Published in final edited form as:

Soc Sci Med. 2020 November ; 264: 113388. doi:10.1016/j.socscimed.2020.113388.

A longitudinal study of height gaps among Mexican children: Disparities and social inequity

Mireya Vilar-Compte*, Graciela Teruel, Diana Flores, Ida C. García-Appendini, Adriana Ochoa-Lagunas

EQUIDE Research Institute for Equitable Development, Universidad Iberoamericana, Prolongación Paseo de la Reforma 880, Lomas de Santa Fe, Mexico City, 01219, Mexico

Abstract

Rationale: Health outcomes such as height are important determinants of social inequities.

Objective: We assess height gaps in Mexico among boys and girls from distinct subpopulation groups over time.

Method: We use longitudinal data from the first three waves of the Mexican Family Life Survey (MxFLS) to analyze children's height differentials by gender and by indigenous and poverty status over 7–10 years. We control for children's characteristics, household factors, and mother's height and use the Blinder–Oaxaca Decomposition method to explain disparities in children's height across the three waves of the MxFLS.

Results: The main findings suggest that height inequalities among indigenous and extremely poor boys and girls, compared with their non-indigenous and less socioeconomically disadvantaged counterparts, are persistent. The results also reveal that height disparities among girls are consistently greater than those among boys in similar population groups and that height gaps increase over time for girls.

Conclusions: These findings indicate the relevance of social and economic determinants on children's growth potential and the need to examine the association of social determinants on health outcomes. They also underscore the necessity to design and implement public policies that consider a gender perspective.

Keywords

Disparities; Gender gap; Child height; Mexico

*Corresponding author. EQUIDE Research Institute for Equitable Development, Prolongación Paseo de la Reforma 880, Lomas de Santa Fe, Mexico City, 01219, Mexico. mireya.vilar@ibero.mx (M. Vilar-Compte).

Author statement

MVC: Conceptualization, Methodology, Writing -original draft & review, Supervision. **GT:** Conceptualization, Methodology, Validation, Writing – review & editing. **ICGA:** Investigation, Writing – review & editing. **DF** and **AOL:** Software, Data curation.

Declaration of competing interest

We declare no competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2020.113388>.

1. Introduction

Height is a critical indicator of access to nutrition and social development (Perkins et al., 2016; Tanner, 1987). Notably, the literature has recognized that the average adult height of a population is a “biological standard of living” (Perkins et al., 2016) and stressed that the growth patterns of children and adolescents reflect political and economic realities that shape poverty and inequality (Bertens et al., 2012; Howe et al., 2012). Height is a relevant health outcome because shorter stature has been associated with adverse consequences for mortality and morbidity (Blane et al., 2013; Victora et al., 2008). Thus, social and economic disparities affecting height likely have long-term consequences in reproducing health and social inequalities.

Although genetics explain up to 80% of height (McCrory et al., 2017; Perkins et al., 2016), this factor is an unlikely major contributor in explaining mean differences in height across modern populations. Research has supported this argument. First, a body of literature examines differences in height between populations with similar genetic pools that reside in different contexts. For example, compared with their counterparts in Guatemala, Mayan immigrant children residing in the United States (US) reported height increases (Bogin et al., 2002). Similarly, Delajara and Rodriguez-Segura (2010), using NHANES data, found that differences in average height between non-Hispanic white and Mexican American boys decreased over years and hypothesized that the decrease might be related to gains in maternal height associated with advantages granted by the migration to the United States. In contrast, Ma et al. (2019) documented a higher prevalence of short stature in rural and underdeveloped areas of China, which have worse social development indicators.

The second source of evidence refers to the studies that document associations between improvements in macroeconomic conditions and development indicators with increased average height. For example, a study examined differences in height among Black schoolchildren in South Africa during and post-apartheid and identified an increase in height across the economic and political transition (Bertens et al., 2012). In Brazil, the literature has also documented that increases in per capita gross domestic product between 1950 and 1980 were associated with 1.2–1.9 cm increase in adult height (De Oliveira and Quintana-Domeque, 2014). The opposite has been observed when armed or violent conflicts arise in nations, as these situations tend to compromise food supplies, access to health care services, and ultimately negatively affect economic and social development indicators. For example, a study in Pakistan showed, through a spatial analysis, an association between regions experiencing terrorism and increased rates of young children (0–5 years) with stunted height (Grossman et al., 2019). Similar findings were documented in reduced stature among individuals exposed during adolescence to the Nigerian Civil War (Akresh et al., 2012).

The third body of research highlights gaps in height in vulnerable populations, namely, between groups with different socioeconomic status or ethnicity. For example, McCroy et al. (2017) examined the data from six prospective cohort studies to highlight the socioeconomic differences in height trajectories in four European countries and found significant differences in children by maternal education. Similarly, Nowak-Szczepanska et al (2016)

demonstrated a consistent relationship between socioeconomic status and height among Polish children between 1966 and 2012.

These three pieces of evidence—(i) differences in height between similar populations residing in different contexts, (ii) improvements in macroeconomic and development indicators and their association with increases in average height, and (iii) height differentials among subgroups of different socioeconomic status or ethnicity—highlight the relevance of non-genetic factors in determining height. This evidence provides information on why compared with their more advantaged peers, individuals (or groups) from more deprived social backgrounds are at risk of significantly shorter stature.

Based on the aforementioned relationships, Fig. 1 summarizes a conceptual framework concerning how direct, distal, and mediating factors affect an individual's height. Factors such as socioeconomic and material conditions (e.g., parental social class, poor socioeconomic conditions, maternal education) are strong predictors of height because they represent access to resources (e.g., healthcare, nutritious diets), differential exposure to risk factors (e.g., overcrowding, pollution, clean water), and health behaviors (e.g., nutrition practices). In turn, access to these resources affects nutrition and health/disease—the direct determinants of height.

Discrimination is also a potential predictor of height differentials, and disparities among individuals with the same socioeconomic status but a different race, social position, or gender have been documented. For example, Coffey et al. (2019) decomposed height differences in Indian rural children from higher castes and rural children from three disadvantaged groups and found that socioeconomic status partially explains height gaps because discrimination has a critical role. Furthermore, the literature documents that intrahousehold gender disparities in the allocation of food (Aurino, 2017) and health care (Saikia et al., 2016) could result in differences in children's health outcomes such as height. For example, a study of the dynamics of gender-based disparities in the intrahousehold allocation of food among Indian children reported a lower intake of proteins and vitamin-rich foods among girls (Aurino, 2017) that could result in further health disparities.

In the context of this conceptual framework (Fig. 1), we aim to assess differentials in height by socioeconomic status (e.g., poverty) and indigenous condition in Mexican children, and how such gaps change as children transition into adolescence. The study period is 2002–2009/12, a notable period in Mexico's history. In 2000, Mexico underwent a political milestone: Through democratic mechanisms, the opposition party unseated the incumbent party, who had retained power for 70 years. This change was the driver of economic and policy changes; for example, from 2000 to 2010, Mexico's gross domestic product increased on average by 3%. Additionally, Mexico implemented many social policies to improve the long-term living standards of vulnerable populations such as indigenous individuals; for example, PROSPERA, one of the world's largest cash transfer programs, had significant positive outcomes in children's physical development (Fernald et al., 2008, 2009), although the cash transfer had differential effects according to children's characteristics (Cooper et al., 2020).

Although these positive trends indicated decreases in height differentials, other indicators have suggested that substantial structural disparities remain. For example, the Gini index has remained relatively high and constant from 2000 to 2020, at approximately 50. Similarly, in Mexico's multidimensional measure of poverty, which categorizes a person as living in poverty when they experience one or more social deprivations (e.g., educational gap, access to social security, access to basic services in the dwelling, access to health services, quality and spaces of the dwelling, access to food) and whose income is insufficient to buy the aggregation of the basic food basket and the basic non-food basket, we observed few changes over the study period (Fig. 2).

According to our review of the literature, one study assessed the association between height and social inequities in Mexico: Castro-Porras et al. (2018) used cross-sectional data from the 2012 National Nutrition and Health Survey (ENSANUT for its acronym in Spanish) and demonstrated important associations between region and socioeconomic status and height; for example, compared with individuals whose educational attainment was the completion of elementary school or higher, the prevalence of short stature among adults who had not completed elementary school was the highest regardless of gender, region, and type of residence (rural or urban). They also found that the prevalence of short height was the highest among the most marginalized adults (e.g., adults who had low incomes, education levels, and access to services; and who lived in small communities).

This study makes three contributions to the literature: (i) We use nationally representative data to assess whether height differentials by poverty status and indigenous self-identification decrease while children transition from childhood to adolescence; (ii) we study height differentials during a period in which Mexico had good economic indicators, and in which a major social cash transfer program was implemented; and (iii) we use longitudinal data to provide insights into the structural social challenges that accompany height gaps and persist across time. This area of research is relevant because reducing height inequalities is a vital policy goal because of its adverse long-term consequences. If differences in height between groups persist, inequities might also persist.

2. Method

2.1. Data

We used data from the first three waves—2002, 2005–6 and 2010/12—of the Mexican Family Life Survey (MxFLS), a longitudinal study representative of the national, urban, and regional levels in Mexico. The first wave (MxFLS-1) collected information on 35,000 individuals in 8400 households from 150 localities in Mexico. In the second and third waves (MxFLS-2 and MxFLS-3), the 2002 baseline sample was re-interviewed, including individuals who migrated from Mexico to the United States and the new households formed in-between the waves. The re-contact rates for the MxFLS-2 and the MxFLS-3 were close to 90% of the original sample. The sample of the MxFLS baseline was under-taken by the National Bureau of Statistics and Geography (INEGI), the Mexican statistics agency, and was designed to represent the entire Mexican population living in Mexico at the time of the baseline survey. The baseline sample is probabilistic, stratified, multi-staged, and independent at every phase of the study. Primary sampling units were selected under criteria

of national, urban–rural, and regional representation on pre-established demographic and economic variables. Regional definitions are per the National Development Plan 2000–2006 (Rubalcava and Teruel, 2004, 2007, 2013).

The main advantages of using the survey in this study are as follows: (i) its unique longitudinal nature—data for the same individuals over approximately ten years; (ii) the direct measurement of height for the entire sample; (iii) the availability of health data for every household member; and (iv) the availability of socioeconomic variables at the individual and household levels.

2.2. Sample

To analyze the height gaps between subpopulation groups (i.e., defined by poverty status and indigenous/non-indigenous status), we first examined the height gaps at the 2002 baseline wave and later analyzed height differentials at subsequent waves. Based on the periods available for the MxFLS waves, the longitudinal sample included all children aged 8 and 9 years in 2002. These children were followed-up in the survey's next two waves, up to age 15–19 years, when girls' growth stage was complete, and that of boys was nearly complete.

The baseline sample was from 2002, with 1696 observations: 836 girls and 860 boys. At baseline, height assessments were incomplete for 12.15% of the age-eligible respondents in the study; thus, the original analytical sample was 1486 observations. Because MxFLS is longitudinal, attrition across waves further decreased the sample. In the second and third waves, height was missing for 20.13% and 19.92% of the sample, respectively. Attrition non-randomness is a concern, especially if the selection into the sample was correlated with height. We explored potential biases associated with the missing data as follows: In the presence of controls for age, gender, urban/rural, indigenous status, and poverty in 2002, the height of respondents in 2002 without information was that same as that of the corresponding measures in 2005 and 2010 and was not statistically different from the respondents with information in all three waves. Likewise, we conducted regressions to check for nonrandom missing values in the different waves, and it was not a concern (Supplemental Table 1).

2.3. Variables

Children's height, measured in centimeters, was the primary dependent variable. The independent variables influencing children's height included those related to mothers' characteristics and the socioeconomic context in which the children grew up. Among mothers' characteristics, maternal height was particularly relevant because it influences offspring growth through genetic and non-genetic factors that promote or prevent the attainment of genetic height potential (Addo et al., 2013). We also controlled for mothers' education. In this regard, mothers' education has been demonstrated to have a positive impact on their babies' birth weight and decrease child mortality within the first year of life (Currie and Moretti, 2003; Strauss and Thomas, 1995).

Therefore, we included a categorical variable to control for maternal educational level: primary or less, secondary, and high school or above. As is typical in analyses of persistence over time, we included mothers' age as an additional covariate. We also controlled for

fathers' height and educational attainment, but the results did not change, and the variables were not statistically significant (statistics not shown). Thus, we retained the mothers' variables to maintain a more parsimonious model.

Finally, to control for early childhood environments, our analyses included a vector of household characteristics; among these, we included affiliation with social security, affiliation with the PROSPERA social program, household per capita food expenditure (in logarithmic form), household characteristics, and type of locality (urban–rural). The first two characteristics were operationalized by dichotomous variables, which indicated whether the family was affiliated with the Social Security System and whether the family benefitted from PROSPERA. The latter program provided health, nutrition, and education resources and services to its beneficiaries (most of whom are residents of marginalized communities) and linked them with other social and productive programs offered at that time. We use these two variables to control for factors that could have improved health status and that contributed to potentiating children's height.

Household food expenditure as a proportion of total expenditures (in logarithmic form) is a common proxy for welfare (Deaton, 1997); the rationale for including the former as a covariate in our analyses is based on the literature suggesting a negative relationship between household income and food expenditure. The literature indicates that the poor allocate—most, to all—their resources to food and other basic needs. That is, the lower a family's socioeconomic level, the higher the expenditure (per capita) on food. Moreover, Deaton and Paxson (1998) suggested that household per capita food demand decreases as household size decreases, contrary to economies of scale theory; therefore, household allocation discrimination might exist when resources are limited, and families may favor certain members of the family, such as children or sons.

Household characteristics were proxies for socioeconomic status and included dummies for living in a house or apartment; access to a toilet; drinks bottled water; and housing with a firm roof, firm floor, and firm ceiling. Last, we included the type of locality to account for differences related to the size of the families' communities. We followed the classification of INEGI for localities: rural: less than 2500 inhabitants; semi-urban: 2500 to 14,999 inhabitants; urban: 15,000 to 99,999 inhabitants; and metropolis: over 100,000 inhabitants (INEGI, 2010).

2.4. Analyses

Following the literature on health inequities (Vargas Bustamante et al., 2012; Costa-Font and Gil, 2008; Delajara and Rodríguez-Segura, 2010; Wagstaff et al., 2001), we used the Blinder–Oaxaca decomposition (BOD) methodology to explain variations in height across the three waves of the MxFLS. We stratified by poverty and indigenous status and separated the analysis for boys and girls. We presented completely interacted models for poverty and indigenous status because these subpopulations have traditionally been disadvantaged. Controlling for their characteristics is insufficient to capture the magnitude of these disadvantages. With this approach, we can examine gaps across the selected subpopulations by focusing on the factors that impact children's height at different growth stages over one decade.

To explore differences across gender, we separated the analyses for boys and girls throughout the three waves. Families were classified as indigenous/non-indigenous according to self-reported indigenous status. In Mexico, indigenous status is extremely correlated with poverty and discrimination; indigenous individuals have different contextual settings that impact health transmission, and its status is a risk factor for health inequalities (Júarez-Ramírez et al., 2014). For this analysis, we categorized the stratification groups according to their response in the first round (2002). Thus, once a family was classified as indigenous or poor in 2002, we maintained such status for the next two rounds.

In the case of poverty levels, we classified families into three groups (i.e., non-poor, moderate poverty, and extreme poverty) according to the National Council for the Evaluation of Social Policy's (CONEVAL's) official measurement of poverty, which is based on two welfare lines and the thresholds for social right deprivations (CONEVAL, 2012).

Next, we used the BOD method to estimate the height gaps between indigenous versus non-indigenous and between poor versus non-poor families and identified the convergence (or divergence) of these gaps across time.

The BOD method is frequently used in labor economics to evaluate the differences in certain variables between groups (e.g., sex, ethnicity, age). This methodology breaks down the mean differences by groups and attempts to identify the differential explained by the differences between them. Because the “unexplained” part represents the measurement of the effect of the differences between groups of unobservable predictors and helps identify the gaps by controlling for all observable covariates, the BOD method is a quasi-experimental technique (Oaxaca, 1973). The BOD method comprises two sequential steps. First, an OLS regression is estimated that captures the effect of all observable covariates on the dependent variable; next, the differential in the mean dependent variable between groups is calculated.

In our case, we first implemented different OLS models that estimate the association of mothers' height on children's height and control for additional characteristics of the mothers, household-level factors, and type of residence. These models follow Akbulut-Yuksel and Kugler (2016), regarding the intergenerational transmission of health among mother–children pairs in the United States.

In particular, the OLS model specifications are presented in Equation (1), where $\widehat{height}_{it}$ represents the height of child i in wave t ; $height_mother_{it}$ is the height of the mother of child i at wave t ; and X_{it} represents a vector of covariates that includes mothers' age and educational attainment, household socioeconomic characteristics, and type of locality. The β coefficient captures the association between mothers' and children's height and measures the level of height persistence by controlling for vector X_{it} . Finally, α and ε_{it} represent the constant and random error terms, respectively. We conducted analyses separately for boys and girls and ran different OLS specifications according to the two stratified groups (i.e., indigeneity status and poverty levels). We ran the model separately at each of the three time points.

$$\widehat{height}_{it} = \alpha + \beta height_mother_{it} + \gamma X_{it} + \varepsilon_{it} \quad (\text{Equation 1})$$

Following the BOD's second step, we calculated differences in $\widehat{height}$ by subgroups and identified height gaps for each of the three waves. We also identified height gap trends over time and analyzed the variances over the period studied. We performed weighted and unweighted analyses and reported weighted results because they did not change. The weights correspond to the MxFLS expansion factors, and the models were estimated in STATA 15 (StataCorp, 2017).

3. Results

3.1. Descriptive statistics

Descriptive statistics at baseline for boys and girls between 8 and 9 years old are shown in Tables 1 and 2, respectively. We stratified both tables by indigenous status and poverty levels. As shown, the height in boys and girls is associated with better socioeconomic status and is negatively correlated with indigenous status. That is, children's and mothers' height are higher for non-poor and non-indigenous individuals, compared with extremely poor and indigenous individuals, respectively. The difference in heights was 3–10 cm.

Descriptive analyses show that for almost all the variables, there is a significant difference between stratified groups, except for the case of mothers' age, some household characteristics, and social security enrollment (for boys only). Compared with their more advantaged counterparts, indigenous and poor mothers have lower levels of education and are associated with worse sanitary housing conditions. Similarly, an affiliation with PROSPERA shows significant differences and highlights the program's objective to assist the most vulnerable populations. Finally, we observe significant differences in type of residence by indigenous status: Compared with non-indigenous families, most indigenous families tend to reside in rural areas.

The descriptive statistics also reveal differences among girls and boys of the same population groups. For instance, indigenous girls and girls living in extreme poverty are 6–8 cm shorter than non-indigenous and non-poor girls, whereas the range among boys under the same circumstances is 3–5 cm. These height differentials by gender gain relevance because the distribution of household characteristics between boys and girls is relatively similar. In addition, mothers' characteristics vary slightly among groups. Mothers' height presents small differences when comparing girls and boys within the same vulnerable group. Finally, compared with indigenous boys, a greater percentage of indigenous girls receive PROSPERA benefits. The opposite is observed when comparing social security.

3.2. BOD's first step: OLS regressions by indigenous status

Table 3 shows the results from the BOD's first-step OLS regressions for boys and for all three MxFLS waves, stratified by indigenous status. The results for girls are similar (Table 4). First, regardless of gender and despite controlling for mothers' characteristics, household characteristics, and social benefits (e.g., PROSPERA, social security status), the coefficient associated with mothers' height is statistically significant for all groups and waves.

The highest coefficient associated with mothers' height is among the indigenous compared with the non-indigenous boys and girls, suggesting that among indigenous children, height permanency (i.e., percent of children's height explained by mother's height) is higher. Furthermore, the difference (i.e., coefficient of mothers' height on their children's height) between indigenous and non-indigenous children is higher among girls than among boys. For instance, by 2009/12, the difference between indigenous and non-indigenous girls was 0.46 cm, versus a difference of 0.019 cm for boys. We observe these results again in the following two waves, suggesting gender disparities that may persist over time.

Another difference between indigenous and non-indigenous children is the association of mothers' educational attainment on boys' height. In 2002, 2009/12, indigenous boys born to mothers who had completed secondary education were on average 6 cm taller than indigenous boys whose mothers had less than six years of schooling. For non-indigenous boys, the only significant coefficient of mothers' education on children's height was in 2005: Boys born to mothers with a high school education or more were approximately 3 cm taller (on average) than those born to mothers with less than six years of education (Table 3). The coefficient of mothers' education on girls' height is not significant, except for the case of non-indigenous girls born to mothers with a high school education or more and for the second wave of MxFLS. These girls were on average 3 cm taller than non-indigenous girls whose mothers had less than six years of schooling (Table 4).

Another significant result is the association of the PROSPERA program and children's height. The OLS regressions in Table 3 show a positive correlation of the program on indigenous boys' height in 2005 and 2009/12 compared with indigenous boys without access. Yet, for the case of indigenous girls, PROSPERA was negatively associated with girls' height in both 2005 and 2009/12 (i.e., indigenous girls affiliated with PROSPERA were on average 5 and 2.7 cm shorter than indigenous girls not affiliated with the program).

3.3. BOD's second step: height gaps by indigenous status

Table 5 summarizes the results of the BOD's second step, by indigenous status and gender. The first finding indicates that regardless of gender, children grew; yet, non-indigenous children are significantly taller than their counterparts in every wave. This finding implies that even after controlling for observable factors that intervene in children's growth, indigenous children are shorter than their non-indigenous counterparts at an early age, and this pattern continues throughout their growth period.

The most relevant finding is that these height gaps are persistent throughout the three waves and tend to increase over time, even when controlling for mothers' height and other characteristics at the household level. The average height gap among boys found in 2002 is consistent in the last wave, despite a decrease in height differentials between 2005 and 2009/2012. Girls' height gaps are wider, and considering that girls stop growing at approximately 16 years old, most of them reached their final height by 2009/12. The average height gap between non-indigenous and indigenous girls increases in each wave. These results suggest that boys and girls have persistent disparities in height, which do not narrow and instead remain constant over time. Moreover, the results suggest that by 2009/2012, the height gap between indigenous and non-indigenous girls (i.e., 6.95 cm) was on average

higher compared with the height differential between indigenous and non-indigenous boys (i.e., 3.75 cm), indicating gender inequities and vulnerability among girls.

3.4. BOD's first step: OLS regressions by poverty level

Tables 6 and 7 show the regression results—for boys and girls, respectively—for poverty level. The results for boys in Table 6 suggest that mothers' height is associated with boys' height (except for boys in extreme poverty in 2005), even when controlling for additional mothers' characteristics, household-level variables, and type of residence. For boys living in extreme poverty, the coefficient for mother's height remains fairly constant and very persistent in each wave. For non-poor boys and boys living in moderate poverty, the association of mothers' height is more inconsistent. The coefficient of mothers' height for boys in extreme poverty is higher in early stages of growth, but it decreases as boys age.

The results indicate a similar pattern in the association of mothers' height on girls' height (Table 7). Yet, we observe non-significant results among non-poor girls in 2002. Among the most socioeconomically advantaged girls, the coefficient of mother's height decreases as girls age. Of particular interest is the incremental association (over time) of mothers' height on the heights of girls in moderate or extreme poverty. Similar to the results by indigenous status, these findings suggest that the height of the poorest girls is more persistent than that of their counterparts.

In relation to education, in 2005, we observe a significant, positive relation for children with mothers with a high school education or more for boys living in moderate or extreme poverty, and higher for girls in extreme poverty. These associations are oddly contradictory for girls in extreme poverty in 2009/12. Another result, similar to the indigenous status regressions, is the difference in the association of PROSPERA between genders. Although inconsistent, PROSPERA has more statistically significant coefficients in boys compared with girls, and this phenomenon only occurs during the last wave in the case of girls in extreme poverty. Yet, as is the case for indigenous status, the coefficient in the final wave is negative for boys and girls.

3.5. BOD's second step: height gaps by poverty level

Last, Table 8 shows the results of the BOD's second step by poverty level and gender. We observe that, regardless of sex and wave, height inversely correlates with poverty status. Thus, non-poor children are significantly taller than their poorer counterparts when aged 8–9 years. Moreover, these height differentials are observed for the next ten years. This finding implies that even when controlling for observable factors that intervene in children's growth, economic status affects height—most probably, in early childhood—and generates persistent height gaps among vulnerable populations.

The main finding, however, is that these height gaps endure the passage of time, and that their magnitudes are maintained across groups, particularly for the case of girls, where height differentials are statistically significant in every wave, and for every level of poverty. The higher height differentials occur between the non-poor and extremely poor children and are significantly larger among girls (1.7 times greater, on average) than among boys. When comparing children in extreme poverty versus children in moderate poverty, the results show

a greater height gap among girls than among boys (on average, 2.1 times greater). Finally, when comparing the non-poor vs. the moderately poor, no significant gap among boys in any wave was observed. Yet, among girls, height gaps were significant, consistent in the first two waves and increasing in the final wave. Similar to the results obtained in the indigenous decompositions, the overall findings show that boys and girls face persistent disparities in height, which do not decrease but remain relatively constant across waves.

4. Discussion

We used distinctive features of the MxFLS, longitudinal data, and direct measurements of height and demonstrated that Mexican children grew consistently from 2002 to 2009/12. Yet, the results from the Oaxaca decomposition models indicate lower growth rates among vulnerable children (compared with less vulnerable children) and the persistence of height differentials between poverty levels and indigenous status throughout the period. We highlight these findings because the analysis controlled for the socioeconomic status in which children grew up as well as for mothers' characteristics including mothers' height, which is particularly important because it accounts for genetic and non-genetic influences on offspring growth (Addo et al., 2013). These findings are in line with the literature that highlights differentials in height among children of different socioeconomic status (Castro-Porras et al., 2018; McCrory et al., 2017; Nowak-Szczepanska et al., 2016; Perkins et al., 2016).

The first main finding of the study relates to the greater persistence and magnitude of height disparities among indigenous and extremely poor boys and girls, compared with non-indigenous and non-poor children, respectively. These (negative) differentials are consistently higher among the most vulnerable groups. The BOD's results by poverty level among girls show that height inequalities decrease as poverty decreases. In each of the three waves, girls in extreme poverty gained fewer centimeters of height than girls in moderate poverty; thus, girls in moderate poverty gained less than non-poor girls. This finding suggests the need to examine social determinants of health outcomes from an intergenerational perspective because children's current and past socioeconomic context is preserved from that of their parents or of former generations.

Not only genetics but also other social determinants continued across generations. For example, in the nutrition literature, gaps in malnutrition indicators between disadvantaged and not disadvantaged groups remain over time (in particular for the indigenous and the poor) after controlling for SES because of inadequate feeding related to quality or quantity, incidence, and presence of infectious diseases and improper care of children (Rivera-Dommarco et al., 2013). In addition, some authors have suggested that improvements in living conditions during the early phases of economic development do not necessarily result in an immediate increase in height among the most socially disadvantaged groups (Cardoso and Caninas, 2010; Komlos, 1987, 1990, 1994, 2007). Notably, these authors claim that the most socially advantaged groups are the first to benefit from better living conditions, which could lead to greater income inequalities between social groups and further widen height gaps between social groups.

The second main finding of this analysis is related to gender disparities. In this regard, girls have a second source of disparity because height gaps between indigenous and non-indigenous girls, and non-poor and extremely poor girls are greater than those between boys in the same subpopulation groups. For instance, the height differential in boys between non-poor and extremely poor boys is approximately 3.3 cm, whereas the difference increases to 8.7 cm when comparing girls from the same poverty levels (i.e., non-poor vs. extremely poor). Similarly, the difference in height between indigenous and non-indigenous boys is 4.6 cm, whereas the difference between indigenous and non-indigenous girls is 6.7 cm. Because the model controls for mother's characteristics and socioeconomic characteristics, the results are in line with discrimination against girls within the household (Aurino, 2017; Saikia et al., 2016). This critical finding highlights the need to design and implement public policies that advocate for girls because gender disparities are found from an early age and exacerbate with time. The girls in this study are likely to become mothers; therefore, gender disparities and poor health outcomes could continue to perpetuate across generations.

The third relevant finding is associated with the different estimates of social determinants by gender and population groups. Notably, mothers' education has an inconsistent or no determinant association on children's height, especially for girls. For example, higher education has contradictory relationships on the growth of girls in extreme poverty. This finding is inconsistent with the literature that suggests education as a protective factor against poor health outcomes (McCrary et al., 2017), given theoretical models such as Grossman et al. (2019). This underscores that breaking poverty traps and promoting the closing of health disparities, especially among girls, is more complex than traditional policies have assumed.

Along these lines, PROSPERA's associations on children's height also call attention to gender differentials. In the boys' case, PROSPERA was associated with a positive relation on height for indigenous status and poverty levels. By contrast, every statistically significant coefficient of PROSPERA on girls' height was negative. In this study, PROSPERA's objective to increase health and nutritional outcomes in vulnerable individuals was not reflected in children's growth and might be perpetuating gender inequality over time and thus for forthcoming generations.

4.1. Limitations

This study has limitations. First, indigenous status was self-reported. Yet, self-identification as indigenous has been used in other analyses of health and gender disparities (Creighton and Park, 2010; Stoddard et al., 2011). Second, because the MxFLS collects limited information on diet, we could not control for aspects such as household's minimum diet diversity, minimum meal frequency, and minimum acceptable diet, which could have correlated with children's height. Finally, it is unlikely that all the children in the sample were done with their growth process by the third wave. Although this limitation could bias the results, following the children in future waves of the MxFLS could help eliminate this potential bias.

5. Conclusions

In summary, we observe persistent height inequalities among girls and boys between different poverty levels and indigenous status. Height gaps are present despite controlling for genetics (mother's height, a common proxy), which suggests an association of social and economic determinants on growth potential in children. Social programs showed moderate associations for boys and no protective correlation among girls. This finding is surprising and directs attention to the importance of carefully designing public policies that consider gender differences from an intricate, complex perspective while targeting budgets to serve vulnerable populations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

We thank Meztli Moncada from EQUIDE for her help in the analyses of the missing values, as well as Roberto Velez and Marcelo Delajara from CEEY for their insightful comments while conducting the research. We acknowledge the grants NICHD-R01HD047522 and NIA-R01-AG030668-04, for data collection of the Mexican Family Life Survey (MxFLS).

Source of funding

Centro de Estudios Espinosa Yglesias (CEEY), Mexico.

References

- Addo OY, Stein AD, Fall CH, Gigante DP, Guntupalli AM, Horta BL, et al., 2013. Maternal height and child growth patterns. *J. Pediatr* 163 (2), 549–554. 10.1016/j.jpeds.2013.02.002 e541. [PubMed: 23477997]
- Akbulut-Yuksel M, Kugler AD, 2016. Intergenerational persistence of health: do immigrants get healthier as they remain in the U.S. for more generations? *Econ. Hum. Biol* 23, 136–148. 10.1016/j.ehb.2016.08.004. [PubMed: 27644070]
- Akresh R, Bhalotra S, Leone M, Osili UO, 2012. War and stature: growing up during the Nigerian civil war, 2012 *Am. Econ. Rev.: Papers Proceed* 102 (3), 273–277. 10.1257/aer.102.3.273.
- Aurino E, 2017. Do boys eat better than girls in India? Longitudinal evidence on dietary diversity and food consumption disparities among children and adolescents. *Econ. Hum. Biol* 25, 99–111. 10.1016/j.ehb.2016.10.007. [PubMed: 27810442]
- Bertens MG, Ulijaszek S, Koziel S, Henneberg M, 2012. Late childhood and adolescence growth sensitivity to political transition: the case of South African Cape coloured schoolchildren during and post-apartheid. *Anthropol. Rev* 75 (1), 19–31. 10.2478/v10044-012-0002-6.
- Blane D, Kelly-Irving M, d'Errico A, Bartley M, Montgomery S, 2013. Social-biological transitions: how does the social become biological? *Longitud. Life Course Stud* 4 (2), 136–146. 10.14301/lcs.v4i2.236.
- Bogin B, Smith P, Orden AB, Varela Silva MI, Loucky J, 2002. Rapid change in height and body proportions of Maya American children. *Am. J. Hum. Biol* 14 (6), 753–761. 10.1002/ajhb.10092. [PubMed: 12400036]
- Cardoso HF, Caninas M, 2010. Secular trends in social class differences of height, weight and BMI of boys from two schools in Lisbon, Portugal (1910–2000). *Econ. Hum. Biol* 8 (1), 111–120. 10.1016/j.ehb.2009.04.005. [PubMed: 19464239]

- Castro-Porras LV, Rojas-Russell ME, Aedo-Santos Á, Wynne-Bannister EG, López-Cervantes M, 2018. Stature in adults as an indicator of socioeconomic inequalities in Mexico. *e29 Rev. Panam. Salud Pública* 42. 10.26633/RPSP.2018.29.
- Coffey D, Deshpande A, Hammer J, Spears D, 2019. Local social inequality, economic inequality, and disparities in child height in India. *Demography* 56 (4), 1427–1452. 10.1007/s13524-019-00794-2. [PubMed: 31309449]
- CONEVAL, 2012. Construction of Wellness Lines. Methodological Document, Mexico.
- Cooper JE, Benmarhnia T, Koski A, King NB, 2020. Cash transfer programs have differential effects on health: a review of the literature from low and middle-income countries. *Soc. Sci. Med* 247, 112806. 10.1016/j.socscimed.2020.112806. [PubMed: 32086171]
- Costa-Font J, Gil J, 2008. Generational effects and gender height dimorphism in contemporary Spain. *Econ. Hum. Biol* 6 (1), 1–18. 10.1016/j.ehb.2007.10.004. [PubMed: 18060848]
- Creighton M, Park H, 2010. Closing the gender gap: six decades of reform in Mexican education. *Comp. Educ. Rev* 54 (4), 513–537. 10.1086/653702.
- Currie J, Moretti E, 2003. Mother's education and the intergenerational transmission of human capital: evidence from college openings. *Q. J. Econ* 118 (4), 1495–1532. <http://www.jstor.org/stable/25053945>.
- De Oliveira VH, Quintana-Domeque C, 2014. Early-life environment and adult stature in Brazil: an analysis for cohorts born between 1950 and 1980. *Econ. Hum. Biol* 15, 67–80. 10.1016/j.ehb.2014.07.001. [PubMed: 25108192]
- Deaton A, 1997. The Analysis of Household Surveys: a Microeconomic Approach to Development Policy. The World Bank.
- Deaton A, Paxson C, 1998. Economies of scale, household size, and the demand for food. *J. Polit. Econ* 106 (5), 897–930. 10.1086/250035.
- Delajara M, Rodríguez-Segura M, 2010. Why are Mexican American boys so much taller now? *Econ. Hum. Biol* 8 (2), 212–222. 10.1016/j.ehb.2010.05.007. [PubMed: 20678742]
- Fernald LC, Gertler PJ, Neufeld LM, 2008. Role of cash in conditional cash transfer programmes for child health, growth, and development: an analysis of Mexico's Oportunidades. *Lancet* 371, 828–837. 10.1016/S0140-6736(08)60382-7. [PubMed: 18328930]
- Fernald LC, Gertler PJ, Neufeld LM, 2009. 10-year effect of Oportunidades, Mexico's conditional cash transfer programme, on child growth, cognition, language, and behaviour: a longitudinal follow-up study. *Lancet* 374, 1997–2005. 10.1016/S0140-6736(09)61676-7. [PubMed: 19892392]
- Grossman D, Khalil U, Ray A, 2019. Terrorism and early childhood health outcomes: evidence from Pakistan. *Soc. Sci. Med* 237, 112453. 10.1016/j.socscimed.2019.112453. [PubMed: 31442823]
- Howe LD, Tilling K, Galobardes B, Smith GD, Gunnell D, Lawlor DA, 2012. Socioeconomic differences in childhood growth trajectories: at what age do height inequalities emerge? *J. Epidemiol. Community Health* 66 (2), 143–148. 10.1136/jech.2010.113068. [PubMed: 20724285]
- Juárez-Ramírez C, Márquez-Serrano M, Salgado de Snyder N, Pelcastre-Villafuerte BE, Ruelas-González MG, Reyes-Morales H, 2014. La desigualdad en salud de grupos vulnerables de México: adultos mayores, indígenas y migrantes. *Rev. Panam. Salud Pública* 35, 284–290. <https://www.scielosp.org/pdf/rpssp/v35n4/08.pdf>.
- Komlos J, 1987. The height and weight of West Point cadets: dietary change in antebellum America. *J. Econ. Hist* 47 (4), 897–927. <https://www.jstor.org/stable/2122037>.
- Komlos J, 1990. Height and social status in eighteenth-century Germany. *J. Interdiscipl. Hist* 20 (4), 607–621. <https://www.jstor.org/stable/204001>.
- Komlos J, 1994. The nutritional status of French students. *J. Interdiscipl. Hist* 24 (3), 493–508. <https://www.jstor.org/stable/206682>.
- Komlos J, 2007. On English pygmies and giants: the physical stature of English youth in the late 18th and early 19th centuries. *Res. Econ. Hist* 25, 149–168. 10.1016/S0363-3268(07)25003-7.
- Ma J, Pei T, Dong F, Dong Y, Yang Z, Chen J, et al., 2019. Spatial and demographic disparities in short stature among school children aged 7–18 years: a nation-wide survey in China, 2014. *BMJ Open* 9, e026634. 10.1136/bmjopen-2018-026634.
- McCrory C, O'Leary N, Fraga S, Ribeiro AI, Barros H, Kartiosuo N, et al., 2017. Socioeconomic differences in children's growth trajectories from infancy to early adulthood: evidence from four

- European countries. *J. Epidemiol. Community Health* 71 (10), 981–989. 10.1136/jech-2016-208556. [PubMed: 28798151]
- Nowak-Szczepanska N, Gomula A, Ipsen M, Koziel S, 2016. Different effects of living conditions on the variation in BMI and height in children before the onset of puberty. *Eur. J. Clin. Nutr* 70 (6), 662. 10.1038/ejcn.2016.30. [PubMed: 26979988]
- Oaxaca R, 1973. Male-female wage differentials in urban labor market. *Int. Econ. Rev* 14 (3), 693–709. <https://www.jstor.org/stable/2525981>.
- Perkins JM, Subramanian SV, Davey Smith G, Özaltın E, 2016. Adult height, nutrition, and population health. *Nutr. Rev* 74 (3), 149–165. 10.1093/nutrit/nuv105. [PubMed: 26928678]
- Rivera-Dommarco JÁ, Cuevas-Nasu L, González de Cosío T, Shamah-Levy T, García-Feregrino R, 2013. Desnutrición crónica en México en el último cuarto de siglo: análisis de cuatro encuestas nacionales. *Salud Publica Mex* 55 (2), S161–S169. <https://www.saludpublica.mx/index.php/spm/article/view/5112/4938>. [PubMed: 24626692]
- Rubalcava L, Teruel G, 2004. The Mexican family life survey User's guide. First Wave 2002. www.ennvih-mxfls.org.
- Rubalcava L, Teruel G, 2007. The Mexican Family Life Survey User's Guide 2005. [http://www.ennvih-mxfls.org/english/assets/usersguidev2-\(1\).pdf](http://www.ennvih-mxfls.org/english/assets/usersguidev2-(1).pdf).
- Rubalcava L, Teruel G, 2013. Mexican Family Life Survey, Third Round. <http://www.ennvih-mxfls.org/english/assets/usersguidemxfls-3.pdf>.
- Saikia N, Moradhvaj, Bora JK, 2016. Gender difference in health-care expenditure: evidence from India human development survey. *PloS One* 11 (7), e0158332. 10.1371/journal.pone.0158332. [PubMed: 27391322]
- StataCorp, 2017. Stata Statistical Software: Release 15. StataCorp LLC, College Station, TX.
- Stoddard P, Handley MA, Vargas Bustamante A, Schillinger D, 2011. The influence of indigenous status and community indigenous composition on obesity and diabetes among Mexican adults. *Soc. Sci. Med* 73 (11), 1635–1643. 10.1016/j.socscimed.2011.09.006. [PubMed: 22033376]
- Strauss J, Thomas D, 1995. Human resources: empirical modeling of household and family decisions. In: Behrman J, Srinivasan TN (Eds.), *Handbook of Development Economics*, vol. 3. Elsevier, pp. 1883–2023.
- Tanner JM, 1987. Growth as a mirror of the condition of society: secular trends and class distinctions. *Pediatr. Int* 29 (1), 96–103. 10.1111/j.1442-200X.1987.tb00015.x.
- Vargas Bustamante A, Fang H, Garza J, Carter-Pokras O, Wallace SP, Rizzo JA, et al., 2012. Variations in healthcare access and utilization among Mexican immigrants: the role of documentation status. *J. Immigr. Minority Health* 14 (1), 146–155. 10.1007/s10903-010-9406-9.
- Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al., 2008. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet* 371, 340–357. 10.1016/S0140-6736(07)61692-4. [PubMed: 18206223]
- Wagstaff A, Doorslaer v.E., Watanabe N, 2001. On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. *J. Econom* 112 (1), 207–223. 10.1016/S0304-4076(02)00161-6.

Fig. 1.
Conceptual framework of factors affecting height.

Fig. 2.
 Percentage of Mexican population with social deprivations 1990–2018. *Note.* Source:
<https://www.coneval.org.mx/Medicion/Paginas/Evolucion-de-las-dimensiones-de-pobreza-.aspx>

Table 1

Descriptive statistics (2002) by indigenous status and poverty level: Boys.

	Indigenous Status				Poverty Level				<i>p</i> ^a			
	Indigenous		Non-Indigenous		Non-Poor		Moderate			Extreme		
	%	SE	%	SE	%	SE	%	SE		%	SE	
Child's height (cm) ^b	126.04	1.37	129.33	0.42	**	130.09	0.68	128.71	0.56	125.12	1.45	***
<i>Mother's characteristics</i>												
Height (cm) ^b	149.59	1.08	153.62	0.41	***	154.51	0.49	152.63	0.63	148.54	1.20	***
Age ^b	33.37	0.78	34.68	0.35	.	34.47	0.50	34.67	0.49	34.85	0.99	.
Education:												
Primary	73.17	6.20	45.49	2.92	***	25.09	3.32	59.74	3.93	84.20	5.56	***
Secondary	14.08	4.06	36.61	2.84		45.59	4.32	30.08	3.67	9.38	4.57	
High school	12.75	5.55	17.90	2.31		29.32	4.28	10.19	2.35	6.42	3.56	
<i>Household's characteristics</i>												
House/apartment	94.93	3.15	96.74	1.06	.	97.71	1.08	98.22	0.80	87.77	5.38	***
WC	56.37	6.16	77.91	2.40	***	83.45	2.96	80.43	2.58	40.68	7.21	***
Bottled water	50.37	6.46	56.64	2.82	.	66.91	3.75	54.86	3.86	37.96	7.29	***
Firm walls	70.01	5.41	84.75	1.94	***	90.39	1.89	82.82	2.92	64.54	6.68	***
Firm ceiling	43.03	6.68	59.48	2.80	**	62.44	4.05	58.34	3.82	43.06	7.58	*
Firm floor	23.41	5.08	32.61	2.58	.	40.40	4.02	30.96	3.55	12.92	4.16	***
PROSPERA	38.77	5.87	11.95	1.62	***	11.44	2.02	12.77	2.15	43.96	8.04	***
Social security	44.00	6.42	53.33	2.85	.	68.64	3.80	51.16	3.94	17.87	6.05	***
Food expend. P/C ^b	6.48	0.13	6.80	0.06	**	7.56	0.06	6.44	0.03	5.44	0.16	***
<i>Stratum of Locality</i>												
Metropolis	29.90	6.38	49.15	2.88	***	49.22	4.23	47.00	3.98	37.92	7.43	.
Urban	3.83	3.00	14.23	2.40		13.39	3.39	11.22	2.93	13.18	6.21	
Semi-urban	15.04	5.68	13.90	1.99		11.25	3.17	17.38	2.95	14.56	5.46	
Rural	51.23	6.53	22.72	1.80		26.14	2.90	24.40	2.70	34.34	6.26	
N	162		698			333		356		123		

	Indigenous Status				Poverty Level				<i>p</i> ^a	
	Indigenous		Non-Indigenous		Non-Poor		Moderate		Extreme	
	%	SE	%	SE	%	SE	%	SE	%	SE
Population ^c	403,914		1,716,048		807,054		900,192		335,492	

Note

- ^a Statistical comparison analysis: *t*-test, *X*² or ANOVA.
Significance level *** *p* < 0.01, ** *p* < 0.05, * *p* < 0.1.
- ^b Continuous variable, the value presented as % refers to the mean.
- ^c Population size with expansion factors.

Table 2

Descriptive statistics (2002) by indigenous status and poverty level: Girls.

	Indigenous Status				Poverty Level							
	Indigenous		Non-Indigenous		<i>p</i> ^a	Non-Poor		Moderate		Extreme		<i>p</i> ^a
	%	SE	%	SE		%	SE	%	SE	%	SE	
Child's height (cm) ^b	123.66	1.20	130.34	0.46	***	131.37	0.59	129.36	0.70	122.67	1.28	***
<i>Mother's characteristics</i>												
Height (cm) ^b	147.99	0.76	154.62	0.48	***	156.16	0.53	152.51	0.66	147.60	1.06	***
Age ^b	35.08	0.65	34.49	0.33	.	34.42	0.47	34.29	0.45	35.82	0.78	.
Education:												
Primary	74.63	5.13	47.78	2.98	***	32.57	3.86	58.94	3.98	89.00	3.34	***
Secondary	14.75	4.05	32.00	2.84		36.05	4.35	29.65	3.66	7.84	2.74	
High school	10.62	3.80	20.22	2.59		31.38	4.28	11.41	2.75	3.17	1.95	
<i>Household's characteristics</i>												
House/apartment	96.26	2.91	96.67	1.11	.	98.17	1.12	95.57	1.83	94.70	3.76	.
WC	47.31	5.69	82.56	2.00	***	91.09	1.82	79.88	2.89	36.38	6.39	***
Bottled water	43.35	5.62	59.49	2.74	***	67.98	3.59	55.85	3.82	34.37	6.52	***
Firm walls	50.45	5.67	86.97	1.73	***	94.56	1.27	79.44	3.10	46.38	6.63	***
Firm ceiling	30.36	5.14	66.90	2.64	***	74.78	3.55	60.25	3.71	23.80	5.53	***
Firm floor	14.06	3.56	40.49	2.83	***	54.87	4.27	26.44	3.11	12.46	4.26	***
PROSPERA	45.92	5.66	10.87	1.38	***	5.06	1.19	19.40	2.67	46.42	7.14	***
Social security	32.48	4.87	57.40	2.83	***	71.57	3.84	48.45	3.84	15.89	4.65	***
Food expend. P/C ^b	6.17	0.13	6.94	0.06	***	7.69	0.07	6.45	0.03	5.32	0.09	***
<i>Stratum of Locality</i>												
Metropolis	23.11	5.07	52.78	2.84	***	62.80	3.76	45.61	3.89	15.16	5.33	***
Urban	10.88	4.39	8.92	1.59		7.63	1.98	12.22	2.90	8.01	3.56	
Semi-urban	18.15	3.88	15.68	2.12		10.56	2.44	19.13	2.96	25.39	6.02	
Rural	47.86	5.63	22.62	1.84		19.01	2.38	23.05	2.58	51.44	6.64	
N	164		672			327		349		116		

	Indigenous Status				Poverty Level				p^a			
	Indigenous		Non-Indigenous		Non-Poor		Moderate		Extreme			
	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE
Population ^c	441,051		1,742,403		868,437		900,253		340,238			

Note.

^aStatistical comparison analysis: *t-test*, *X²* or *ANOVA*.

Significance level *** *p* < 0.01, ** *p* < 0.05, * *p* < 0.1.

^bContinuous variable, the value presented as % refers to the mean.

^cPopulation size with expansion factors.

Table 3

First-step regressions by indigenous status for boys.

	2002		2005		2009/12	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
<i>Mother's characteristics</i>						
Height (cm)	0.509*** (0.114)	0.389*** (0.062)	0.764*** (0.124)	0.220*** (0.069)	0.539*** (0.110)	0.520*** (0.047)
Age	0.018 (0.105)	0.098* (0.051)	0.236** (0.100)	0.080 (0.094)	- 0.101 (0.099)	0.158*** (0.049)
Secondary education ^a	6.261*** (2.196)	- 0.862 (0.841)	2.625 (1.965)	- 2.128 (1.350)	6.364*** (1.801)	1.243 (0.775)
High school education ^a	4.398* (2.644)	1.668 (1.120)	6.186 (5.827)	3.311** (1.512)	1.660 (3.702)	0.418 (1.162)
<i>Household's characteristics</i>						
House/apartment	4.628 (4.142)	0.360 (1.796)	- 0.554 (2.931)	- 1.314 (3.224)	- 2.406 (3.836)	3.983*** (1.476)
WC	3.334 (3.002)	- 0.081 (1.112)	5.595** (2.215)	2.182 (1.694)	3.502 (2.393)	1.172 (0.984)
Bottled water	- 2.123 (2.322)	0.042 (0.756)	- 1.512 (2.617)	- 1.634 (1.161)	2.486 (2.228)	1.361* (0.744)
Firm walls	0.903 (1.934)	1.721 (1.167)	7.793*** (2.553)	1.718 (1.900)	- 2.320 (2.408)	- 0.696 (1.156)
Firm ceiling	0.216 (1.881)	0.196 (0.801)	- 4.547* (2.366)	2.133* (1.185)	- 1.369 (1.858)	0.262 (0.916)
Firm floor	- 0.002 (2.047)	- 0.663 (0.858)	- 1.892 (2.881)	1.874* (1.120)	1.721 (1.622)	0.499 (0.736)
Social security	- 1.094 (1.652)	0.066 (0.845)	- 3.520 (2.189)	2.051* (1.210)	- 2.250 (2.009)	1.077 (0.876)
PROSPERA	- 0.467 (2.060)	- 2.081 (1.286)	2.594* (1.545)	- 1.639 (1.544)	4.794** (2.345)	- 0.651 (0.793)
Food expenditure P/C (log)	- 0.142 (1.292)	0.718 (0.569)	- 1.633 (1.370)	- 0.140 (0.827)	- 0.899 (1.277)	0.221 (0.600)
<i>Stratum of Locality²</i>						
Metropolis ^b	- 0.384 (2.716)	- 0.482 (0.998)	3.298 (4.554)	0.479 (1.630)	1.035 (3.544)	- 0.071 (0.862)
Urban ^b	- 2.122 (3.555)	- 0.132 (1.232)	11.186*** (3.375)	- 2.361 (1.929)	3.283 (2.884)	- 0.010 (0.983)
Semi-urban ^b	0.607 (3.213)	- 0.214 (1.202)	- 6.281* (3.297)	1.452 (1.472)	3.510 (2.408)	1.624 (1.042)
Constant	43.75*** (15.894)	60.14*** (10.470)	23.64 (20.981)	109.05*** (12.334)	91.16*** (17.345)	73.45*** (8.991)
R ²	0.490	0.210	0.616	0.209	0.504	0.397
Population ^c	291,325	1,386,044	261,174	1,126,910	188,238	961,018

Note. Standard errors between parenthesis.

Author Manuscript

Significance level $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
 a Mother's education level of reference is "Primary or less."
 b Stratum of Locality level of reference is "Rural."
 c Population size with expansion factors.

Author Manuscript

Author Manuscript

Author Manuscript

Table 4

First-step regressions by indigenous status for girls.

	2002		2005		2009/12	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
<i>Mother's characteristics</i>						
Height (cm)	0.568*** (0.117)	0.300*** (0.071)	0.505*** (0.103)	0.377*** (0.115)	0.763*** (0.066)	0.300** (0.128)
Age	0.149 (0.161)	0.071 (0.075)	0.185 (0.138)	0.047 (0.075)	0.060 (0.070)	0.086 (0.065)
Secondary education ^a	0.250 (2.348)	-0.587 (1.103)	2.314 (2.322)	0.368 (1.414)	2.272 (1.489)	-0.243 (1.129)
High school education ^a	0.431 (3.648)	0.200 (1.662)	-1.256 (3.384)	2.683*** (1.225)	-0.607 (3.035)	1.105 (1.692)
<i>Household's characteristics</i>						
House/apartment	2.286 (2.837)	-1.378 (1.746)	-6.732*** (2.311)	-0.089 (2.067)	-2.203 (2.278)	-1.528 (1.704)
WC	6.267** (2.453)	1.775 (1.172)	1.444 (1.798)	0.321 (1.395)	1.552 (1.479)	-0.560 (0.982)
Bottled water	4.503** (1.775)	1.345 (1.021)	6.694*** (1.840)	0.058 (1.024)	-2.984** (1.334)	1.403 (1.073)
Firm walls	-1.776 (2.032)	-0.263 (1.401)	-1.390 (1.618)	-0.435 (1.775)	0.375 (1.154)	1.848 (1.475)
Firm ceiling	2.670 (1.946)	-0.019 (1.043)	0.564 (1.541)	-0.612 (1.075)	0.718 (0.877)	-0.125 (0.743)
Firm floor	-2.386 (2.462)	-0.012 (0.983)	-2.524 (2.451)	0.929 (1.169)	-1.067 (1.445)	-0.179 (1.097)
Social security	-0.176 (2.029)	1.230 (1.008)	-0.471 (1.522)	-0.338 (1.013)	0.591 (1.008)	1.309 (0.958)
PROSPERA	1.718 (2.955)	1.595 (1.257)	-5.051*** (1.715)	0.664 (1.006)	-2.662*** (0.955)	-1.288 (1.049)
Food expenditure P/C (log)	0.386 (0.961)	0.188 (0.650)	2.474** (1.154)	0.260 (0.685)	-0.073 (0.909)	0.538 (0.603)
<i>Stratum of Locality</i>						
Metropolis ^b	4.061 (2.650)	1.299 (1.099)	4.004 (2.739)	0.688 (1.247)	-0.299 (1.451)	-0.949 (1.094)
Urban ^b	5.296 (4.002)	5.449*** (1.697)	-0.683 (4.184)	0.579 (1.551)	2.280 (2.295)	-2.367 (2.492)
Semi-urban ^b	-0.177 (2.521)	-0.483 (1.421)	-1.235 (1.843)	-0.133 (1.201)	0.301 (1.880)	1.700 (1.171)
Constant	23.44 (18.733)	77.67*** (10.764)	51.18*** (18.463)	87.12*** (17.503)	38.087*** (11.436)	102.66*** (19.553)
R ²	0.574	0.195	0.651	0.178	0.717	0.218
Population ^c	353,837	1,325,563	315,365	1,141,140	270,251	909,537

Note. Standard errors between parenthesis.

Significance level *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

^a Mother's education level of reference is "Primary or less."
^b Stratum of Locality level of reference is "Rural."
^c Population size with expansion factors.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 5

Oaxaca decomposition results by indigenous status and gender.

	Boys			Girls		
	2002	2005	2009/12	2002	2005	2009/12
Non-Indigenous	129.4 *** (0.421)	149.0 *** (0.619)	168.3 *** (0.460)	130.3 *** (0.502)	150.0 *** (0.538)	157.5 *** (0.517)
Indigenous	126.3 *** (1.159)	142.2 *** (1.610)	164.6 *** (1.083)	123.9 *** (1.179)	143.2 *** (1.323)	150.5 *** (1.044)
<i>Height Gaps</i>						
Non Indigenous - Indigenous	3.093 ** (1.233)	6.810 *** (1.725)	3.750 *** (1.177)	6.393 *** (1.281)	6.752 *** (1.428)	6.953 *** (1.165)
(2005–2002)	3.717			0.359		
(2009–2005)	-3.060			0.201		
(2009–2002)	0.657			0.560		

Note. Standard errors between parenthesis.Significance level *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6

First-step regressions by poverty level for boys.

	2002			2005			2009/12		
	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme
Mother's characteristics									
Height (cm)	0.428 *** (0.111)	0.413 *** (0.078)	0.575 *** (0.081)	0.607 *** (0.105)	0.257 *** (0.084)	0.155 (0.128)	0.586 *** (0.066)	0.537 *** (0.072)	0.320 *** (0.093)
Age	0.039 (0.066)	0.105 (0.065)	0.221 ** (0.087)	0.100 (0.126)	0.240 ** (0.103)	0.026 (0.103)	-0.012 (0.062)	0.209 *** (0.065)	0.261 *** (0.092)
Secondary education ^a	-0.804 (1.396)	1.001 (1.119)	-7.375 ** (2.878)	0.832 (1.959)	-0.724 (1.600)	-8.279 ** (3.228)	-0.555 (1.028)	3.228 *** (1.084)	1.842 (1.842)
High school education ^a	1.470 (1.633)	2.228 (1.604)		4.519 ** (2.117)	5.470 ** (2.243)	3.862 ** (1.944)	-2.958 (1.341)	3.901 ** (1.758)	4.164 (3.535)
House/apartment	2.125 (2.315)	-5.171 ** (2.396)	3.215 (2.785)	-1.129 (2.406)	0.998 (4.896)	5.078 ** (2.221)	4.164 *** (1.600)	3.648 * (1.890)	1.573 (2.011)
WC	3.270 * (1.777)	-1.957 (1.320)	-4.256 ** (1.774)	2.675 (2.490)	3.000 (1.917)	-1.100 (2.101)	0.278 (1.375)	4.643 *** (1.463)	2.162 (1.569)
Bottled water	-1.193 (1.219)	-0.335 (0.915)	8.209 *** (2.506)	-4.361 *** (1.658)	-2.077 (1.528)	4.995 ** (2.437)	2.789 ** (1.198)	0.620 (0.965)	2.760 * (1.602)
Firm walls	4.326 ** (2.107)	0.311 (1.422)	0.573 (2.028)	0.671 (3.041)	2.846 (2.558)	3.181 (2.252)	-4.566 *** (1.492)	-1.410 (1.404)	1.119 (2.001)
Firm ceiling	0.106 (1.181)	0.492 (1.065)	-1.707 (1.750)	0.262 (1.652)	2.404 (1.676)	0.735 (2.683)	-1.157 (1.118)	1.038 (0.978)	0.392 (1.625)
Firm floor	-2.653 ** (1.192)	0.677 (0.971)	6.803 ** (2.965)	-0.131 (1.708)	0.726 (1.322)	7.212 ** (3.119)	3.068 *** (1.058)	0.721 (0.935)	-3.407 *** (1.725)
Social security	1.734 (1.397)	-0.267 (0.912)	-0.341 (1.827)	2.659 (1.920)	-0.157 (1.443)	5.163 ** (2.059)	1.888 * (1.063)	0.913 (1.184)	-0.981 (2.165)
PROSPERA	0.254 (1.591)	-4.511 ** (1.872)	0.030 (2.300)	-3.825 * (2.197)	-1.031 (1.920)	-0.145 (2.053)	-1.016 (1.294)	2.093 ** (1.006)	-2.488 (2.494)
Food expend. P/C (log)	1.166 (0.926)	2.147 * (1.173)	1.597 (1.247)	1.080 (0.986)	-0.185 (1.192)	-2.409 ** (1.223)	0.246 (0.915)	0.237 (1.025)	-0.718 (1.255)
Metropolis ^b	0.720 (1.357)	-1.918 (1.399)	-1.478 (3.264)	1.323 (2.109)	0.598 (2.462)	6.280 (4.445)	0.381 (1.131)	1.048 (1.449)	-0.980 (2.421)
Urban ^b	-2.080 (2.132)	0.033 (1.814)	1.246 (2.917)	-5.441 (3.998)	3.288 (2.604)	3.396 (2.432)	2.802 * (1.682)	0.483 (1.610)	-3.040 * (1.631)
Sratum of Locality									

	2002			2005			2009/12		
	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme
Semi-urban ^b	-0.966 (1.952)	1.521 (1.802)	1.148 (2.565)	-2.448 (2.351)	3.799* (2.010)	2.801 (3.227)	3.230** (1.290)	3.247** (1.566)	-5.438*** (2.021)
Constant	45.41*** (16.844)	55.15*** (15.668)	19.93 (12.226)	40.79** (18.881)	93.07*** (14.851)	122.52*** (17.281)	73.22*** (12.027)	63.78*** (13.035)	110.62*** (12.502)
R²	0.264	0.306	0.705	0.419	0.221	0.670	0.431	0.511	0.581
Population^c	684,062	748,869	187,956	465,267	642,006	220,291	425,797	533,779	149,306

Note. Standard errors between parenthesis.

Significance level *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

^a Mother's education level of reference is "Primary or less."

^b Stratum of Locality level of reference is "Rural."

^c Population size with expansion factors.

Table 7

First-step regressions by poverty level for girls.

	2002			2005			2009/12		
	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme
Mother's characteristics									
Height (cm)	0.104 (0.076)	0.468*** (0.097)	0.518*** (0.136)	0.421*** (0.112)	0.368** (0.153)	0.613*** (0.171)	0.245* (0.140)	0.526*** (0.075)	0.686*** (0.138)
Age	0.214** (0.106)	-0.054 (0.101)	0.284 (0.216)	0.092 (0.095)	-0.017 (0.119)	0.383*** (0.143)	0.097 (0.099)	-0.065 (0.077)	0.343*** (0.096)
Secondary education	1.020 (1.300)	-2.904** (1.440)	2.345 (1.721)	0.728 (1.684)	0.035 (1.632)	-2.849 (4.018)	0.455 (1.718)	-0.639 (1.277)	4.149* (2.319)
High school education	1.016 (1.766)	-4.576* (2.652)		2.095 (1.651)	1.915 (2.021)	9.024*** (2.447)	-0.141 (1.803)	2.122 (2.349)	-6.821*** (2.253)
House/apartment	0.471 (2.084)	-1.760 (1.572)	-5.004 (3.504)	-0.782 (2.467)	-1.954 (1.499)	0.236 (3.691)	-4.643 (3.123)	-2.172 (1.740)	-0.887 (2.890)
WC	3.186* (1.849)	2.101 (1.561)	0.670 (2.103)	-0.397 (2.106)	-0.555 (1.819)	3.155 (2.215)	0.401 (1.362)	0.037 (1.365)	2.194 (1.436)
Bottled water	4.056*** (1.198)	-0.696 (1.429)	-2.957 (2.794)	-0.601 (1.486)	1.034 (1.171)	6.217*** (2.079)	1.283 (1.612)	-0.688 (0.911)	-2.042 (2.171)
Firm walls	-1.164 (2.070)	1.610 (1.847)	0.400 (1.934)	4.419 (2.880)	-3.110* (1.674)	-3.120 (2.322)	1.482 (1.717)	4.872*** (1.558)	-3.954** (1.546)
Firm ceiling	1.463 (1.182)	-0.452 (1.598)	-0.171 (2.313)	0.192 (1.365)	1.341 (1.440)	1.759 (2.380)	-1.789* (1.048)	0.856 (1.045)	2.171 (2.184)
Firm floor	-1.390 (1.012)	1.225 (1.652)	1.806 (2.792)	-0.496 (1.499)	2.877** (1.447)	-3.372 (3.839)	1.315 (1.471)	-1.823 (1.274)	1.926 (1.703)
Social security	0.399 (1.306)	2.211* (1.216)	-2.305 (2.121)	0.962 (1.558)	-0.872 (1.332)	1.120 (1.850)	2.587* (1.324)	0.412 (1.166)	-0.066 (1.381)
PROSPERA	3.130 (1.929)	-0.434 (1.824)	0.756 (3.865)	0.179 (1.799)	-1.491 (1.334)	-0.687 (1.836)	-2.241 (1.762)	-1.570 (1.194)	-2.558** (1.270)
Food expend. P/C (log)	0.026 (0.948)	-0.129 (1.462)	0.113 (1.827)	0.510 (1.087)	-0.503 (0.754)	2.774* (1.518)	0.500 (0.882)	-0.447 (0.624)	1.156 (0.998)
Metropolis ²	-0.383 (1.422)	2.909 (1.803)	3.399 (4.877)	-0.457 (1.755)	2.838* (1.652)	4.076* (2.432)	-2.070 (1.291)	-0.764 (1.171)	-0.150 (2.215)
Urban ²	1.931 (1.763)	5.934** (2.993)	18.012*** (6.389)	-4.189* (2.351)	4.020** (1.985)	5.885** (2.724)	-6.568** (3.235)	3.829** (1.848)	0.390 (2.391)
Semi-urban ²	-4.085* (2.239)	1.060 (1.816)	7.028** (3.485)	0.210 (1.782)	0.939 (1.592)	-2.448 (1.957)	1.048 (1.611)	0.206 (1.513)	-3.505* (1.830)
Stratum of Locality									

	2002			2005			2009/12		
	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme	Non Poor	Moderate	Extreme
Constant	101.63 ^{***} (13.489)	58.05 ^{***} (18.595)	36.42 (25.478)	74.83 ^{***} (17.645)	97.59 ^{***} (23.481)	15.17 (28.462)	113.98 ^{***} (23.068)	80.10 ^{***} (11.842)	29.89 (21.862)
R-squared	0.211	0.306	0.504	0.249	0.281	0.588	0.205	0.496	0.722
Population ³	685,162	687,763	242,950	558,569	627,578	214,139	488,051	463,710	174,756

Note. Standard errors between parenthesis.

Significance level *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

¹ Mother's education level of reference is "Primary or less."

² Stratum of Locality level of reference is "Rural."

³ Population size with expansion factors.

Table 8

Oaxaca decomposition results by poverty level and sex.

	Boys			Girls		
	2002	2005	2009/12	2002	2005	2009/12
Non Poor	129.9 *** (0.651)	148.7 *** (1.061)	168.4 *** (0.625)	131.3 *** (0.596)	150.6 *** (0.746)	158.0 *** (0.678)
Moderate Poverty	128.9 *** (0.568)	147.8 *** (0.791)	167.7 *** (0.656)	129.5 *** (0.737)	148.9 *** (0.749)	155.9 *** (0.678)
Extreme Poverty	125.0 *** (1.320)	146.3 *** (1.684)	165.9 *** (1.313)	122.0 *** (1.321)	143.2 *** (1.501)	149.8 *** (1.119)
<i>Height Gaps</i>						
Non Poor - Moderate Poor	1.011 (0.864)	0.888 (1.323)	0.743 (0.906)	1.788 * (0.947)	1.752 * (1.057)	2.162 ** (0.958)
(2005–2002)	–0.123			–0.036		
(2009–2005)	–0.145			0.410		
(2009–2002)	–0.268			0.374		
Non Poor - Extreme Poor	4.874 *** (1.472)	2.355 (1.990)	2.515 * (1.454)	9.315 *** (1.449)	7.449 *** (1.676)	8.180 *** (1.308)
(2005–2002)	–2.519			–1.866		
(2009–2005)	0.160			0.731		
(2009–2002)	–2.359			–1.135		
Moderate Poor - Extreme Poor	3.863 *** (1.437)	1.468 (1.860)	1.772 (1.467)	7.527 *** (1.512)	5.697 *** (1.678)	6.018 *** (1.308)
(2005–2002)	–2.395			–1.830		
(2009–2005)	0.304			0.321		
(2009–2002)	–2.091			–1.509		

Note. Standard errors between parenthesis.

Significance level *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.