advances the literature on early childhood growth in Latin American countries from a comparative perspective by using a combination of national surveys. We harmonized and merged the data on early childhood stunting and sociodemographic variables, which no study has done before, resulting in a study of a considerable sample size. A particular strength is the standardization of the anthropometric measures—HAZ and stunting—allowing a reasonable degree of comparability between estimates. Finally, we use the most recent surveys from countries, most from 2012–2013.

In conclusion, we found that maternal education is associated with height and stunting in preschool-aged children in our sampled Latin American countries. The association's magnitude is higher for LMICs than for countries with a higher income per capita in the zone (i.e., Chile and Uruguay). This could be explained in part because formal education may equip parents to apply successfully knowledge about health, sanitation, and responsive interaction when caring for their children (Pamuk et al., 2011), which could prevent them from stunting in the context of low or moderate income.

These findings support the importance of improving maternal education as a way of enhancing children's nutritional and environmental conditions during the early ages to ensure proper linear growth throughout childhood. Another approach would be to provide additional supports to families with less educated mothers. Successful interventions are often implemented as multi-sectoral packages anchored in nurturing care and include parenting support, preschool participation, and responsive care (Britto et al., 2016). Interventions should aim at lessening the difficulties imposed by the environmental disruptors of child development. This is part of the Sustainable Development Goals (SDGs) for 2030, aiming to tackle stunting to ensure every child can reach their potential over their life course (Richter et al., 2017).

Declarations

Ethics approval and consent to participate: not applicable, data was public.

Consent for publication: not applicable, data was public.

Availability of data and material: the datasets analyzed during the current study are available in the web page for each survey.

https://www.iadb.org/en/sector/education/pridi/home

https://mics.unicef.org/surveys

https://www.gub.uy/ministerio-desarrollo-social/endis

http://observatorio.ministeriodesarrollosocial.gob.cl/elpi-tercera-ronda

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Tables

Table 1: Height-for-Age Z-score (HAZ) by Country

	HAZ Index WHO	
Country	Mean	SD
Chile	0.00	1.08
Uruguay	-0.17	1.06
Costa Rica	-0.43	1.47
Paraguay	-0.47	2.12
Mexico	-0.87	1.13
El Salvador	-1.00	1.09
Nicaragua	-0.91	1.28
Peru	-1.04	1.45

Notes: Height-for-age z-scores (HAZs) based on WHO Child Growth Standards.

Table 2: Demographic Indicators for Countries Year 2013

	Unit	Chile	Uruguay	Costa-Rica	Paraguay	Mexico	El Salvador	Nicaragua	Peru
ation	1,000 inhabitants	17,571	3,389	4,742	6,510	118,827	6,266	6,062	29,773
per	Constant 2010 US$	14,461	13,541	8,785	4,699	9,693	3,212	1.716	5.919
ty ount at al ty (% of ation)	%	14.4	11.5	20.7	28.0	45.5	29.6	42.5	23.9
cient	Coefficient	47.3	40.5	49.3	47.9	45.4	43.4	43.9	43.9
lity	Per 1,000 live births	7	8	8	20	14	15	17	14
nt diture GDP)	%	7.44	8.82	7.68	6.97	5.81	6.97	7.33	4.92
stic al nment diture pita	Current international $	997.67	1,168.63	822.68	300.21	526.25	344.95	188.30	328.97

Notes: OECD; CELAC; WORLD BANK data 2014-2017.
https://ourworldindata.org/pre-primary-education.
http://estadisticas.cepal.org/cepalstat/WEB_CEPALSTAT/perfilesNacionales.asp?idioma=.
https://stats.oecd.org.

Table 3: Descriptive Statistics

	Chile		Uruguay		Costa Rica		Paraguay	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height raw	97.2	6.087	92.7	5.418	94.0	7.475	94.4	8.760
HAZ	0.005	1.076	-0.153	1.058	-0.446	1.494	-0.491	1.997
Stunting	2.8%	0.164	3.8%	0.191	9.0%	0.286	13.1%	0.337
Mother's education								
Primary or less	4.3%	0.204	20.6%	0.405	50.9%	0.500	34.3%	0.475
Secondary	74.5%	0.436	54.3%	0.498	37.4%	0.484	43.5%	0.496
Tertiary	21.1%	0.408	25.0%	0.433	11.7%	0.321	22.2%	0.416
Mother's age	29.7	7.005	29.5	7.021	27.5	6.207	29.4	6.895
Mother's ethnicity	7.8%	0.269	8.0%	0.271	0.7%	0.082	37.1%	0.483
Age in months	38.7	6.394	33.1	5.802	36.6	7.119	37.3	6.732
Female	48.7%	0.500	52.8%	0.499	51.1%	0.500	45.9%	0.499
Tercile								
Wealth tercile 1	37.7%	0.485	33.4%	0.472	37.7%	0.485	31.9%	0.466
Wealth tercile 2	30.0%	0.458	35.3%	0.478	32.2%	0.467	35.3%	0.478
Wealth tercile 3	32.3%	0.468	31.3%	0.464	30.2%	0.459	32.8%	0.470
Overcrowding	4.8	1.646	4.8	1.834	4.9	2.072	5.1	1.877
Number of other children in HH	0.9	0.929	1.2	1.273	1.0	0.997	1.0	1.027
Rural	10.6%	0.308			19.0%	0.393	32.2%	0.467
Breastfed	95.4%	0.209	97.0%	0.169	88.3%	0.321	94.6%	0.227
Sang a song	92.0%	0.272	89.8%	0.303	76.3%	0.426	72.3%	0.448
Told a story	79.3%	0.405	81.6%	0.387	56.0%	0.497	46.2%	0.499
Number of observations	4.640		1.454		746		734	

	Mexico		El Salvador		Nicaragua		Peru	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height raw	91.8	6.382	91.7	6.322	92.2	6.231	91.5	6.983
HAZ	-0.872	1.133	-1.001	1.094	-0.906	1.285	-1.047	1.447
Stunting	14.5%	0.352	16.2%	0.369	19.5%	0.397	23.0%	0.421
Mother's education								
Primary or less	24.6%	0.431	40.4%	0.491	47.5%	0.500	24.9%	0.433
Secondary	63.6%	0.481	49.0%	0.500	37.8%	0.485	50.3%	0.500
Tertiary	11.8%	0.322	10.6%	0.308	14.7%	0.354	24.8%	0.432
Mother's age	29.1	7.778	32.5	10.092	27.5	6.505	29.5	6.607
Mother's ethnicity	11.1%	0.314	0.9%	0.092	19.6%	0.397	6.7%	0.249
Age in months	35.7	7.318	36.2	7.529	36.5	6.851	36.1	6.998
Female	48.6%	0.500	47.7%	0.500	50.9%	0.500	47.6%	0.500
Tercile								
Wealth tercile 1	33.9%	0.473	34.3%	0.475	32.4%	0.468	32.8%	0.470
Wealth tercile 2	32.3%	0.468	30.2%	0.459	34.0%	0.474	34.7%	0.476
Wealth tercile 3	33.8%	0.473	35.5%	0.479	33.6%	0.473	32.6%	0.469
Overcrowding	5.1	1.910	5.1	2.021	5.6	2.345	4.7	1.695

Number of other children in HH	1.6	1.431	1.3	1.308	1.1	1.137	1.0	1.237
Rural	37.1%	0.483	43.0%	0.495	39.4%	0.489	31.8%	0.466
Breastfed	90.9%	0.288	95.0%	0.218	98.5%	0.122	96.4%	0.186
Sang a song	34.0%	0.474	29.4%	0.456	68.3%	0.466	69.6%	0.460
Told a story	27.0%	0.444	17.9%	0.384	37.6%	0.485	56.3%	0.496
Number of observations	3.428		3.176		994		1.486	

Notes: HAZ stands for Height-for-age (z-score)

Table 4: Linear Regression Model Height-for-Age by Country

	Chile	Uruguay	Costa Rica	Paraguay	Mexico	El Salvador	Nicaragua	Peru
condary (ref. mary)	0.075	0.155*	0.152	-0.138	0.228***	0.153***	0.142	0.237**
	(0.083)	(0.079)	(0.115)	(0.206)	(0.046)	(0.043)	(0.095)	(0.097)
rtiary (ref. mary)	0.157*	0.258**	0.500***	0.205	0.250***	0.254***	0.559***	0.402***
	(0.089)	(0.102)	(0.166)	(0.205)	(0.067)	(0.082)	(0.133)	(0.122)
ther's age	0.009***	0.003	-0.000	0.010	0.006**	0.008***	0.015**	0.001
	(0.002)	(0.005)	(0.010)	(0.012)	(0.002)	(0.002)	(0.007)	(0.006)
ther's ethnicity f. no igenous)	0.060	0.032	0.396	-0.017	-0.471***	-0.406*	-0.010	-0.858***
	(0.058)	(0.099)	(0.589)	(0.198)	(0.062)	(0.238)	(0.108)	(0.167)
ld's age in nths	0.003	-0.010**	0.009	-0.008	-0.003	-0.003	-0.018***	-0.000
	(0.002)	(0.005)	(0.009)	(0.012)	(0.003)	(0.003)	(0.006)	(0.005)
ld's sex (ref.)	-0.009	-0.077	-0.050	-0.122	-0.007	0.016	0.014	0.178**
	(0.031)	(0.056)	(0.111)	(0.143)	(0.037)	(0.037)	(0.080)	(0.071)
alth terciles 2 f. first tercile)	0.114***	0.160**	0.017	0.292	0.289***	0.352***	0.264***	0.151
	(0.040)	(0.070)	(0.146)	(0.219)	(0.050)	(0.047)	(0.099)	(0.102)
alth terciles 3 f. first tercile)	0.189***	0.076	0.335**	0.709***	0.411***	0.573***	0.395***	0.487***
	(0.041)	(0.083)	(0.136)	(0.262)	(0.056)	(0.056)	(0.115)	(0.121)
mber of people household	0.008	-0.017	0.004	0.055	0.006	0.006	-0.019	0.039*
	(0.013)	(0.027)	(0.036)	(0.046)	(0.013)	(0.012)	(0.023)	(0.024)
mber of other ldren in usehold	-0.106***	-0.056	0.014	-0.013	-0.089***	-0.096***	-0.019	-0.080***
	(0.022)	(0.037)	(0.076)	(0.080)	(0.018)	(0.019)	(0.050)	(0.028)
ral (ref. urban)	0.145***		0.042	-0.395*	-0.004	0.050	-0.038	-0.057
	(0.051)		(0.142)	(0.220)	(0.044)	(0.044)	(0.092)	(0.090)
eastfed (ref. no astfed)	-0.041	0.064	0.258	0.473			-0.064	0.803***
	(0.073)	(0.177)	(0.208)	(0.446)			(0.266)	(0.192)
ng a song (ref. sing)	-0.095	0.078	-0.090	-0.277*	0.141**	0.031	-0.048	0.017
	(0.061)	(0.093)	(0.152)	(0.159)	(0.059)	(0.056)	(0.087)	(0.089)
d a story (ref. story)	0.073*	0.003	0.140	-0.140	-0.064	0.027	0.140	-0.157**
	(0.041)	(0.080)	(0.112)	(0.148)	(0.057)	(0.059)	(0.093)	(0.080)
nstant	-0.451**	-0.086	-1.233**	-1.067	-1.215***	-1.496***	-0.829**	-2.308***
	(0.178)	(0.282)	(0.580)	(0.649)	(0.142)	(0.130)	(0.382)	(0.333)
mber of servations	4,640	1,454	746	734	3,428	3,176	994	1,486

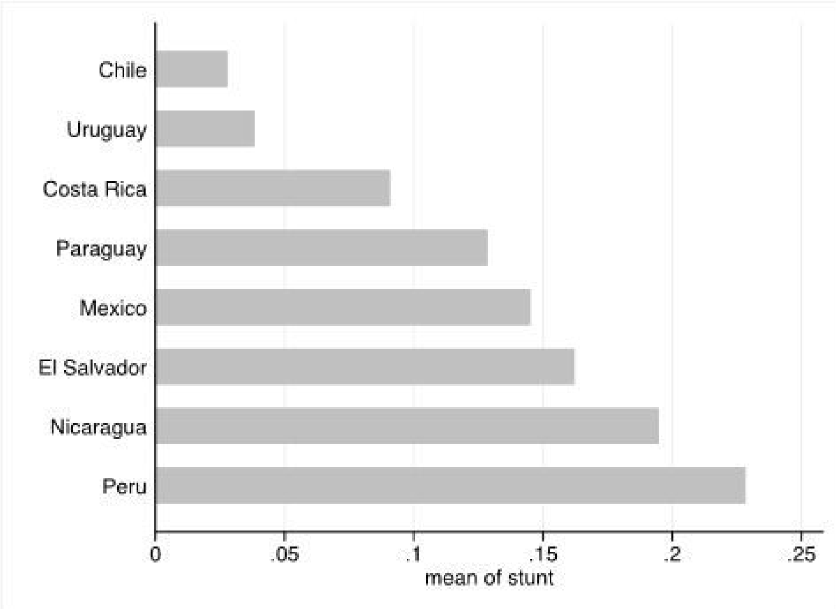
tes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Omitted/reference categories mentioned following the "ref." abbreviation term.

Table 5: Odd Ratios (OR) for the Prevalence of Stunted Children by Country

	Chile	Uruguay	Costa Rica	Paraguay	Mexico	El Salvador	Nicaragua	Peru
	OR(SD)	OR(SD)	OR(SD)	OR(SD)	OR(SD)	OR(SD)	OR(SD)	OR(SD)
condary (ref. mary)	0.796	0.758	0.665	0.766	0.644***	0.683***	0.660**	0.720**
	(0.326)	(0.245)	(0.190)	(0.213)	(0.073)	(0.078)	(0.124)	(0.114)
rtiary (ref. mary)	0.628	0.641	0.442	0.525*	0.501***	0.492***	0.296***	0.519***
	(0.293)	(0.304)	(0.250)	(0.205)	(0.116)	(0.124)	(0.102)	(0.120)
ther's age	0.963***	1.013	1.015	0.964**	0.984**	0.988**	0.977	1.021**
	(0.014)	(0.018)	(0.021)	(0.016)	(0.007)	(0.006)	(0.014)	(0.011)
ther's ethnicity f. no indigenous)	0.450*	0.690		0.990	2.105***	2.696**	1.204	2.286***
	(0.208)	(0.406)		(0.302)	(0.279)	(1.093)	(0.277)	(0.561)
ld's age in nths	0.984	1.017	0.959**	0.963**	0.998	1.006	1.019	1.001
	(0.011)	(0.024)	(0.018)	(0.017)	(0.008)	(0.008)	(0.012)	(0.009)
ld's sex (ref. boy)	1.042	1.341	1.097	1.160	1.026	0.824*	0.841	0.830
	(0.187)	(0.405)	(0.294)	(0.262)	(0.104)	(0.082)	(0.139)	(0.106)
alth terciles 2 f. first tercile)	0.744	0.444**	0.564*	1.041	0.635***	0.522***	1.004	0.734*
	(0.160)	(0.159)	(0.174)	(0.317)	(0.083)	(0.065)	(0.201)	(0.123)
alth terciles 3 f. first tercile)	0.540**	0.625	0.405**	0.536*	0.443***	0.377***	0.837	0.552***
	(0.132)	(0.254)	(0.144)	(0.202)	(0.070)	(0.059)	(0.208)	(0.118)
mber of people in usehold	0.992	1.244**	0.963	1.034	0.986	1.026	1.025	0.962
	(0.073)	(0.137)	(0.069)	(0.089)	(0.032)	(0.033)	(0.049)	(0.044)
mber of other ldren in usehold	1.200	0.880	0.889	0.833	1.189***	1.125**	1.017	1.038
	(0.150)	(0.119)	(0.147)	(0.133)	(0.049)	(0.053)	(0.098)	(0.058)
ral (ref. urban)	0.569		1.460	1.562	1.101	0.864	1.454**	1.085
	(0.200)		(0.468)	(0.475)	(0.127)	(0.101)	(0.265)	(0.179)
eastfed (ref. no astfed)	0.795	0.464	1.072	0.534			0.730	0.348***
	(0.295)	(0.281)	(0.456)	(0.238)			(0.408)	(0.108)
ng a song (ref. no g)	1.438	1.044	2.274**	2.700***	0.627***	1.045	1.041	0.834
	(0.569)	(0.475)	(0.881)	(0.851)	(0.098)	(0.152)	(0.193)	(0.130)
d a story (ref. no ry)	0.935	0.748	0.705	1.162	1.186	0.846	1.241	1.336**
	(0.217)	(0.269)	(0.208)	(0.282)	(0.190)	(0.140)	(0.231)	(0.196)
nstant	0.226*	0.025***	0.377	1.532	0.423**	0.401***	0.296	0.814
	(0.199)	(0.033)	(0.379)	(1.512)	(0.158)	(0.140)	(0.227)	(0.439)
mber of servations	4,640	1,454	741	734	3,428	3,176	994	1,486

tes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Omitted/reference categories mentioned following the "ref." abbreviation term.

Figures



Notes: Stunting is defined as a height-for-age (z-score) less than or equal to two height-for-age standard deviations (SDs) from the WHO Child Growth Standards.

Figure 1

Prevalence of stunted children by country

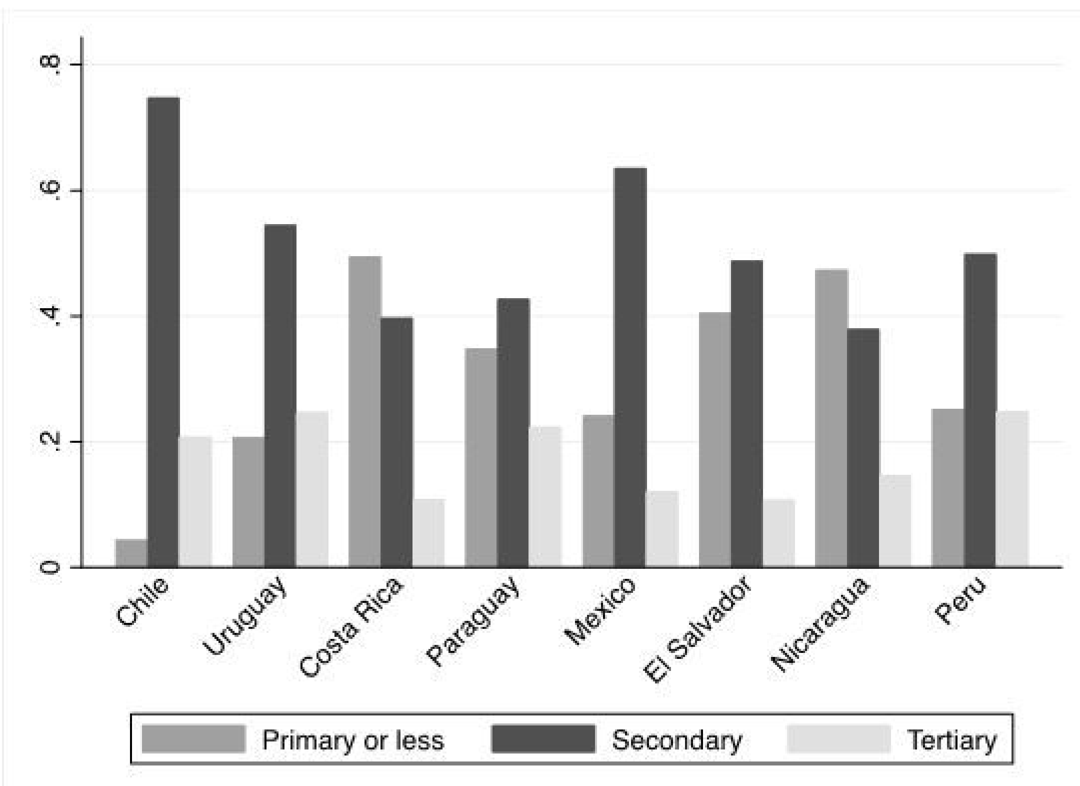


Figure 2

Maternal education level by country

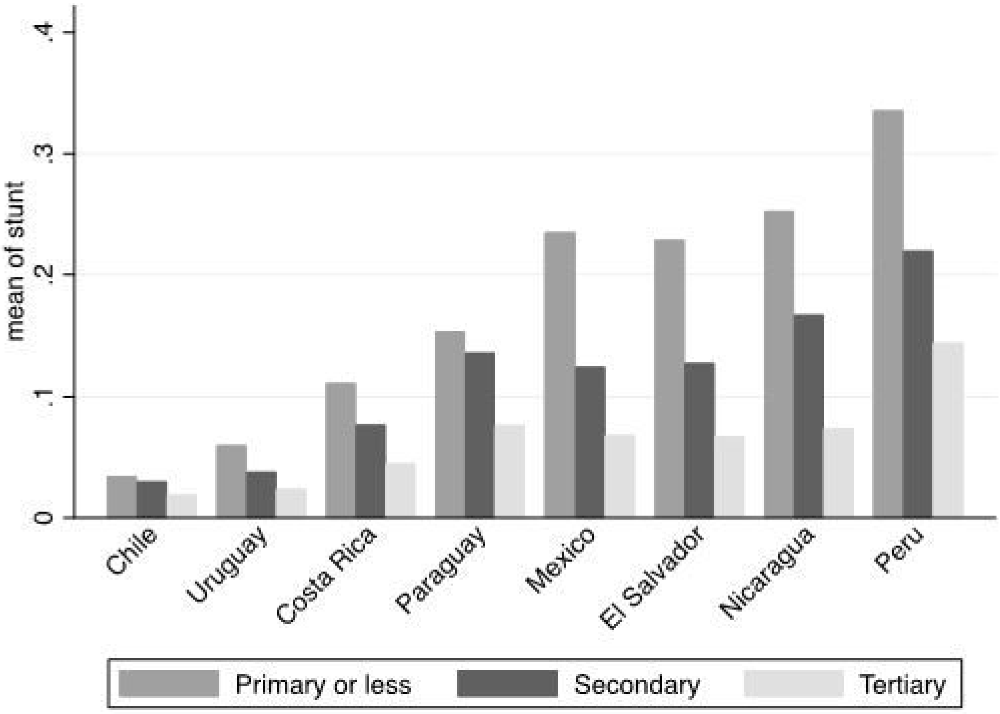
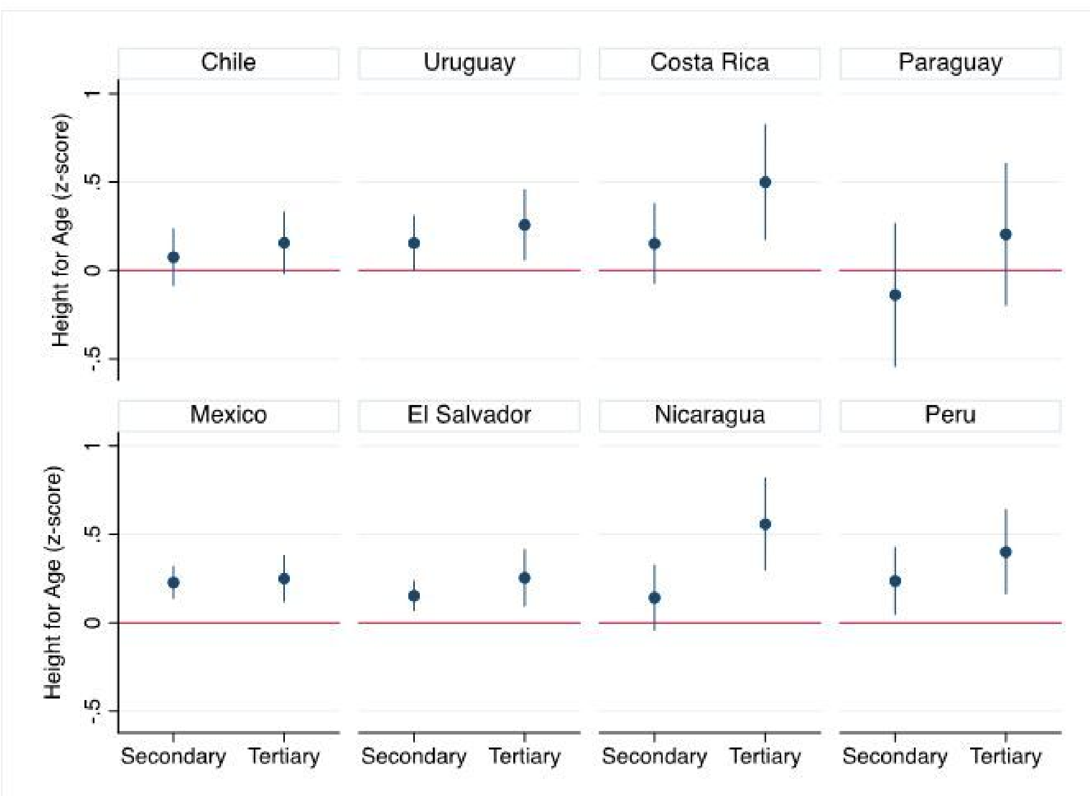


Figure 3

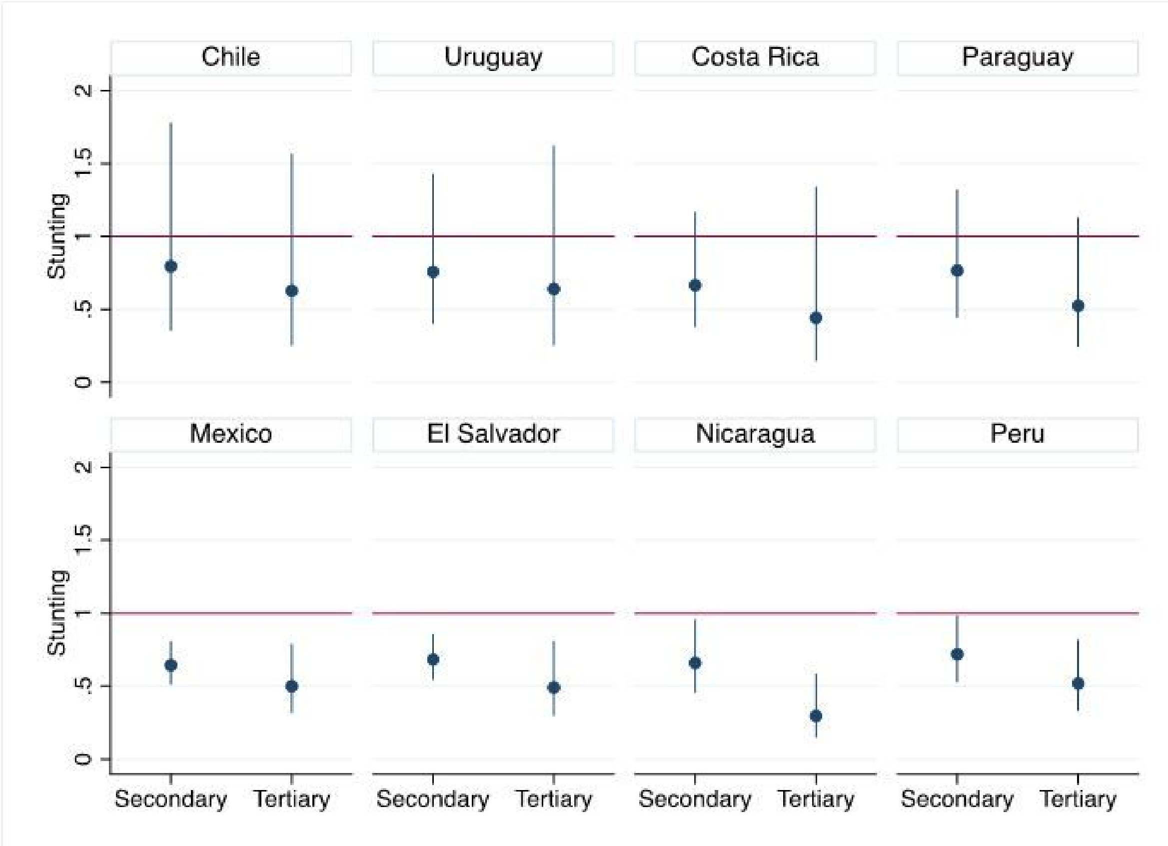
Children's stunting prevalence and maternal education level by country



Notes: Solid dots are parameter estimates from the linear regression model detailed in Table 4. Vertical lines are 95% confidence intervals. Red horizontal line is at zero. See Table 4 for full details.

Figure 4

Parameter estimates for height-for-age by country from the linear regression model



Notes: Solid dots are parameter estimates from the odds ratios detailed in Table 5. Vertical lines are 95% confidence intervals. Red horizontal line indicates an OR = 1. OR>1 means that education has a positive association with stunting prevalence, while OR<1 indicates that a higher educational level tends to reduce children's stunting prevalence. See Table 5 for full models.

Figure 5

Parameter estimates for stunting prevalence by country from the odd ratios model

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- formulas.docx
- 4Appendix.docx