



Height, skills, and labor market outcomes in Mexico [☆]



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ABSTRACT

Taller workers are paid higher wages. A prominent explanation for this pattern is that physical growth and cognitive development share childhood inputs, inducing a correlation between adult height and two productive skills: strength and intelligence. This paper explores the relative roles of strength and intelligence in explaining the labor market height premium among Mexican men. While cognitive test scores account for a limited share of the height premium, roughly half of the premium can be attributed to the educational and occupational choices of taller workers. Taller workers obtain more education and sort into occupations with greater intelligence requirements and lower strength requirements, suggesting a possible role for cognitive skill.

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1. Introduction

In a wide range of economies—rich and poor, historical and contemporary—taller workers earn more than their shorter counterparts.¹ Given the ubiquity of this relationship, researchers have devoted considerable effort to determining its origins, setting forth numerous hypotheses. One theory, popular for developing economies, posits that the returns to stature derive from the greater strength (and health) of taller individuals, which leads to a productivity advantage in economies that rely heavily on manual labor (Haddad and Bouis, 1991; Thomas and Strauss, 1997). For industrialized economies, explanations have been more varied, typically involving social–psychological pathways such as self esteem (Freedman, 1979), social dominance (Hensley, 1993), discrimination (Hamermesh and Biddle, 1994; Loh, 1993), and the social consequences of being short in adolescence (Persico et al., 2004). However, more recent research on the U.K. (Case and Paxson,

2008) suggests that the height premium has much to do with a correlation between height and cognitive skill. Like the strength-based explanation, the cognitive skill theory is rooted in the idea that physical growth and skill development share many inputs—such as health, nutrition, and care in early life—so that for a given genetic height potential, people who achieve greater stature also tend to achieve greater skill.

The extent to which cognitive skill (and human capital more generally) explains the height premium in contemporary developing economies is an open question. The reliance of these economies on manual labor does not necessarily bias them towards a solely strength-based height premium. Cognitive capacity improves entrepreneurship, the capacity to adapt to shocks, and general problem-solving skills, which may be valuable even entirely agrarian economies. For example, the literature on technology adoption in developing countries has emphasized the abilities of farmers to learn about the optimal uses of new seed varieties and fertilizers (Duflo, 2001; Foster and Rosenzweig, 1995). Along these lines, Hanushek and Woessmann (2008) argue that cognitive skill is a fundamental determinant of individual income, the income distribution, and the rate of economic growth in developing countries.

This paper examines the relative roles of strength and intelligence in forging the link between height and labor market outcomes in Mexico, a country that straddles the line traditionally dividing economies intensive in manual labor from those intensive in skilled labor. The term “strength” is meant to encompass physical health, robustness, and endurance. The analysis takes advantage of rich data from the Mexican Family Life Survey (MxFLS), which includes modules on health, anthropometry, cognitive skill, parental characteristics, and labor

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¹ See, for example, Persico et al. (2004) and Case and Paxson (2008) on the U.S. and U.K.; Lundborg et al. (2009) on Sweden; Thomas and Strauss (1997) on Brazil; and Haddad and Bouis (1991) on the Philippines. The return to height was also high historically, for example among slaves in the antebellum American South (Margo and Steckel, 1982) and among 19th century German workers (Komlos, 1990).

market outcomes. As the first nationally representative survey from a developing country to administer cognitive tests to working-age adults, the MxFLS provides a unique opportunity to unpack the height premium in a less industrialized setting.

Several existing studies explore the relative returns to strength and intelligence in developing country labor markets. Pitt et al. (forthcoming) focus on body mass endowments (rather than height) in Bangladesh, showing that larger men are more likely to engage in energy-intensive activities, while larger women are less likely. They argue that these sorting patterns are consistent with a high return to physical skill; body mass is more strongly correlated with strength for men than for women. Rosenzweig and Zhang (2012) complement these results in a study of Chinese twins, finding that female twins with higher birthweight attain more education, while male twins with higher birthweight develop greater adult body mass. On the other hand, Behrmann et al. (2009) use data from Guatemala to argue that brains, not brawn, have significant wage returns.² Both studies follow in the tradition of an earlier paper by Thomas and Strauss (1997), which finds that wages are positively related to height, body mass, and nutrient intake among Brazilian men. Thomas and Strauss document interesting heterogeneity in the elasticity of wages with respect to body size. In the market sector, height and earnings are most strongly correlated among the most educated workers, suggesting a role for cognitive skill. But in the self-employed sector, the correlation is strongest among the illiterate, who primarily engage in physical labor, suggesting a role for strength.³ Note that many of these studies' interesting results concern sectoral affiliation; Pitt et al. (forthcoming) study the sorting of workers across sectors, while Thomas and Strauss (1997) glean their conclusions from effect heterogeneity across sectors.

This paper also devotes much attention to the sectoral affiliations of taller and shorter workers. The paper begins with an exploration of the relationships linking height, cognitive skill, education, and earnings, but it then moves on to its primary contribution, an analysis of height-based occupational sorting. To avoid issues of endogenous labor force participation, the analysis sample only includes male workers, among whom each centimeter of height is associated with 2% higher hourly earnings. This premium is similar to those observed in other developing countries but more than twice those observed in most wealthy countries.⁴ Childhood health conditions and parental socioeconomic status explain a substantial share of this height premium, but the premium remains statistically and economically significant even after adjustment for these background characteristics. However, cognitive test scores account for only a limited part of the height premium. The test instrument is relatively crude, so its coefficient may be attenuated. At the same time, because survey respondents took the test in adulthood, their scores may in part reflect job-related opportunities to practice cognitive tasks, which would tend to (spuriously) inflate the role of cognitive skill. Regardless, the findings do indicate that roughly half of the premium can be attributed to the sorting of workers across skill groups or occupations.

The rest of the paper focuses on this sorting. Based on a new linkage of Mexican occupational categories to job characteristics from the U.S. Dictionary of Occupational Titles (DOT), the paper considers the skill requirements of occupations with greater concentrations of tall workers. In line with the evidence from industrialized countries, taller workers select into occupations with higher intelligence requirements and lower strength requirements. This result is consistent with Roy's (1951) model in which taller workers have a comparative advantage

in intelligence-intensive tasks. Importantly, education mediates nearly all of the relationship between height and occupational choice; taller workers tend to have more education, and educated workers tend to work in skill-intensive occupations. The role of education has two natural interpretations. First, parents' propensities to invest in child health and education may be correlated, a hypothesis raised by both Haddad and Bouis (1991) and Thomas and Strauss (1997) as a caveat to their argument that the height premium reflects a return to strength. Second, the early-life conditions that promote growth in childhood also promote cognitive development, which may raise the productivity of educational investments.

As a consequence, although the paper contributes several new findings to the literature on the correlates of height, these findings do not pin down a single interpretation. Scores on a (crude) cognitive test account for little of the height premium in earnings regressions, suggesting that cognitive skill may matter less in Mexico than in Britain (Case and Paxson, 2008). But taller workers obtain more schooling and sort into skill-intensive occupations, reintroducing a possible role for cognition. These two sorting results may be driven either by shared inputs in the production of physical and cognitive skill or by unobserved heterogeneity in parental investment. In either case, the data suggest an important role for human capital in explaining the earnings premium paid to taller workers.

The paper proceeds as follows. Section 2 reviews of the literature on the early-life determinants of height and skill, which Section 3 fits into a conceptual framework to understand the relationship between height and labor market outcomes. A description of the data sources follows in Section 4. Section 5 reports the results of earnings analyses, while Section 6 reports the results of occupational choice analyses. Section 7 concludes.

2. Growth, cognitive development, and adult achievement

Adult height reflects the interaction of genetic and environmental factors from the womb to adulthood (Tanner, 1979). During this period, an individual experiences two phases of intense growth, the first during gestation and infancy—from ages zero to three—and the second during adolescence. Good nutrition and freedom from infection during these periods, particularly the first, are critical to achieving optimal growth. Apart from its direct effects on growth, nutritional deprivation increases young children's susceptibility to infection. Infection, in turn, inhibits nutrient absorption and appetite, leading to a “synergism” between nutrition and infection (Scrimshaw et al., 1968).

The prenatal and very early postnatal periods appear to be of particular importance for adult height. Early-life adversity may alter tissue differentiation and development in ways that boost short-run survival at the expense of long-run health (Barker, 2001). A growing body of research indicates that deprivation during this period—whether inside or outside the womb—has lasting effects on stature. Among identical twins in Norway, those born with a 10% birthweight advantage over their twins gain an extra 0.6 cm in height by age 18 (Black et al., 2007). Results of this type extend as far as rural Indonesia, where Maccini and Yang (2009) show that women exposed to above average rainfall in their birth years attain significantly greater heights.⁵ In a similar vein, among French soldiers in the 19th and early 20th centuries, childhood exposure to the grape vine parasite phylloxera reduced adult height, presumably through a reduction in parental income (Banerjee et al., 2010).

Negative health and nutrition shocks, both in utero and in early childhood, have similarly detrimental effects on cognition and physical

² Importantly, Behrmann et al.'s (2009) conclusions rest on quite strong exclusion restrictions. Their instruments for cognitive skill and body size include childhood proximity to a health post, class size at age 7, birth cohort, and parental characteristics.

³ Thomas and Strauss (1997) also find that the returns to body mass are uniformly stronger among the illiterate.

⁴ See the sources listed in footnote 1.

⁵ Interestingly, Maccini and Yang do not find similar benefits of early-life rainfall for men.

strength later in life. In industrialized countries, a large body of research has documented cognitive deficits among children born with low birth weight (Breslau, 1995).⁶ The specific effects of low birth weight are not well-documented in developing countries, but randomized trials have confirmed the effects of nutrition on cognition in such settings (Grantham-McGregor, 1995).⁷ Evidence linking early-life health and muscle strength in adulthood is somewhat rarer, but a number of studies in rich and poor countries have shown a positive relationship between birth weight and muscle strength over the lifecourse (Dodds et al., forthcoming).

Combined, these results suggest that superior health and nutrition promote both physical growth and cognitive development.⁸ Indeed, height is correlated with cognitive test scores in children from a range of settings.⁹ This association carries well into adulthood, as evidenced in Hawaii (Abbott et al., 1998), the U.K. (Case and Paxson, 2008; Richards et al., 2002), urban Latin America (Maurer, 2010), and China (Huang et al., 2012). Taller individuals' enhanced cognitive skills may also increase the productivity of schooling, which may explain the correlation between height and education, observed in such diverse settings as Brazil (Strauss and Thomas, 1998), India (Perkins et al., 2011), Sweden (Magnusson et al., 2006), and the U.S. and U.K. (Case and Paxson, 2010). Height is also associated with physical strength in adults (Lundborg et al., 2009; Tuvemo et al., 1999).

3. Conceptual framework

The current knowledge on the co-evolution of body size, strength, and cognitive skill fits nicely into a theoretical framework in the tradition of Roy (1951). In a complementary line of work, Pitt et al. (forthcoming) and Rosenzweig and Zhang (2012) also use the Roy model to study strength and cognitive skill in developing economies. For tractability, they use the functional form assumptions of Ohnsorge and Trefler (2007) and derive predictions for gender and occupational segregation. In the framework below, I aim to conceptualize key issues in the relationship between height and labor market outcomes, rather than derive analytic results. As such, I do not assume functional forms.

Let h , v^p , and v^c denote a worker's height, physical ability (including strength, health, and robustness), and cognitive ability, respectively. For clarity of exposition, we treat v^p and v^c as endowments that are fixed after early childhood; when we specify the wage function below, we will allow workers to augment their cognitive ability endowments through investments after early childhood. The three worker traits have the following production functions:

$$\begin{aligned} h &= h(N; B, D, X, \varepsilon_h) \\ v^p &= v^p(N; B, D, X, \varepsilon_p) \\ v^c &= v^c(N; B, D, X, \varepsilon_c) \end{aligned}$$

⁶ In Black et al.'s study of Norwegian twins, a 10% increase in birth weight increases age 18 IQ by roughly one third of a standard deviation. Richards et al. (2002) find similarly-sized associations among young British adults who were born with low birth weight.

⁷ In one well-known trial in Jamaica (Grantham-McGregor et al., 1991), administration of milk-based formula to young stunted children led to substantial gains on developmental tests, especially when researchers coupled cognitive stimulation with nutritional supplementation.

⁸ Height and intelligence may share common chemical antecedents, including insulin-like growth factor (Berger, 2001) and thyroid hormone (Richards et al., 2002).

⁹ Conditional on age, sex, and family background characteristics, the correlation of height and cognitive test scores is roughly 0.05–0.10 among both British children (Case and Paxson, 2008) and Ecuadorian children (Paxson and Schady, 2007). In a cohort of Peruvian children, severe stunting at age two is associated with a one standard deviation deficit in cognitive test scores at age nine (Berkman et al., 2002). In a cohort of Filipino children, moderate stunting and severe stunting at age two are associated with a 0.25 and 0.6 standard deviation decline in cognitive test scores at age eight (Mendez and Adair, 1999).

where N denotes childhood nutrition and health inputs, B denotes childhood background characteristics, D denotes the childhood disease environment, X is a vector of exogenous demographic controls, and $\{\varepsilon_h, \varepsilon_p, \varepsilon_c\}$ are mutually independent error terms. The three production functions share partial derivatives of the same sign with respect to N , B , and D . Thus, conditional on X , h , v^p , and v^c are positively correlated.

Upon reaching adulthood, the worker faces a labor market with J sectors, indexed j . The worker's potential wage in each sector is given by:

$$w_j = w_j(v^p, v^c, S; X, \varepsilon_j)$$

where S denotes schooling and the other variables are defined as before. For all sectors, the partial derivatives of wages with respect to v^p , v^c , and S are positive.

The simplest formulation of the model would have the worker and his parents choose $\{N, S, j\}$ to maximize a utility function over parental consumption (C) and the worker's wage in adulthood:

$$U(C, w_j(v^p, v^c, S; X, \varepsilon_j)).$$

Maximization would then be subject to the following budget constraint:

$$I = p_C C + p_N N + [p_S + \psi(v^p, v^c; \varepsilon_\psi)] S$$

where I is parental income; p_C , p_N , and p_S are the prices of parental consumption, child nutrition and health inputs, and schooling, respectively; and $\psi(\cdot)$ is the opportunity cost of schooling. The opportunity cost of schooling can be thought of as wage income from teenage employment.

This simple setup with no uncertainty delivers the main predictions of the paper. First, it leads to an unambiguously positive correlation between height and wages, working through the production functions for h , v^p , and v^c .¹⁰ Second, if cognitive ability increases the productivity of schooling in all sectors ($\partial^2 w_j / \partial v^c \partial S > 0$ for all j)—as the literature on the returns to schooling typically assumes (Card, 2001)—then taller individuals obtain more schooling. Third, if the sector-specific returns to cognitive ability are large and heterogeneous (relative to the returns to physical ability), then taller workers sort into sectors with higher returns to cognitive ability. At the same time, the fact that parents maximize their utility suggests a caveat; many of the same patterns may result from heterogeneity in parental income and preferences. Parents who invest more in their children's health may also invest more in their children's schooling, for reasons unrelated to the cross-partial $\partial^2 w_j / \partial v^c \partial S$.

A more realistic version of the model would separate the decision process into three stages—nutrition, schooling, and sectoral choice—and would introduce environment, income, and labor market shocks at each stage. This setup would not only deliver similar predictions but also allow for correlations between height and labor market outcomes after controlling for parental characteristics like income. In either case, the principal results derive from the fact that h , v^p , and v^c share inputs.

Much of the empirical analysis focuses on the sorting of workers across sectors, measured as occupations. Ideally, one would study both occupational choice and within-occupation skill returns, to verify that taller workers indeed sort into occupations with high returns to both height and either cognitive or physical skill. However, within-occupation skill returns are difficult to estimate. The researcher

¹⁰ On average, taller workers hold an absolute advantage over shorter workers (in both physical and cognitive ability), so the envelope theorem implies that they will earn higher average wages after making their wage-maximizing choices.

Table 1
Summary statistics, men aged 25–65.

	Earnings analysis	Occupational choice analysis
	(1)	(2)
Height (cm)	165.6 [6.9]	165.4 [7.0]
Raven score	0.1 [1.0]	0.1 [1.0]
Years of education	8.4 [4.6]	8.1 [4.8]
Hourly earnings (2002 Mex\$)	20.0 [18.6]	
Brawn occupation		0.89
Age	40.1 [10.3]	41.0 [10.5]
Indigenous	0.12	0.15
Rural residence	0.20	0.23
# of observations	5286	7401
# of individuals	3860	4715

Notes: Weighted sample means, with standard deviations in brackets. The sample in column (1) only includes observations with non-missing wages, and the sample in column (2) only includes observations with occupations that can be matched to the Dictionary of Occupational Titles.

observes only one realized wage per worker, rather than potential wages in every occupation. As a result, within-occupation estimates based only on realized wages are inconsistent because sorting induces a negative correlation between the skill and the error term. With adequate panel data and structural assumptions, one can recover within-occupation skill returns (see, e.g., Gibbons et al., 2005). However, these methods require substantial movement of workers across occupations, and too few workers in the Mexican Family Life Survey change occupations between survey waves. As a result, I focus on occupational choice, and I then compare the observed occupational sorting with estimates of occupational skill requirements from the U.S. Dictionary of Occupational Titles.

4. Data

The analysis of height and labor market outcomes draws on data from the Mexican Family Life Survey (MxFLS), a panel with two waves (so far) in 2002 and 2005. The MxFLS, a nationally representative household survey, included modules on household economic decisions and household demographic structure, as well as individual-level questions on labor market participation, self-reported health, schooling, and the living conditions that adults experienced while growing up. The survey administered a short cognitive test and also collected data on the heights and weights of all household members. To avoid sample selection issues arising from endogenous labor force participation, I employ data on men aged 25–65.

To measure height and cognitive skill, I use standing height in centimeters and a cognitive test score based on the short-form Raven's Progressive Matrices test (Raven et al., 1983).¹¹ The Raven test, which is intended to measure abstract reasoning, presents the subject with a series of patterns (called matrices), each with a missing element.¹² For each matrix, the subject selects the missing element from a bank of eight candidates. In the MxFLS, the adult Raven test comprised 12 matrices. To obtain a composite measure of test performance, I sum the number of correct responses and then standardize them among all men in the MxFLS to have a mean of zero and a standard deviation of one. In interpreting analyses of the Raven test score, two caveats are worthy of note. First, the test score measures accumulated cognitive

skill over the lifecycle, reflecting early-life cognitive development, schooling, and cognitive reinforcement learning in adulthood. Second, with only 12 simple matrices on the Raven test, the test score is a noisy measure of cognitive skill. Both caveats suggest that the Raven score is not an ideal measure of v^c from the theoretical framework in Section 3. The first might lead us to overstate the effect of early-life conditions because of the endogenous reinforcement of cognitive skill over the lifecycle (from having a cognitively demanding job, for example). On the other hand, the second might lead us to understate it because of attenuation bias.

I measure hourly earnings using an individually-administered survey module on labor market outcomes over the previous year. Wages are notoriously difficult to measure in developing countries, given the prevalence of informal contracting and self-employment. However, the MxFLS posed a detailed set of questions that enable the calculation of hourly earnings for a wide variety of individuals, including farmers and small business owners. Every respondent answered questions about the number of weeks worked in his or her main job, the number of hours worked per week, and post-tax labor earnings. Non-working individuals reported on their previous jobs if they worked in the previous year. I compute hourly earnings for individuals who reported working 20 or more hours per week regularly over the previous year. For wage earners, the survey collected data on earnings both over the previous month and over the previous year. Appendix A describes the algorithm used to reconcile differences between the monthly and annual reports.

Occupational classifications are crucial to the analysis. For the earnings analysis, I use the 19-category Mexican Classification of Occupations (MCO), but one cannot merge the MCO to measures of occupational skill requirements from the Dictionary of Occupational Titles (DOT). As an alternative, I use the nine civilian occupations in the coarser International Standard Classification of Occupations (ISCO), which can be matched to both the Mexican and the U.S. job classification systems.¹³ From England and Kilbourne's (1988) job characteristic file, which maps DOT measures to the three-digit detailed occupational classification of the 1980 U.S. Census, I assign measures of occupational skill requirements to workers in the 1980 U.S. Census (Ruggles et al., 2008). Then, using the 1980 U.S. distribution of occupations, I then aggregate the detailed occupation categories up to the nine-category ISCO. This procedure assumes that the distribution of detailed occupations and relative skill requirements within each broad ISCO category is the same in the 1980 U.S. and 2002 Mexico. Although these assumptions are unlikely to hold exactly, the aggregation procedure can nonetheless provide a useful guide to the skill content of height-based occupation sorting.

In the analysis of the DOT, I use the "intelligence aptitude" and "strength" intensities of each occupation as measures of cognitive and physical skill requirements. Alternative measures from the DOT (such as "numerical skills" and "physical demands") yield results similar to those reported below. Some of the results are more interpretable with a binary categorization of occupational skill requirements, so that workers select either the "brains" sector or the "brawn" sector. Appendix Fig. 1 plots intelligence aptitude requirements against strength requirements for the civilian occupations in the ISCO, revealing that the occupations divide naturally into "brains" and "brawn" sectors. I define the two sectors as indicated in the figure.

In all analyses, I only use data on individuals who were in the 2002 baseline survey wave. I use survey weights to estimate population regression parameters, and I cluster standard errors at the primary sampling unit (PSU) level.¹⁴ Because I only study original members of

¹¹ I trim the top and bottom 0.5% of the height distribution to reduce the influence of outliers.

¹² The Raven test exhibits high 'g-loading,' meaning that its score correlates strongly with general factor intelligence, a unidimensional variable that many cognitive psychologists hypothesize underlies cognitive skills (Carroll, 1993).

¹³ Most of the two-digit MCO categories map perfectly onto the ISCO, but three do not: worker in personal establishments; worker in domestic services; and protection, monitoring and armed forces. In the analysis of skill requirements, I omit these occupation groups.

¹⁴ Because the paper aims to describe the relationship between height and labor market outcomes at the national level, the use of survey weights is appropriate (Deaton, 1997).

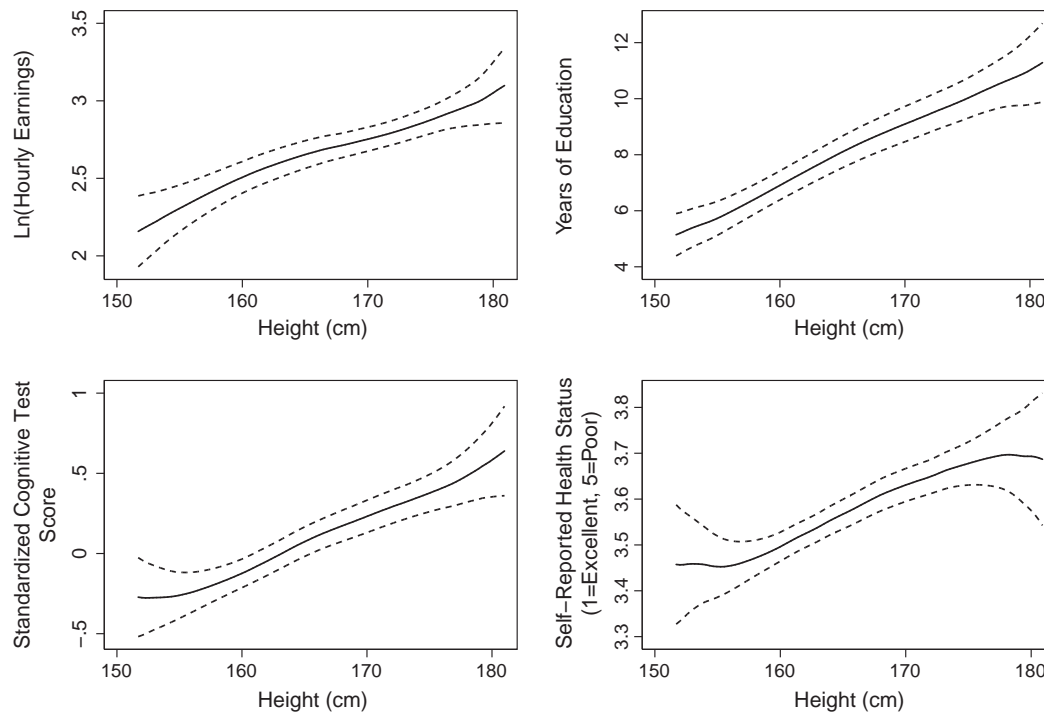


Fig. 1. The returns to height, various outcomes. Notes: The panels show local linear regressions with bandwidths of 4 cm; the dashed curves correspond to pointwise 95% confidence intervals, block-bootstrapped at the PSU level. All regressions are weighted using sampling weights. The sample includes all men aged 25–65.

the 2002 cohort, I use the 2002 survey weights and the 2002 PSUs.¹⁵ If an individual has two height measurements, I average them.¹⁶ If an individual has two measurements for any other covariates (particularly the cognitive test and childhood conditions), I use the first measurement.¹⁷

Table 1 presents summary statistics for selected characteristics, with one column for each of the two samples used in the study. Because earnings are missing for many workers, the sample for the earnings analysis is smaller than the sample for the occupational choice analysis.¹⁸ On average, workers in both samples are about 40 years old, are a meter and a two-thirds tall, and have eight years of education.¹⁹ 15% report that they recognize themselves as part of an indigenous group. In the earnings sample, average

hourly earnings is roughly 20 Mexican pesos (or US\$2). In the occupation sample, 90% of workers are in “brawn” occupations rather than “brains” occupations.

5. The returns to height: graphical evidence

For four outcomes—log hourly earnings, educational attainment, cognitive test scores, and self-reported health—Fig. 1 documents the returns to height graphically. Each panel shows local linear regression of an adult outcome on height. The solid curves correspond to the regression function estimates, while the dotted curves bound pointwise 95% confidence intervals.

Height bestows advantages in cognitive skill, education, health, and earnings. The top left panel of Fig. 1 shows a positive, monotonic relationship between height and earnings. An increase in height by 10 cm is associated with an increase in hourly earnings by roughly one quarter of a log point, implying a semi-elasticity of 2–3%/cm. The remaining panels of Fig. 1 reveal that taller individuals enjoy other benefits. For every 10 cm of height, educational attainment rises more than one year, cognitive test scores increase by 40% of a standard deviation, and self-reported health status improves by just short of 20% of a standard deviation. All regression functions are precisely estimated, showing no clear evidence of nonlinearity.

One possible interpretation for the relationships in Fig. 1 is ethnic heterogeneity. This theory posits that indigenous people are both shorter and more disadvantaged, but for separate reasons.²⁰ However, Fig. 2 reveals that ethnic heterogeneity does not explain the strong relationships in Fig. 1. The left-hand panel of Fig. 2 plots separate

¹⁵ The MxFLS does not provide survey weights for the 2005 wave.

¹⁶ Slightly fewer than 8% of the male respondents to the employment module had missing heights. The probability of a missing value for height was increasing in education: each year of education reduces the probability of height measurement by 0.36 percentage points (p -value < 0.01). As a result, my estimates of the height premium may be biased slightly downward.

¹⁷ Use of the first measurement is important for the cognitive test, since the same test questions were administered in both survey waves.

¹⁸ In Section 7 below, I show that the two samples show similar relationships between height and a measure of imputed earnings based on the worker’s occupation, industry, and education level.

¹⁹ Respondents with post-secondary education did not reply to questions regarding years of schooling, so I impute years of schooling for them using data from the 2000 Mexican Census. I divide individuals with post-secondary education into sex-specific, five-year age groups, and I then calculate the average number of years of post-secondary schooling within each cell. I then merge these data with the MxFLS on the basis of sex and age group. The five-year age groups in the 2000 census tabulations run from 25 to 64, so they do not perfectly match the cohorts in the MxFLS, who were aged 25–65 in the year 2002. However, all of the cell means from the census are extremely close to four years, so this mismatch should not bias the results.

²⁰ For instance, indigenous people may be genetically short and historically persecuted.

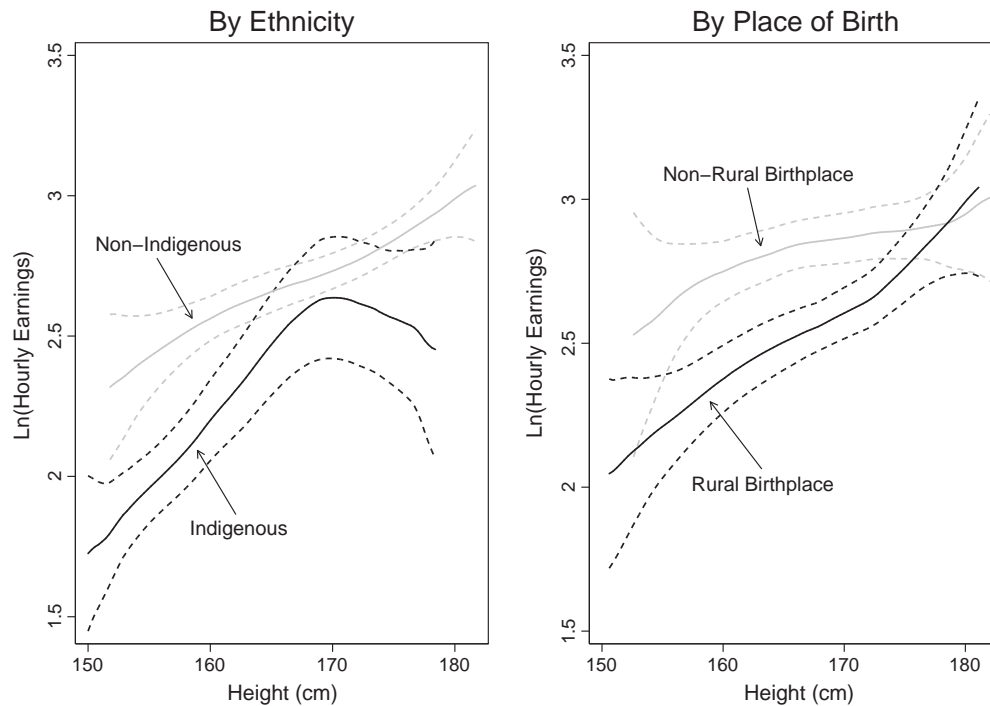


Fig. 2. Heterogeneity in the height-earnings relationship. Notes: The panels show local linear regressions with bandwidths of 4 cm; the dashed curves correspond to pointwise 95% confidence intervals, block-bootstrapped at the PSU level. All regressions are weighted using sampling weights. The sample includes all men aged 25–65.

height-earnings profiles for workers with indigenous and non-indigenous backgrounds; both curves are steeply positive. Notably, the measure of ethnicity is self-reported and as such may be measured with error, so Fig. 2 does not completely rule out ethnic heterogeneity. Nonetheless, the steepness of the curve for indigenous workers suggests that ethnic heterogeneity is not to blame. The right-hand panel of Fig. 2 disaggregates the sample by sector of birth instead of ethnicity. Again, both curves slope upwards, with a steeper curve for workers born in rural areas. Because the rural-born are three times more likely than the urban-born to be indigenous (16% versus 5%), the two panels of Fig. 2 have related interpretations.

Both indigenous and rural-born workers have steeper relationships between height and earnings. Two theories are particularly natural for interpreting the steeper curves for more disadvantaged groups. First, the variance of the non-genetic determinants of height may be higher for disadvantaged groups; nutritional inputs and the local disease environment may be more volatile. In a simple statistical model in which height is a proxy for childhood conditions, the estimated return to height is higher when the variance of childhood conditions is larger.²¹ Second, the returns to skill may be higher for individuals from disadvantaged backgrounds, who may have more to gain from migration. In the figures, one can see that indigenous and rural workers are most disadvantaged at short heights. However, at taller heights, these workers are indistinguishable from their more advantaged counterparts.

More broadly, the non-parametric regressions in Fig. 1 suggest several skill-based explanations for the covariance of height and earnings. One possibility, in the spirit of Case and Paxson (2008), is that the inputs to physical growth in childhood coincide with the inputs to cognitive development, so that height is merely a proxy for intelligence. This could also explain why educational attainment rises with height, if schooling and cognitive ability are complimentary. A competing account, more in line with the previous literature on developing countries, would emphasize the negative association of short stature with health status and strength (Lundborg et al., 2009; Tuvemo et al., 1999). Note, however, that the positive associations of height with cognitive skill, education, and health status still may reflect unobserved family-level heterogeneity—in parents' tendency to invest in all forms of child development, for example—which could just as easily explain the height-earnings gradient.

6. Height and earnings

Table 2 reports the main regressions of the logarithm of hourly earnings on height. Much of the literature on industrialized settings (e.g., Case and Paxson, 2006; Persico et al., 2004) has analyzed height in levels, leading to semi-elasticities, whereas the literature on developing settings (e.g., Haddad and Bouis, 1991; Thomas and Strauss, 1997) has used the logarithm of height, leading to elasticities. For conciseness, I focus exclusively on semi-elasticities, but unreported results using elasticities show similar patterns. All regressions control for demographic characteristics including age and indigenous group membership. Column (1) runs a regression with just the demographic control variables; the remaining columns add height and a variety of other covariates. Comparing the adjusted *R*-squared terms from columns (1) and (2), one learns that the inclusion of height improves the fit of the basic model by 60%. Relative to ethnicity and age, height has substantial explanatory power for earnings.

²¹ Suppose $h = \alpha^h + \beta^h z + \eta$ and $\ln w = \alpha^w + \beta^w z + \zeta$, where h is height, w is wages, and z is childhood conditions. Then the slope coefficient from a regression of the log wage on height converges in probability to $\frac{\alpha^w}{\alpha^h + \frac{\sigma_z^2}{\beta^w \sigma_z^2}}$. Thus, the probability limit of the coefficient increases in σ_z^2 . In words, earnings differences between tall and short workers are greatest when childhood conditions are more variable.

Table 2
Childhood conditions, cognitive skill, and the height premium. OLS estimates, dependent variable: Ln(hourly earnings).

	(1)	(2)	(3)	Incl. childhood covariates	
				(4)	(5)
Height (cm)		0.023*** [0.004]	0.020*** [0.003]	0.015*** [0.003]	0.014*** [0.003]
Raven score			0.144*** [0.021]		0.091*** [0.018]
Indigenous	−0.417*** [0.071]	−0.313*** [0.062]	−0.289*** [0.061]	−0.192*** [0.058]	−0.188*** [0.059]
Age	0.062*** [0.013]	0.058*** [0.012]	0.053*** [0.012]	0.066*** [0.012]	0.062*** [0.012]
Age squared	−0.0008*** [0.0001]	−0.0007*** [0.0001]	−0.0006*** [0.0001]	−0.0007*** [0.0001]	−0.0007*** [0.0001]
<i>p</i> -Value on childhood vars.				<0.001	<0.001
Adj. <i>R</i> -squared	0.039	0.070	0.096	0.146	0.156

Notes: The sample includes 5286 observations from 3860 men. Brackets contain standard errors clustered at the PSU-level. Regressions are weighted using sample weights and control for a survey year dummy. The Raven score is standardized to have a standard deviation of 1 across the entire Mexican adult population. The childhood covariates include the father's first job, the father's education, the mother's education, access to piped water and sanitation at age 12, and urban place of birth. To keep the sample sizes adequate, the specifications that control for childhood covariates also include indicators for whether these variables are non-missing. The *p*-values at the bottom of the table are from joint *F* tests of the coefficients on the actual variables, not the non-missing indicators.

* *p* < 0.10.

** *p* < 0.05.

*** *p* < 0.01.

The coefficient on height in column (2), 0.023, implies that each centimeter in height is associated with hourly earnings gains of 2.3%. This result contrasts findings from the United States and Britain (e.g., Case and Paxson, 2010), which put the semi-elasticity at roughly 2% per *inch* of height (or 0.8% per centimeter). As Section 5 pointed out in discussing heterogeneity by ethnicity or birthplace, the difference has two interpretations. First, it may stem from differences in skill returns or the relationships linking child health with adult height and skill. Second, it may be the result of a higher variance of the non-genetic determinants of height in Mexico, which would bias upward the return to height.

Columns (3)–(5) add the Raven score and a vector of childhood covariates to the regression. The inclusion of the cognitive test score results in a 13% reduction in the height premium. Although this change is relatively small, a generalized Hausman test that allows for clustering indicates that the fall in the height premium is statistically significant (*p* < 0.01). Furthermore, the coefficient estimate is probably attenuated. Despite past emphasis by (some) cognitive scientists on the existence of a unidimensional factor underlying intelligence, cognitive skill is in fact multifaceted, so one cannot expect an analysis to fully identify its effects with a single, 12-question matrix test. At the same time, insofar as high-paying work reinforces workers' cognitive skills, a cognitive test taken in adulthood may overstate the role of cognitive skill.

Meanwhile, columns (4) and (5) show that childhood conditions explain a substantial part of the returns to height and cognitive skill. The vector of childhood conditions is fairly comprehensive, including the father's first job, the father's and mother's education, access to piped water and sanitation at age 12, and urban birthplace. In the fullest model (column [5]), the vector's inclusion reduces the coefficient on height to 0.014 and the coefficient on the Raven score to 0.094. The coefficients on the childhood covariates are jointly significant at the 0.1% level, and the model's explanatory power is now quite high, with an *R*-squared of 0.16.

Table 3 explores heterogeneity in these results by ethnicity and birthplace, confirming the patterns in the non-parametric regressions in Fig. 2. In particular, column (1) reveals higher returns to height among indigenous workers and among workers born in the countryside. The Raven score explains a larger share of the height premium among the same two groups of workers. On the other

hand, childhood covariates explain a larger share of the premium among the non-indigenous and among those born in cities. This result may have to do with the larger variances of the *observable* childhood covariates in these more advantaged groups of workers. Thus, the higher height premium of workers from disadvantaged

Table 3
Childhood conditions, cognitive skill, and the height premium: heterogeneity. OLS estimates, dependent variable: Ln(hourly earnings).

	(1)	(2)	Incl. childhood covariates	
			(3)	(4)
<i>Indigenous (637 observations, 481 individuals)</i>				
Height (cm)	0.037*** [0.008]	0.031*** [0.007]	0.027*** [0.007]	0.023*** [0.007]
Raven score		0.215*** [0.056]		0.185*** [0.053]
<i>Non-indigenous (4649 observations, 3379 individuals)</i>				
Height (cm)	0.021*** [0.004]	0.018*** [0.004]	0.014*** [0.004]	0.013*** [0.004]
Raven score		0.134*** [0.021]		0.079*** [0.018]
<i>Non-urban birthplace (3521 observations, 2582 individuals)</i>				
Height (cm)	0.023*** [0.005]	0.020*** [0.005]	0.017*** [0.005]	0.016*** [0.004]
Raven score		0.128*** [0.027]		0.083*** [0.024]
<i>Urban birthplace (1765 observations, 1278 individuals)</i>				
Height (cm)	0.015*** [0.005]	0.015*** [0.005]	0.012*** [0.005]	0.012*** [0.005]
Raven score		0.123*** [0.030]		0.096*** [0.027]

Notes: Brackets contain standard errors clustered at the PSU-level. Regressions are weighted using sample weights and control for a survey year dummy. The Raven score is standardized to have a standard deviation of 1 across the entire Mexican adult population. The childhood covariates include the father's first job, the father's education, the mother's education, access to piped water and sanitation at age 12, and urban place of birth. To keep the sample sizes adequate, the specifications that control for childhood covariates also include indicators for whether these variables are non-missing.

* *p* < 0.10.

** *p* < 0.05.

*** *p* < 0.01.

Table 4
Education, occupational choice, and the height premium. OLS estimates, dependent variable: Ln(hourly earnings).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Height	0.023*** [0.004]	0.015*** [0.003]	0.013*** [0.004]	0.012*** [0.003]	0.018*** [0.003]	0.014*** [0.003]	0.013*** [0.004]	0.012*** [0.003]
Raven score					0.145*** [0.023]	0.046*** [0.014]	0.011 [0.014]	−0.0003 [0.011]
Years of education			0.073*** [0.006]	0.042*** [0.006]			0.072*** [0.005]	0.043*** [0.006]
Occupation dummies?	No	Yes	No	Yes	No	Yes	No	Yes
p-value on occ. dummies		<0.001		<0.001		<0.001		<0.001
R-squared	0.070	0.226	0.205	0.252	0.096	0.229	0.204	0.253

Notes: The sample includes 5286 observations from 3860 men. Brackets contain standard errors clustered at the PSU-level. Regressions are weighted using sample weights and control for year, ethnicity, age, and age squared. The Raven score is standardized to have a standard deviation of 1 across the entire Mexican adult population. The p-values at the bottom of the table are from joint F tests of the coefficients on the occupation dummies.

* p < 0.10.
** p < 0.05.
*** p < 0.01.

backgrounds may be due to greater idiosyncratic volatility in living conditions, rather than variation in longer-term, observable living conditions.

Returning to the full sample, Table 4 investigates whether the returns to height accrue within or between occupation and education groups. This is strictly an accounting exercise; occupation and education should be interpreted as choice variables. The inclusion of either occupation dummies or educational attainment (as a continuous covariate) cuts the estimated height premium approximately in half (compared with column [1]), implying that a large part of the height premium is attributable to the higher educational attainment of taller workers or to their sorting into higher-paying occupations.²²

7. Height and occupational choice

The results of the previous section imply that sorting across occupations contributes to the returns to height. This finding is interesting, especially in light of Case and Paxson’s (2006) evidence from the United States that taller individuals sort into occupations with greater cognitive demands. As discussed in Section 3, if cognitive ability explains the height premium, then the tallest workers will sort into the most cognitively demanding occupations. This section assesses height-based occupational selection in two steps. First, it assesses whether “taller” occupation groups have higher intelligence aptitude or strength requirements. Second, it explores the roles of cognitive skill, childhood conditions, and educational choices in explaining height-based selection into “brains” or “brawn” occupations. Throughout, it uses a full sample of workers, rather than restricting the sample to workers with non-missing hourly earnings. The full sample exhibits sectoral sorting that is similar to the earnings sample in Section 6. Appendix Table 1 assigns each worker the mean hourly earnings of her occupation–industry–education cell in the 2000 Mexican census, and then regresses the logarithm of this sectoral earnings score on height and demographic characteristics. The coefficients on height in the full sample and the earnings sample are quite close.

For the first step of the occupational choice analysis, I follow Case and Paxson (2006) in estimating a multinomial logit regression of

occupation category (as classified by the ISCO) on height:

$$\ln \left[\frac{p_{ij}}{p_{i0}} \right] = \gamma_j \text{height}_i + X_i' \Gamma_j, j > 0 \tag{1}$$

where p_{ij} is the probability that worker i selects an occupation in category j , and $j = 0$ corresponds to the professional occupation category. To reduce the dimensionality of the likelihood maximization problem, I restrict X_i , the vector of control variables, to include only a constant term, ethnicity, age, and a squared term in age. After estimating the logit regressions, I plot occupational skill measures from the DOT against each occupation category’s relative risk ratio on height (e^{γ_j}). An occupation category’s relative risk ratio measures the association between height and the risk of selection into that occupation category, relative to the professional occupation category. By plotting each occupation category’s cognitive and physical skill intensities against its relative risk ratio on height, one can infer whether physical or cognitive skill drives height-based occupational sorting.

The results, which appear in Fig. 3, indicate that taller men systematically select into occupations with larger intelligence aptitude demands and smaller strength demands. The plots are surprisingly similar to the occupational sorting patterns that arise in industrialized countries (Case and Paxson, 2006). Combined with Table 4, we reach the conclusion that nearly half of Mexico’s height premium can be attributed to the sorting of taller workers into occupations intensive in cognitive skill. Seen through the lens of the theoretical framework of Section 3, this result suggests that the return to cognitive ability (and human capital more broadly) drives a substantial part of the height premium.

Again, these results are not merely driven by ethnic or birthplace heterogeneity. Figs. 4 and 5 draw the same plots by ethnicity and birthplace. The same patterns emerge, with “taller” occupations exhibiting higher average intelligence requirements and lower average strength requirements. Perhaps surprisingly, the patterns appear quite similar for indigenous, non-indigenous, rural-born, and urban-born workers.

To further understand these patterns, Table 5 performs an analysis of occupational choice that is analogous to Table 2’s analysis of the height premium. The table reports marginal effects from logit regressions in which the dependent variable equals 0 for a “brains” occupation and 1 for a “brawn” occupation. The marginal effects are multiplied by 100, so that a marginal effect of 1 corresponds to a 1 percentage point increase in the probability of working in a “brawn” occupation. Each column adds a different set of covariates to the basic specification.

²² A Mincer-style earnings regression that omits height yields a return to schooling of 7.7%.

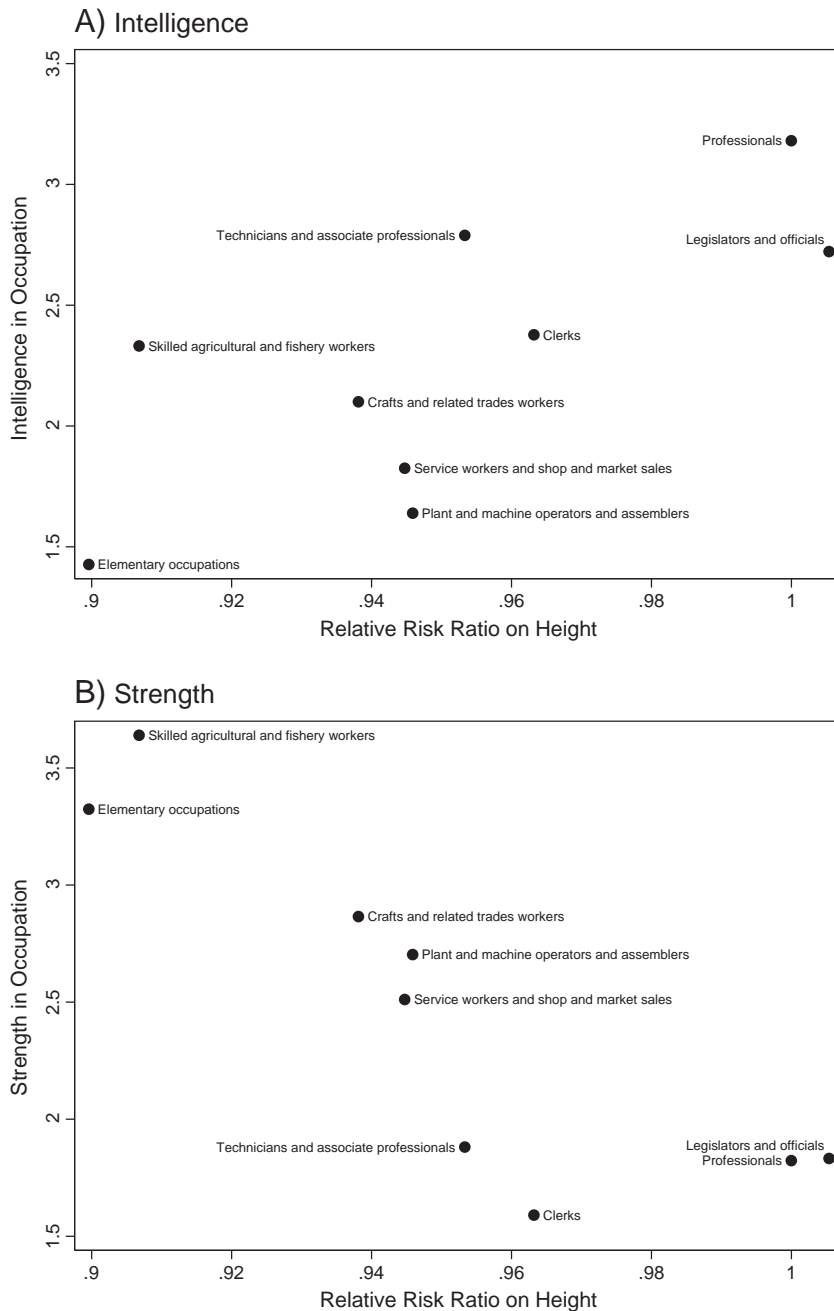


Fig. 3. Height and occupational skill requirements. Notes: Figures plot average occupational skill requirements from the Dictionary of Occupational Titles against the relative risk ratio on height from a multinomial logit regression of occupation on height, age, age squared, and an ethnicity dummy. The reference category is “professionals.”

The associations of height with cognitive skill, childhood conditions, and educational investments account for the lion's share of the decreased likelihood of taller workers to select into manual occupations. Column (1) indicates that a centimeter of height decreases the probability of working in a “brawn” occupation by 0.63 percentage points. This association falls to 0.34 percentage points with inclusion of childhood covariates (column [2]), and further to 0.26 percentage points with the addition of the Raven score (column [5]). Strikingly, the roles of cognitive skill and childhood conditions pale in comparison to that of educational attainment. In columns (3) and (6), the inclusion of educational attainment as covariate all but eliminates the negative relationship between height and manual labor. The logit coefficients on height remain

statistically significant, but they are an order of magnitude smaller than before the inclusion of education as a covariate. That is to say, the educational investments of taller workers almost entirely explain their selection into more lucrative, more skilled occupations. Of course, these education investments have antecedents in cognitive ability and childhood conditions. Regardless, the results suggest that most of the relationship between height and occupational choice in adulthood is set before labor market entry.

8. Conclusion

Despite the universality of the association between height and labor market outcomes, conventional wisdom holds that its sources differ

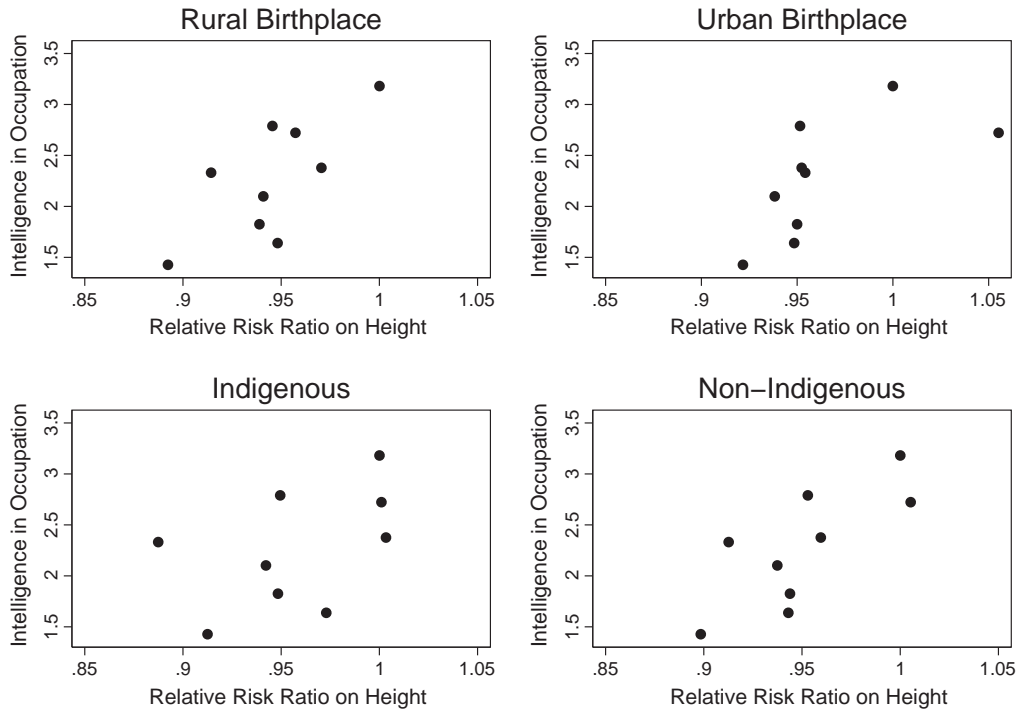


Fig. 4. Heterogeneity in the relationship between height and occupational intelligence requirements. Notes: Figures plot average occupational intelligence requirements from the Dictionary of Occupational Titles against the relative risk ratio on height from a multinomial logit regression of occupation on height, age, age squared, and an ethnicity dummy. The reference category is “professionals.”

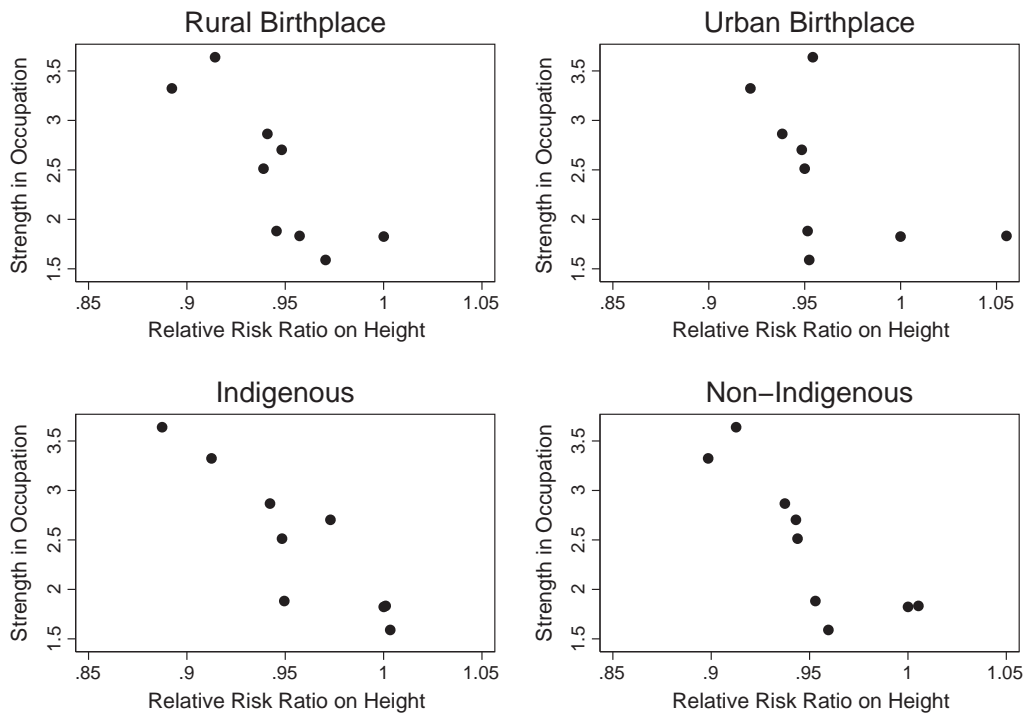


Fig. 5. Heterogeneity in the relationship between height and occupational strength requirements. Notes: Figures plot average occupational strength requirements from the Dictionary of Occupational Titles against the relative risk ratio on height from a multinomial logit regression of occupation on height, age, age squared, and an ethnicity dummy. The reference category is “professionals.”

Table 5
Explaining occupational sorting by height. Logit marginal effects, dependent variable: Pr(brawn occupation), 1 unit = 1% point.

	(1)	(2)	(3)	(4)	(5)	(6)
Height	−0.627*** [0.104]	−0.299*** [0.081]	−0.054** [0.023]	−0.419*** [0.082]	−0.229*** [0.073]	−0.052** [0.023]
Raven score				−5.80*** [0.735]	−3.71*** [0.567]	−0.198 [0.193]
Years of education			−1.10*** [0.105]			−1.08*** [0.113]
Childhood covariates?	No	Yes	No	No	Yes	No
p-value on childhood vars.		<0.001			<0.001	

Notes: The sample includes 7401 observations from 4715 men. Marginal effects from logit estimations, evaluated at the means of all independent variables. Marginal effects are multiplied by 100, so that 1 unit equals 1 percentage point. Brackets contain standard errors clustered at the PSU-level. Regressions are weighted using sample weights and control for year, ethnicity, age, and age squared. The Raven score is standardized to have a standard deviation of 1 across the entire Mexican adult population. The childhood covariates include the father's first job, the father's education, the mother's education, access to piped water and sanitation at age 12, and urban place of birth. To keep the sample sizes adequate, the specifications that control for childhood covariates also include indicators for whether these variables are non-missing. The p-values at the bottom of the table are from joint Chi-squared tests of the coefficients on the actual variables, not the non-missing indicators.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

widely by setting. This paper shows that the origins of the height premium in developing and industrialized economies may be more similar than was previously thought. Much of the height premium accrues across broad occupation and schooling categories. As with Americans and Britons (Case and Paxson, 2006), taller Mexicans sort into occupations with greater cognitive skill requirements and lower physical strength requirements, a pattern almost entirely explained by their greater educational attainment. However, while childhood conditions account for a noteworthy portion of the higher earnings and “brainier” occupations of taller workers, cognitive test scores account for far less. Although their interpretation is ambiguous, these results contribute to previous work on the relative roles of brains and brawn in the link between body size and labor market outcomes in developing countries (Behrmann et al., 2009; Pitt et al., forthcoming; Rosenzweig and Zhang, 2012; Thomas and Strauss, 1997).

The occupational sorting identified here may appear to be at odds with the results of Thomas and Strauss (1997), which show a higher height premium among the self-employed than among wage laborers. Thomas and Strauss interpret this difference as possible evidence for a strength-based height premium, given the tendency of the self-employed to engage in manual labor. In fact, unreported analyses reveal similar patterns in the Mexican data, with a higher height premium among the self-employed. But height is also negatively associated with self-employment, which suggests that the estimates for the self-employed may suffer from selection bias.

Looking toward future research, the paper points in two fruitful directions. First, the Raven's matrix test measures just one dimension of cognitive skill; we would learn much from a richer set of cognitive tests. New work by LaFave and Thomas (2013) makes progress on this front by adding measures of fluid intelligence and word recall. When they include all three measures as covariates, they find a larger proportional reduction in the height premium than I do in this paper, although the residual height premium remains large. The measurement of cognitive skill in adulthood—after schooling investment decisions—is a limitation to both their analysis and mine. Longitudinal data with test scores from early childhood, as in Case and Paxson (2008), would provide a useful extension. Second, this paper has not explored the role of noncognitive skills (Bowles et al., 2001; Heckman et al., 2006). Using data from Sweden, Lundborg et al. (2009) show that height is correlated with measures of noncognitive ability and estimate that this correlation explains a non-negligible share of the height premium. The role of noncognitive ability in explaining the height premium in developing economies is a fruitful topic for future research.

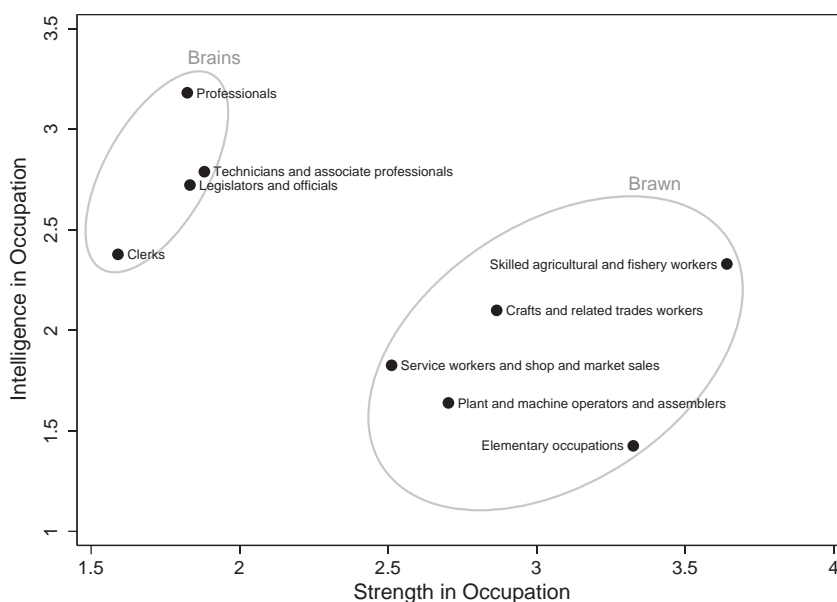
Whatever the explanation for the height premium, it lays bare the profound effects of early-life conditions on later-life outcomes in school and in the labor market. In Mexico as elsewhere, the children of better-off parents experience superior physical growth and cognitive development. These dynamics may play an instrumental role in the intergenerational transmission of economics status. Research that disentangles the mechanisms underlying these relationships—including the returns to height—will help guide policies aimed at improving health and expanding the capability sets of young individuals as they reach adulthood.

Appendix A. Reconciliation of annual and monthly earnings

As described in Section 4 of the text, the Mexican Family Life Survey (MxFLS) includes data on both monthly and annual earnings for wage earners. These data sometimes coincided, but in many cases they did not correspond perfectly. This short Appendix A describes the algorithm used to reconcile any differences and produce a measure of hourly earnings.

For workers employed in the market sector, I used the following procedure. First, some respondents simply reported annual income as twelve times their monthly income, without any adjustment for weeks worked. For individuals in this group who worked at least 48 weeks in their main occupations over the previous year, I used annual earnings, divided by the product of weeks per year and hours per week. For individuals who worked less than 48 weeks, I used the monthly data, divided by 4.35 times hours per week. I repeated this process for any individuals whose reported monthly earnings multiplied by twelve lay within 90 to 110% of their reported annual earnings. For remaining individuals, if the implied hourly wage from the monthly earnings report was within 20% of the implied hourly wage from the annual data, I averaged the two. From here, I settled any remaining discrepancies in individuals who worked less than 48 weeks by using the monthly data. Among discrepant individuals who worked more than 48 weeks, I discarded values that implied hourly earnings of greater than 200 pesos or less than 1 peso, which correspond to the top and bottom 0.5% of the wage distribution from census data. Finally, if remaining discrepant observations were professionals, technical workers, or directors, I used annual data. For the remaining occupations, I used monthly earnings.

For self-employed workers, I followed the same procedure, except that in the final step, I used monthly earnings for all workers, regardless of occupation.



Appendix Fig. 1. Intelligence aptitude and strength requirements in the ISCO. Notes: The figure displays average Dictionary of Occupational Titles intelligence aptitude and strength requirement scores in occupation categories from the International Standard Classification of Occupations (ISCO). The brains/brawn categorization is the author's creation.

Appendix Table 1

Imputed earnings regressions. OLS estimates, dependent variable: Ln(sectoral earnings score).

	All workers (1)	Workers with non-missing earnings (2)
Height (cm)	0.016*** [0.002]	0.014*** [0.002]
Age	0.033*** [0.006]	0.039*** [0.007]
Age Squared	-0.00047*** [0.00007]	-0.0005*** [0.00009]
Indigenous	-0.210*** [0.048]	-0.179*** [0.050]
# of observations	7793	5103
# of individuals	4930	3782

Notes: Brackets contain standard errors clustered at the PSU level. The sectoral earnings score is the average hourly earnings in the worker's occupation–industry–education cell in the 2000 Mexican census. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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