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THE TALL AND THE SHORT OF THE RETURNS TO HEIGHT

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ABSTRACT

We revisit the US evidence of the association of height with socioeconomic status. We document non linear height profiles that are different for males and females. For males the profile is a spline function with a single node at mean height. Below mean height there is a sharply positive slope with height, while the function is roughly horizontal above the mean. For females the spline has two nodes. There is positive slope below mean height and in the top 10 percent of heights, and the profile is roughly horizontal between the mean and the 90th percentile. Remarkably, these stylized profiles describe the association of height with socioeconomic outcomes ranging from teenage cognitive scores to adult poverty, suggesting a common origin. We investigate some of the implications of these findings for analyses of the contributions of cognitive and non cognitive skills to the height profile in wages.

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1. Introduction

Variation in social, health and economic outcomes by height is studied in the humanities, medicine, public health and the social sciences. This research reports that taller people have advantages ranging from higher wages and educational achievement through higher overall life satisfaction, but also face higher probabilities of certain morbidities (e.g., Deaton and Arora 2009, Case and Paxson 2010). Possible explanations for the relationship of height with any of these outcomes include genes, the environment and discrimination, and the relative roles of these different factors remains an open question.

In this paper we revisit the US evidence of the association of height with socioeconomic (SES) status using the National Health Interview Survey (NHIS). This survey provides much larger sample sizes than the data sources used in previous investigations, and this advantage leads to our first contribution.[1] We estimate single inch height profiles, and find distinct, non linear profiles for US males and females which are common to a range of outcomes. For males, the profile is roughly a spline function with a single node at mean height. Below mean height SES varies positively with height, while above mean height the profile has little slope. For females the profile is a spline with two nodes. SES varies positively with height below the mean and in the top 10 percent of heights, while the profile is roughly horizontal between mean height and the 90th percentile. Remarkably, these same stylized profiles describe the association of height with SES outcomes ranging from teenage cognitive scores to adult poverty.

Our second contribution is using these findings as an additional source of identification in the horse race regressions used in research on the returns to height. Typically researchers regress

[1] Case and Paxson (2006) examine the relationship between height and occupational skills using the NHIS. This study is discussed in footnote 12.

some outcome, for example wages, on measures of height, and then add explanatory variables that proxy for various hypotheses of the source of the outcome/height profile. The explanatory variables leading to the greater attenuation in the estimates of the height profile variables are awarded the greater causal relevance. Therefore, sorting among the causal claims of the various hypotheses is an "empirical question".

The fact that a common, non linear height profile characterizes so many outcomes across the lifecycle provides some additional leverage for distinguishing among the competing hypotheses. The logic is analogous to that for the regression kink design. To be specific, if the outcome in the regression shares a common kink, or spline node, in its height profile with the height profile of one of the explanatory variables, but not with the height profiles of the others, we would expect the former explanatory variable to have greater empirical relevance, and the empirical relevance to more likely reflect causal relevance.

As application, we take this intuition to the research exploring how teenage measures of cognitive and non cognitive skills account for the adult height profile in wages in the US. For males, if we specify a linear height profile, we find that the account of cognitive skills is roughly 50 percent greater than the account of non cognitive skills. However, when we more appropriately specify a non linear height profile, the account of cognitive skills grows to 3 to 6 times the account of non cognitive skills particularly for variation below mean height. For females the inference is different in two interesting ways. First, while the relative role of cognitive skills is again enhanced when a non linear height profile is specified, the account of non cognitive skills is not as diminished to the extent as in the male case. Second, in comparison to other height intervals, neither cognitive or non cognitive skills make significant inroads accounting for the variation of wages over the tallest females.

Underlying these results, we show that the measures of teenage cognitive skills display the same distinctive non linear height profiles we document for adult outcomes. In contrast, the measures of non cognitive skills do not. Adding to the evidence in Case and Paxson (2008), these results suggest that variation of these socioeconomic outcomes with height primarily reflects some factor which manifests in the cognitive scores of children, rather than some later life environmental influence.

In the next section we review previous studies of the association of height with various SES outcomes in the US. Section 3 provides a description of the data and our empirical framework. In sections 4 and 5, we document the pervasiveness of the common, gender specific, non linear height profiles in socioeconomic outcomes. In Section 6 we show how the variation in these outcomes below mean height compares to their variation by race/ethnicity. In Section 7 we document the height profiles in teenage measures of cognitive and non cognitive skills and compare them to the height profiles in adult outcomes. Section 8 contains an analysis of how the adult height profile in wages is related to these measures of teenage cognitive and non cognitive scores. In section 9 we compare our results to evidence of non linear height profiles in wages and income from other countries. Section 10 contains discussion and conclusions.

2. Previous US Evidence

As noted by Case and Paxson (2008), the study of the relationship between height and socioeconomic status in the US dates back more than a century (e.g., Gowin 1915). For example, Komlos (1987) and Steckel (1992) present evidence from the 19th century.

More recent research leans heavily on panel data sets such as the National Longitudinal Survey of Youth (NLSY79). Two prominent recent papers using this type of data are Persico et al. (2004) and Case and Paxson (2008). Persico et al. (2004) document a wage return of 2.5

percent per inch in a sample of white males who work full time in the NLSY79. Case and Paxson (2008) present comparable estimates for broader samples from the Panel Study of Income Dynamics (PSID) of just under 2 percent per inch for males and 1.2 percent per inch for females. Mankiw and Weinzierl (2010) also use data for white males in the NLSY79, obtaining a result quite close to Persico et al. (2004).

Case and Paxson (2008) also document a positive relationship between childhood (age 5-6) height and childhood test scores among the children of the NLSY79. The estimated associations are just over 5 percent of a standard deviation per inch in the full sample, and a little more than half that using sibling differences, at both ages 3 and 5. They also report obtaining similar results for males and females. Case and Paxson (2010) provide evidence of the association of height with a wider array of SES and health outcomes based on NLSY79, PSID and Health and Retirement Study data. Pursuing the source, they document the association, within families, of mothers' behaviors through pregnancy and birth conditions with their children's stature. Bleakley et al. (2014) investigate the relationship between height and educational attainment for American males using an array of historical and more current data sets (including the NLSY79). They report a range of estimates that decline over time. A centimeter of height is associated with 0.08 more years of schooling among WW2 enlistees falling to just under 0.04 years for more recent cohorts in the in the National Health and Nutrition Examination Survey (NHANES) and the National Health Interview Survey (NHIS).

While there remain unresolved debates in this literature,[2] a consensus from the studies reviewed is that height varies linearly with wages and childhood measures of skills, and the

[2] Notable here is the relative roles of cognitive and non cognitive skills in accounting for the wage/height profile. See Persico et a. (2004) and Case and Paxson (2008).

variation is fairly similar for females and males. The linearity of the variation reflects the majority of the existing evidence, but it is primarily by assumption rather than evidence, most likely a concession to the relatively small sample sizes of these surveys.

Before preceding we also note that studies for other countries have documented non linearity in the income/height relationship for males. We return to this research below as points of agreement and contrast to the results we present.

3. Data and Empirical Framework

To examine the variation of various socioeconomic outcomes by height we use data from the NHIS. This is a national, representative survey of the American population with a primary focus on health outcomes. For our purposes it captures self reported height; highest level of education; race/ethnicity; in some years 3-digit occupation; self reported health; and the poverty status of the household. Much of our evidence is based on the 1990-1994 NHIS. These are survey years that offer detailed occupational coding and match well with the 1991 edition of the Dictionary of Occupational Titles and 1990 census, which we use in some of the occupational analysis. It is also a period in which the response rate to the NHIS averaged near 95 percent (Lucas et al. 2006, Moriarity and Dahlhamer 2012). We also obtain evidence from later years of this survey (2010-2013) to examine stability in the height profiles over time. However, it is important to note that response rates in the NHIS have fallen over time, dropping by more than 10 percentage points between the mid 1990s and 2010 (Czajka and Beyler 2016). Except where noted, we select samples of adults aged 25-59. This is to be more certain that formal human capital investments are complete and adult height has been obtained, and to avoid sample selection issues in some of the outcomes due to retirement.

The NHIS surveys record self reported height. Doctor or interviewer recorded height would be preferable because validation studies have revealed error in the self reports of this variable. As explained below we also examine data from the NHANES to discover if the self report of heights in the NHIS is materially affecting our results.

We also use data from the NLSY79 to investigate the height profiles in teenage cognitive and non cognitive skills and their contributions to the height profiles of adult wages. The NLSY79 first surveyed a sample of 14-21 year olds in 1979, with follow-ups annually until 1994 and every two years thereafter. Each wave asks questions about completed education and earnings. Because there is sample attrition over time, we use a relatively early wave – 1990 – for our analysis. This is the earliest year in which all respondents are at least 25 years of age, which helps ensure that we are measuring completed education. To maximize sample size, we follow the approach Lang and Manove (2011) and use a 3 year average of wages from 1989, 1990 and 1991. This procedure allows us to include individuals who do not report wages in 1990. Self-reported height is available in the 1981, 1982 and 1985 waves, and every survey year from 2006-2014. We use the 1985 wave because it is the year closest to the time when our wage and education variables are measured. The NLSY79 also contains each respondent's Armed Forces Qualification Test (AFQT) score (recorded in 1981), as well as a wide variety of personality and attitudinal measures.

A canonical empirical model in the literature is a regression of some human developmental or economic outcome y on a measure of height at a certain age, h, and control variables X.

$$y_i = \sigma + \kappa h_i + X\psi + \nu_i$$

In many if not most applications the model is linear in all variables. Any estimated relationship between the outcome and height is usually interpreted as proxying for an underlying relationship between the outcome and some unobserved factor which is correlated with height. For example, Case and Paxson (2008) discuss a model in which an endowment influences both height and cognitive ability. Wages (the outcome) are related to cognitive ability. In this case, the relationship between height and wages will reflect the association of cognitive ability and height through the endowment. However, there are alternative interpretations in which, for example, height is a proxy for an underlying relationship between the outcome and non cognitive skills (e.g., Persico et al. 2004).

In many applications empirically distinguishing among alternative models reduces to a "horse race" regression (e.g., Case and Paxson 2010). How is the estimated coefficient on height in the wage regression affected as direct measures of cognitive and non cognitive skills are added as control variables (e.g., Persico et al. 2004, Case and Paxson 2008, Lundborg et al. 2014, Schick and Steckel 2015)? How is the estimated coefficient on adult height affected as measures of height at different ages are added to the regression (e.g., Persico et al. 2004, Case and Paxson 2008)? An important consideration in this approach is that all permutations of the entry of these explanatory variables to the regression are considered.

In some cases, additional identifying information comes from the assumed underlying model of the relationship between height and economic outcomes. For example, the model in Case and Paxson (2008) implies a testable relationship between cognitive ability and the age of adolescent growth spurts.

Our base parametrization of the height profile, where sample sizes allow, is at the same level of detail as the responses in the surveys. Specifically, we regress, by sex, various outcomes on single inch height dummy variables and a minimal set of controls.

(1) $ED_i = \alpha + H\gamma + X\beta + \varepsilon_i$

where, for example, ED_i is a measure of completed education, *H* is a vector of (single inch) height dummy variables (the dummy for mean height is excluded), and *X,* which initially includes age (single year), region, race/ethnicity (African American, Hispanic, "other"), foreign birth and indicators for survey year (where necessary).

For the analyses of surveys with smaller samples, and also as a means of summary, we reparametrize the height dummy variables to capture larger ranges in height. We continue to omit mean height and then add dummies to roughly divide heights on each side of the mean into equal segments. As example, for the analysis of males in the NLSY79 the regression is

(2) $ED_i = \theta + \pi_1 HLT68_i + \pi_2 H6869_i + \pi_3 H7172_i + \pi_4 HGT72_i + X\tau + \omega_i$

where the height dummy variables capture the intervals less than 68", 68"-69", 71"-72" and greater than 72" and the omitted category is 70".

As noted in the Introduction, we document the similarity of the height profiles that characterize socioeconomic outcomes spanning the lifespans of males and females. We also highlight these similarities as an additional source of identification sorting among alternative accounts of the association of height with outcomes in the horse race framework. Our interpretation of our findings leans on the fact that the outcomes examined share a similar height profile with some of these accounts and not with others.

4. The Height Profile in Completed Education and Occupational Choice

In table 1 we report summary statistics, by sex, for the self reported heights reported in the NHIS data. Average height is 70” for males and 64” for females. For males, the interquartile and 90/10 percentile ranges are +/- 2 and 4 inches from the mean. For females there is a similar progression above mean height, but the 25th and 10th percentiles are one and three inches below mean height, respectively.

We begin the analysis with, perhaps, the most studied determinant of labor market earnings—formal education. In figure 1 we graph the height profile (estimates of γ), with 95 percent confidence intervals,[3] for years of completed education in the 1990-94 NHIS. We specify a full set of height dummy variables in the estimation, but report estimates for the height ranges 63” though 76” for males and 59” though 70” for females in the figures.[4] Note that the markers for 70” (males) and 64” (females) are located at 0 and have no confidence interval indicating the omitted category.

The results for males in the first panel exhibit three distinct features. First, there is little economically or statistically significant variation in completed education with height above mean height. Second, and in contrast, the variation below mean height is both statistically and economically significant. At one inch below the mean it is almost one half a year, and at the 10th percentile of height (66”) it is over one year. Third, there is a remarkable asymmetry directly around mean height—the difference in completed education is much greater one inch below the

[3] We estimate robust standard errors.

[4] In both cases this omits about 4 percent of the distribution of heights. While the 1990-94 NHIS include all heights reported, the 2010-13 NHIS only reports height between 63” and 76” for males and 59” and 70” for females. Furthermore, other heights are not observed if the individual reported a weight that was outside bottom coding and top coding for this variable. Adding controls for weight (single pound) does not substantively change the height profiles of completed education.

mean than one inch above. It is clear in this figure that specifying a linear relationship between height and completed education would completely miss the very different variation of education with height above and below the mean.

Figure 1 also presents the profile omitting African Americans and Hispanics from the sample, to discover if variation in height and completed education levels across these groups is confounding the inference. While the educational deficits at shorter heights are smaller making this omission, the spline like profile with a node at mean height remains.

Because it is not obvious how differences in completed years of education map into degrees and diplomas, we have also estimated these profiles for significant milestones of educational attainment (not reported).[5] Each displays similar non linearity. For example, at a height just one inch below the mean, the "no high school diploma" rate is almost one-third higher than at average height, which was 11 percent (or 10 percent for non-Hispanic whites) in 1990-94 (see also figure B2 in appendix B). At two inches below mean height, the 4 year college degree or higher rate is more than 18 percent lower than at mean height, while at two inches above mean height it is roughly the same.

We have considered how our inference might be confounded by a) the fact that we observe self reported, rather than exam recorded, height in the NHIS, b) changes in average height and educational attainment by birth cohort, and c) any relationship between height and weight. In appendix B we compare the height profiles for the no high school diploma outcome[6] in the NHIS and in the NHANES, which records both self reported height and examination recorded height. While there is no doubt some error in the self report of height, it does not

[5] These results are available on request. The profiles for not completing a high school diploma from the 2010-13 NHIS are reported in appendix B.
[6] Years of completed education are not available in the public use NHANES.

appear to affect our inference for the height profiles of educational attainment.[7] Estimates of separate height profiles (not reported) for the 25-40 and 41-59 age intervals display similar patterns, as do the height profiles from the 2010-13 NHIS (see appendix A). Thus the fact that older cohorts are both shorter (the variation of average height by age is 0.59 inches in our sample) and less educated is not driving our results. Finally, the height profile estimated conditional on single pound weight dummy variables (not reported) is very similar to the one reported in figure 1.

In the second panel of figure 1 is the profile for females. It exhibits both similarities to, and differences from, the male profile. There is significant variation in educational attainment below, and asymmetry around, mean height, although the range is smaller than for males.[8] What's new here is the positive variation in completed education within the upper 10 percent heights. Again a linear specification of the height profile would miss the different associations of height with education across the distribution. In profiles not shown, the estimates for no high school diploma at heights 61" through 63" are more than twice, in absolute value, the estimates at heights 65" through 67". At 3 inches below mean height, college attainment is lower by almost 5 percentage points or 22 percent, while at 3 inches above the mean it is just over 1 percentage point higher.

A potential limitation of the NHIS is that it does not record labor market earnings or wages. There is a trade off, however, because its much larger sample size than US surveys that record both height and wages permits the estimation of the granular height profiles in figure 1.

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[7] Persico et al. (2004) come to a similar conclusion for their inference comparing self reported and exam recorded heights in the NCDS.

[8] For females, conditioning on weight the differences by height are marginally larger and the profile retains the same shape as in figure 1.

We can, however, examine the height profile in occupational earnings, an important component of total earnings. The occupational component of earnings will capture more of the permanent part of labor market compensation relative to total earnings in which more transitory components play a role. Also, previous research indicates that occupational choice is a primary mediator of the height profile in earnings or wages (e.g., Case et al 2009, Lundborg et al. 2014).[9]

The 1990-94 NHIS provides information on respondents' detailed (3 digit) occupation.[10] We calculate average annual earnings at this occupational level by sex, using a similarly selected sample from the 1990 US census. We next assign these averages to NHIS respondents based on their reported occupations. We then estimate equation (1) using the log of these averages as the dependent variable.

The results are reported in figure 2.[11] For both males and females the profiles are very similar to those observed for completed education in figure 1. For males, it is effectively a spline function, with a node at mean height and a positive slope below the mean but a zero slope above. For females, it is a spline with two nodes, one at mean height and one at the 90th percentile. For males this component of earnings varies by over 15 percent below mean height, while for females the variation is less than 10 percent. For both males and females we also plot the profiles when we add completed education as an additional control. Because of the similarity of the height profiles in the two outcomes, the impact of the modification is as expected. Education

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[9] Case et al. (2009) demonstrate that in a wage regression the estimated coefficient on height is significantly attenuated when additional controls for educational attainment and occupational fixed effects are added as control variables. Likewise, Lundborg et al. (2014) demonstrate that for males occupational fixed effects attenuate the association between height and earnings at shorter heights, indicating that very short people sort into lower paying occupations

[10] The 1990-1994 NHIS contains a detailed occupation variable with coding that corresponds to the 1990 Census occupational classification.

[11] Excluding African Americans and Hispanics from the sample does not substantially change the inference (estimates not shown). We cluster the standard errors by occupation.

attenuates the male height profile below mean height where both education and occupational earnings vary with height but has little impact above mean height where they do not. Similarly, an impact of adding education is observed for the female height profile at heights below the mean and in the upper 10 percentiles.

The attenuation of the height profile in occupational earnings conditional on completed education suggests we are observing some underlying variation of height with skills. We push this hypothesis forward by ranking occupations by their underlying skill level.[12] To do this we merge Dictionary of Occupational Title (DOT) data (1991 edition) to our 1990-94 sample. We construct the different routine and non routine task constructs as proposed by Autor et al. (2003). We then standardize each task to have 0 mean and unit standard deviation and then assign the task content of NHIS respondents' employment based on their reported 3-digit occupation. These estimates of occupational task content then serve as a dependent variable in (1).[13]

By these definitions, Autor and Price (2013) show that non routine analytical and interpersonal skills are in the ascendency in the American labor market over the past four to five decades, while manual and routine cognitive skills are in the decline. In figure 3 we report the height profiles for Non Routine Interpersonal skills and Routine Cognitive skills, the skills that saw the largest increase or decline over the period 1960 through 2010. For males, we see the height profiles observed in figures 1 and 2. At a height of two inches below the mean (the 25th percentile) the content of Non Routine Interpersonal skill is 10 percent of a standard deviation

[12] Case and Paxson (2006) investigate how height is related to occupational characteristics in the NHIS using a linear specification of the height profile. They demonstrate that height is positively correlated with selection into occupations which require greater use of cognitive skills and negatively correlated with selection into occupation which require greater physical skills.
[13] Excluding African Americans and Hispanics from the sample produce does not substantially change the inference (estimates not shown).

lower, and the content of Routine Cognitive skill just over 5 percent of a standard deviation higher, than at mean height. The estimates for those in the bottom quartile of height are substantially larger. For females the profiles also mirror the results in figures 1 and 2, except the variation in the upper 10 percent of heights is attenuated for Routine Cognitive skill.

Some argue that taller people have an advantage in interpersonal skills so the profiles in Non Routine Interpersonal skills might be expected. However, the profile for Non Routine Analytic skill for males (not reported), the other task in ascendancy over the period, is similar to that for Non Routine Interpersonal, but it spans a larger interval (for males over 30 percent of a standard deviation) at shorter heights.[14]

5. The Height Profile in Poverty and Self Reported Health

Given the preceding evidence of common non linear profiles in important determinants of labour market compensation, we might predict similar non linear profiles in other measures of socioeconomic status. We examine two markers of socioeconomic wellbeing—measured poverty and self reported health—to check this hypothesis.

The height profiles for a measure of household poverty are reported in figure 4.[15] For males the profile mirrors the profiles in completed education and occupational choice. The poverty rate at average height is 5 percent, as it is at most taller heights. In contrast, at lower heights it rises in excess of 6 percentage points. For females we see the greater variation at

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[14] The height profile for routine manual skills is flatter for both sexes.

[15] The measure of poverty is based family size, number of children under 18 years of age and family income using poverty levels derived from the Current Population Survey from the same year. Producing poverty rates from the NHIS comparable to those from other sources is not straightforward (Czajka and Denmead 2008). Here we simply code persons as in poverty as per the survey supplied indicator that the individual's household income is below the poverty line

heights below the mean, but not so prominently the variation at the very tallest heights. The poverty rate at average height for females is 8 percent.

Because stature is sometimes interpreted as a proxy for physical nutrition and development, the self reported measure of overall health from the NHIS is also of interest. However, this outcome may also capture some part of labor market outcomes. Justification bias raises the possibility that causality runs from poorer labour market outcomes through to poorer reported health outcomes.

The height profiles are reported in figure 5 for a 0/1 indicator that the respondent reports either excellent or very good health. The height profile for males is the now familiar spline with a node at mean height. The height profile for females shows greater resemblance to the male profile for this outcome. It lacks a strong positive association between height and health at the tallest heights. The profiles for self reported health from the 2010-13 NHIS, reported in figure A2 of appendix A, are very similar.

6. How Significant is the Variation in Socioeconomic Outcomes Below Mean Height?

The preceding evidence is that a common, gender specific, profile describes the variation of permanent and more transitory measures of economic status with height within the American population. Is the resulting variation in status by height economically significant?

We focus on the variation below mean height, as it is substantial for both males and females, comparing it to corresponding inequality by race/ethnicity. We re-specify the controls for height in our regression equation as dummy variables for (approximately) the bottom decile, the 10^{th} through the 30^{th} percentiles, and the 30^{th} through 50^{th} percentiles of the height distribution. In table 2 we report estimates of the dummy variables for the two shortest height categories and for dummy variables for African Americans and Hispanics from these regressions.

For both females and males, height in the bottom 12-13 percent of the distribution is a marker of lower educational outcomes that is persistent over time and economically significant in its magnitude. It is comparable in magnitude to the outcomes for African Americans. Height in the next roughly 20 percentiles is again a persistent indicator of lower educational attainment, but the estimates are roughly half of those for the bottom decile.

The estimates for the employment rate for the bottom decile for males sit amidst the estimates for African Americans and Hispanics, while for the shortest females the inference is more period specific. For excellent or very good health, among males the estimate for the shortest 12 percent of height is similar to those for African Americans and Hispanics, while for females it is negative but about half as large.

7. The Height Profiles in Cognitive and Non Cognitive Skills

Much of the economic research on height has been devoted to the height profile in earnings or wages. In attempting to account for this height profile, researchers have turned to widely acknowledged ingredients of labor market success—cognitive and non cognitive skills. The preceding evidence is primarily for precedents—education, occupational skills—and antecedents—poverty—of labor market compensation. Inasmuch, we might expect cognitive and non cognitive skills to have similar height profiles as these outcomes. In fact, we might better distinguish their relevance, if these skills were discovered to differentially exhibit the common, sex specific height profiles.

We next document the non linearity in the height profiles of measures of cognitive and non cognitive skills used in the US research. We use data from the NLSY79. The primary measure of cognitive skill in the NLSY79 is the AFQT. As measures of non cognitive skills we follow research that has used the NLSY79 (i.e., Persico et al. 2004). These are variables capturing participation in social activities during high school and the Rosenberg index of self-esteem, which was measured when the respondents were young adults.[16]

An overview of the inference is provided in figures 6 and 7. We plot estimates of the single inch adult height profiles from (1) for these measures of cognitive and non cognitive skills. The male height profile for AFQT percentiles (figure 6) strongly echoes the height profiles for the socioeconomic outcomes in the NHIS. It is sharply non linear, asymmetric around the mean and there is little to no return to height above the mean. Individuals in the bottom decile of heights score almost 30 percentiles lower than men of mean height. For women the height profile for AFQT scores displays a less distinct variation across mean height than observed in the NHIS outcomes, but there is familiar variation below the mean and in the upper 10 percent of heights.

In figure 7 are the height profiles for high school social activities from the NLCY79. The profile for males is different than the profiles for the other outcomes. There is no sharp break at mean height, and no monotonic decline in activity in the lower percentiles. In contrast, for females there is systematically lower activity at the shorter heights.[17]

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[16] Social participation, "activities", is measured as the number of organizations or other extra-curricular activities the respondent participated in in high school. The measure ranges from 0 to 7 with a mean of 1.53 and 1.23 for females and males respectively, and a standard deviation of 1.59 and 1.36. Self-esteem is measured using the Rosenberg self-esteem scale, which is a measure that runs from 0 to 40 with higher values indicating higher self-esteem. Self-esteem was measured in 1987, when the respondents were 22-29 years old. The sample means are 22.41 and 22.77 for females and males respectively, with standard deviations of 4.15 and 3.99.

[17] We have also examined an array of other measures of non cognitive skills that were collected at older ages (in 2014). These include: two personality traits related to emotional stability (calm/emotionally stable and anxious/easily upset), two traits related to responsibility (dependable/self-disciplined and disorganized/careless), and four traits related to social skills (extraverted/enthusiastic, sympathetic/warm, reserved/quiet, and critical/quarrelsome.). Each is measured using participants' self-assessed ratings of pairs of personality traits on a scale of 1 to

In table 3 we formalize this inference presenting estimates of (2) for these measures of cognitive and non cognitive skills. For males, the estimates for AFQT are true to figure 6, with deficits 5.5 and 13+ percentiles at the lower height intervals which are 19 and 44 percent of a standard deviation, respectively. For the two non cognitive measures, there are also negative, statistically significant estimates for the shortest height interval but these are smaller in context, representing 16 percent of standard deviation for social activities and 20 percent of a standard deviation for the Rosenberg measure of self esteem. For females, the differences in AFQT are 18 percent of a standard deviation for the shortest interval and 16 percent for the tallest. The estimates for the non cognitive measures display more linear progression through the distribution of heights, although figure 7 indicates that this is driven by the tails of the height distribution. Also, there is no remarkable increase in the scores for the tallest height category. The corresponding estimates from the sample of non Hispanic whites (not shown) are almost identical to those for the full sample.

Previous research using AFQT in the NLSY79 as a measure of cognitive skills have acknowledged a number of limitations (e.g., Neal and Johnson 1996, Lang and Manove 2011). One criticism is that rather than capturing underlying cognitive skills, AFQT may instead be a proxy for completed education or socioeconomic advantage. In appendix C we investigate the impact of environmental factors on the relationship between height and AFQT to help sharpen its interpretation. There we show that neither controlling for family income or measures of school quality significantly changes the non linear relationships between this measure of skills and height for males or females.

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7. The majority of the height profile estimates from (2) for these traits are economically and statistically insignificant.

In appendix D we take a different tack, drawing on data from the UK National Child Development Study (NCDS). The NCDS has figured prominently in past research on the relationship between height and wages. Also, many studies have used data from both the US and UK and demonstrated some common features of the height wage and height/test score relationship in the two countries.[18] An advantage of the NCDS is that it provides exam recorded height and measures of cognitive and non cognitive skills from much earlier ages that the AFQT. The analysis of these data (figure D1) reveals that the adult height profiles of age 7 math and reading scores exhibit the distinctive male and female profiles we have documented for US outcomes. Also, the adult height profiles in measures of age 7 non cognitive scores do not.

This analysis shows that the adult height profiles in teenage cognitive skills foretell the profiles found in the adult socioeconomic outcomes. They provide a graphic example of how the distribution of adult outcomes can be set early in life, a theme that has dominated social science research since the work of Barker (1990). In contrast, the profiles for teenage non cognitive skills exhibit less similarity to the adult profiles. This suggests these cognitive skills may find greater resonance in accounting for the height profiles in adult outcomes.

8. Wages, Cognitive and Non Cognitive Skills

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[18] For example, the wage returns to height in the UK are quite similar. Case and Paxson (2008) report estimates of the wage return to an inch of height from the NCDS and the British Cohort Study (BCS) ranging from 1 to 2.3 percent for males and from 1.5 to 1.9 percent for females. Persico et al (2004) report estimates ranging for 2.2 to 2.7 percent per inch of adult height for males in the NCDS, but also that this return is primarily for teenage rather than adult height when both measures are entered in the estimating equation. Schick and Steckel (2015) report estimates of 2.2 percent per inch for males and 1.9 percent per inch for females from the NCDS. For skills, Schick and Steckel (2015) estimate that a roughly 2 inch increase in age 7 height is associated with just over a 0.1 standard deviation increase in age 11 math and reading scores for both girls and boys, controlling for an array of background factors. Case and Paxson (2008) report comparable estimates from the NCDS as well as from the BCS (in which extended controls make a larger difference). Again the estimates for boys and girls are very similar.

The preceding evidence that adult socioeconomic outcomes and childhood cognitive scores share a common height profile, may provide leverage to distinguish the impact of different accounts of the association of outcomes with height in the horse race regressions used in the literature. To explore this hypothesis, as an example we re-examine the relationship between height and wages in US.

In table 4 are the results of regressing males' log wages on various specifications of the height profile, alternatively adding controls for cognitive (AFQT) skills, non-cognitive (social participation and self esteem) skills and their combination using the NLSY79. In the first panel are the results for a linear height profile. The return to height in the first column is 1.8 percent per inch, which is just a bit smaller than the estimates for American males in Persico et al. (2004) and Case and Paxson (2008). The next columns reveal that, on their own, cognitive and non cognitive skills can account for 44 percent and 28 percent of the estimated correlation of height with wages, respectively. Together their account is 50 percent, and the marginal contribution of cognitive skills conditional on non cognitive skills is much larger than the reverse.

In the next two panels, are the estimates substituting the height profile according to (2). In the first column is the familiar male non linear height profile, except that the point estimates indicate a modest wage premium for the tallest males. In the full sample, adding cognitive skills to the regression attenuates the estimates for the two height intervals below the mean by 57 to 69 percent. In contrast adding non cognitive skills accounts for 10 to 28 percent of these estimates. Furthermore, conditional on cognitive skills, the measures of non cognitive skills have little impact on the estimates for these heights, while conditional on non cognitive skills, cognitive skills have a substantive impact, especially for height just below the mean. At heights above the mean, these skills have much less traction. At the tallest heights non cognitive skills make a modest contribution, while these males are, if anything, over paid for their cognitive skills, consistent with the relatively flat profile of AFQT scores at these heights (figure 6). Restricting the sample to non Hispanic whites makes little difference to this inference.

The corresponding results for females are presented in table 5. In the linear height specification, the gross return to height is 2.1 percent per inch. Cognitive skills can account for 38 percent of this correlation, while non cognitive skills can account for 24 percent. Again cognitive skills make the larger contribution conditional on non cognitive skills, than vice versa.

Substituting the height profile according to (2), there is a statistically significant wage deficit at the shortest heights and wage premium at the tallest heights. The estimates at heights around the mean are both statistically insignificant, but the point estimates indicate a larger return above than below mean height. At heights below the mean, adding cognitive skills to the regression attenuates the estimates as much as 65 percent. The impact of adding non cognitive skills is smaller, but not as dramatically different as it was for male heights below the mean. An additional distinction of the female case is what little effect either measure of skills has for the estimated wage return for taller females. While the measure of cognitive skill does appear to have a larger effect, net of all the measures of skills the wage return to the tallest height remains substantive and statistically significant.

The message here for males is that conditional on a non linear specification of the height profile in wages, measures of cognitive skills provide a much greater account of the association of wages with height below mean height than measures of non cognitive skills. [19] This message is missed specifying a linear specification of the height profile. It is important to note that the

[19] This conclusion is robust to specifying low order polynomials in the measures of cognitive and non cognitive skills—the account of cognitive skills is marginally enhanced while the account of non cognitive skills is unchanged.

measures of non cognitive skills have statistically significant and substantive direct associations with wages. However, adding them to the regression has relatively less impact on the estimates of the height profile. Correspondingly, as demonstrated in figure 7 and table 3, their variation with height displays less coherence with the height profiles in wages and the other outcomes studied here, than the height profile in AFQT.

For females, the inference is not so dependent on specifying a non linear versus linear height profile, although the height profile in wages is clearly non linear. Relative to the male case, the account of cognitive skills is more marginally enhanced moving to a non linear profile. Where this difference in specification does make a difference is for taller females. Across an array of outcomes the very tallest US females experience a positive return to their stature. We are unaware of previous documentation of this finding. The results in table 5 indicate that neither measures of cognitive of non cognitive skills make a substantive account of this association. Again, this story is missed in the linear specification of the height profile.

9. Other Evidence of Non-linearities in Height Profiles

Many studies analyze both US and UK data and have documented similarities in the wage and skill returns to height in these two countries (see footnote 18). While much of this analysis has been conducted with a linear specification of the height profile, an important exception is Schick and Steckel (2005), who plot the results of estimating a spline specification for wages that divides NCDS males' heights into 5 intervals. The results indicate that the height profile in males' wages plateaus at 72 inches of height. Related is the evidence of Heineck (2009) of a quadratic relationship between wages and height in the British Household Panel Survey. As noted above, in appendix D we document that in the NCDS, age 7 math and reading scores display similar height profiles to the height profiles for AFQT from the NLSY79, and the NHIS SES outcomes, while the age 7 behavior scores do not.

Lundborg et al. (2014) investigate the income returns to height for Swedish males using administrative data on military enlistees. While the analysis is initially conducted using a linear specification of the height profile, in the final section of the paper the analysis is extended to a specification using single centimetre height dummy variables and piecewise linear models. The unconditional estimates of the centimeter dummy variables specification reveal a profile with a "slightly concave" shape, with greater slope below mean height.[20] The authors also report the changes in these returns to height, sequentially controlling for cognitive skills, then non cognitive skills and finally handgrip strength.[21] In the linear specification cognitive skills can account for 23 percent of the returns while adding non cognitive skills can account for an additional 10 percent. Because the model includes sibling fixed effects, the estimated absolute contributions of these skills may be attenuated relative to an analysis across families. These relative contributions remain roughly the same within the 7 centimeter height intervals when the height profile is specified piecewise linear.[22] Also of note is that handgrip strength can account for an additional 8 to 15 percent of the returns to height conditional on the other skills, across specifications and height.

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[20] The income return to 7 centimeters (roughly 2 ¾ inches) of height from the piecewise linear specification is 13.2 percent at the shortest heights, 7.2 percent at heights just below and including median height, 4.1 percent at heights just above median height and a statistically insignificant 1.9 percent at heights 189 centimeters (almost 6'2.5") and higher.

[21] Age 18 measures of cognitive skills, non cognitive skills and handgrip strength collected in the enlistment process.

[22] For heights between 165 and 188 centimeters (roughly 5'5" to 6'2") the account of cognitive skills ranges from 18 to 29 percent, while the contribution of estimate of non cognitive skills ranges from 10 to 14 percent. The exception is the interval for heights above 188 centimeters in which the skills measures incrementally add very little relative to the sibling fixed effects.

Relative to the inference here, there is no strongly enhanced role of cognitive skills once the authors make allowance for a non linear profile.[23] However, also in contrast to the evidence here the age 18 measures of cognitive skills, non cognitive skills and hand grip strength for Swedish males vary linearly with height throughout most of the height distribution (figure 2, p. 153). There is no obvious visual connection between the non linear variation of income with height and the variation of one of these skills with height.

Finally, Kim and Han (2017) investigate the returns to height for monthly earnings in South Korea. They show (figure 1) that the unadjusted relationship between height and monthly wages of Korean males plateaus at the mean height in their sample, very similar to the height profiles for males documented here for the US. This finding is of particular interest because the average height of Korean males, the point of the start of the plateau, at 67", is considerably less than of the American males we analyze (70"). The profiles for females are roughly linear throughout the height distributions in contrast to the evidence for American females. The authors parameterize the height profile in 5 centimetre (roughly 2 inch) intervals and conclude that conditioning on a variety of demographic and economic characteristics, the estimates for males indicate that the increase of earnings with height exhibits "…leveling-off at approximately the average height" (p. 16).[24]

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[23] It is not possible to determine whether cognitive skill makes a much larger incremental account to the income returns to height conditional on non cognitive skills, than vice versa, as is the case here for the wage returns to height, because the authors add the skills to the regression in a set order.

[24] See also Hubler (2009) for evidence of a non linear relationship between height and wages in Germany. Our focus here is the evidence for developed countries. There is also a literature that either implicitly (by graphing non parametric estimates of the height profile) or explicitly examines the non linearity of the height profile of outcomes in less developed countries. See, for example, Vogl (2014) and LaFave and Thomas (2017).

10. Discussion and Conclusions

We present evidence of gender specific height profiles, which are common to a range of socioeconomic outcomes in the US, ranging from teenage cognitive scores to adult poverty. For males there is little to no “return” to height above mean height, but a substantial return below the mean. As such, mean height is a dividing line between individuals who see a return to height and those that don’t. For females there is also a bend in the profile at mean height but not as distinct as the one for males. Also, females in the top 10 percent of the height distribution see a positive return the height. The presence of these profiles in outcomes ranging such a span of ages provides graphic testimony to the important relationship between childhood and adult outcomes.

Connecting the profiles across ages reveals the relatively greater role cognitive skills play in generating the height profiles in adult outcomes than non cognitive skills within the US population. Case and Paxson (2008) have also made this argument based in part on evidence that childhood cognitive skills vary with height and also can account for a substantive part of the variation of wages with height. The evidence here sheds some light into the black box of these horse race regressions, explicitly demonstrating how the height profile in adult outcomes echoes the profiles in childhood cognitive skills.

Additional questions are raised by the similarities between the height profiles for males in the US and Korea, and the differences in the profiles for males in the US and Sweden. Previous research documents the relationships between genes and pre natal/childhood environments with realized height (e.g., Case and Paxson 2010 and the references therein). Differences in the association of height with cognitive and non cognitive skills, health and labour market outcomes across developed countries suggest country specific factors mediate the consequences of the genes/environment/height nexus for realized adult socioeconomic status.

The differences in socioeconomic outcomes below mean height in the US rival the differences by race/ethnicity. Understanding the sources of these differences is therefore an important input to understanding inequality in American society. The systematic and persistent association of SES with below average height, which we document in the first part of this paper, will imply corresponding differences in the environments of children by parental stature. Because height is strongly heritable and there is evidence of assortative mating on height (e.g., Stulp et al. 2017), the challenges of understanding the separate genetic and childhood environmental legacies of parents are particularly acute in this application. However, the evidence that the non linear differences by height emerge by the teenage years in the US (by childhood in the UK), highlight the importance of this question.

Limitations of these results include that the NHIS, which is one of the largest US surveys that captures individuals' heights, provides but a selected sample of inputs and outcomes of interest. To focus on the child development of females and males whose adult heights are below the mean will require data sources with even larger sample size. While administrative data sources from other countries can clearly provide additional sample size, their applicability to the US case may be limited by some of the cross country differences in the height profiles of different outcomes, such as cognitive and non cognitive skills, discussed above.

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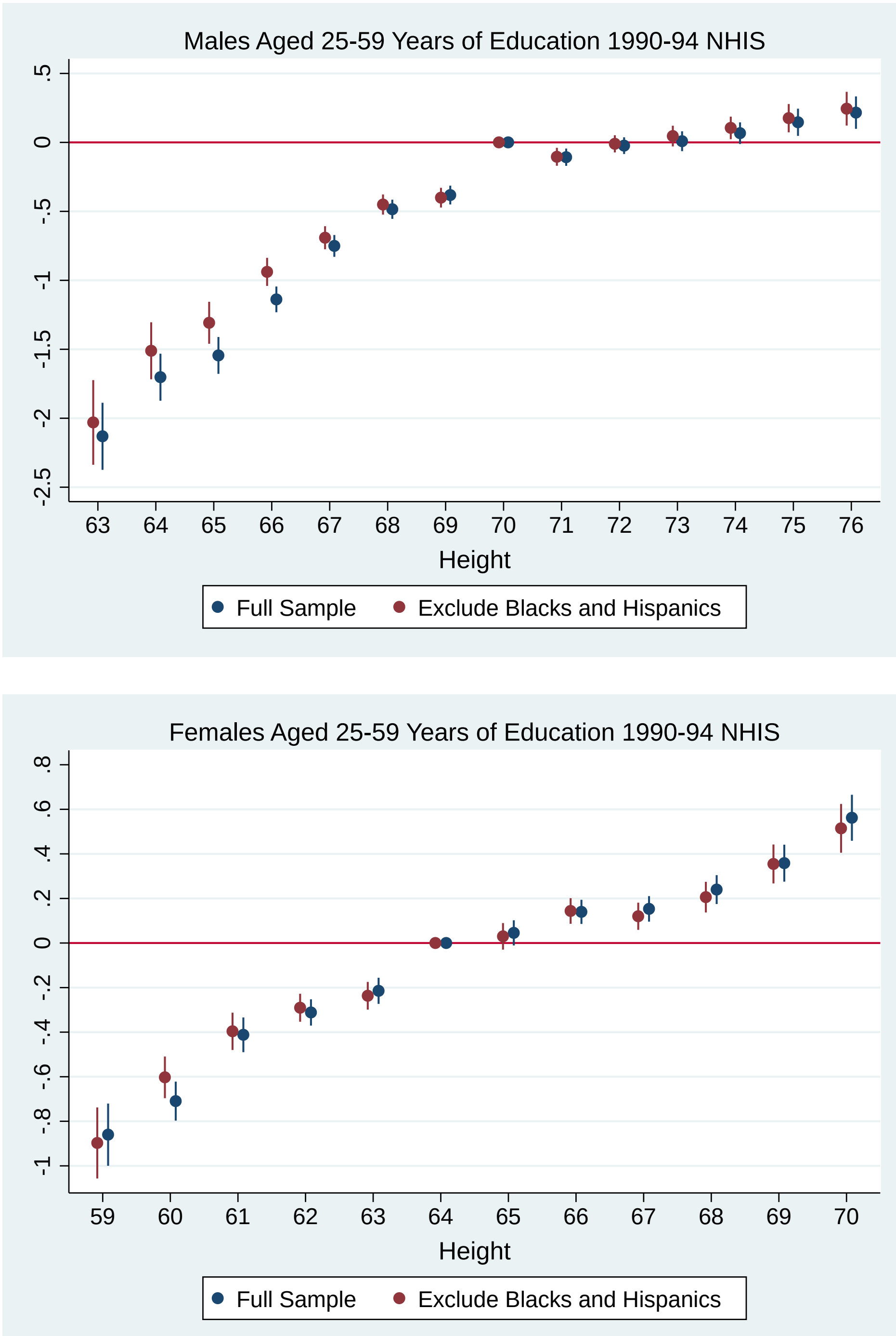
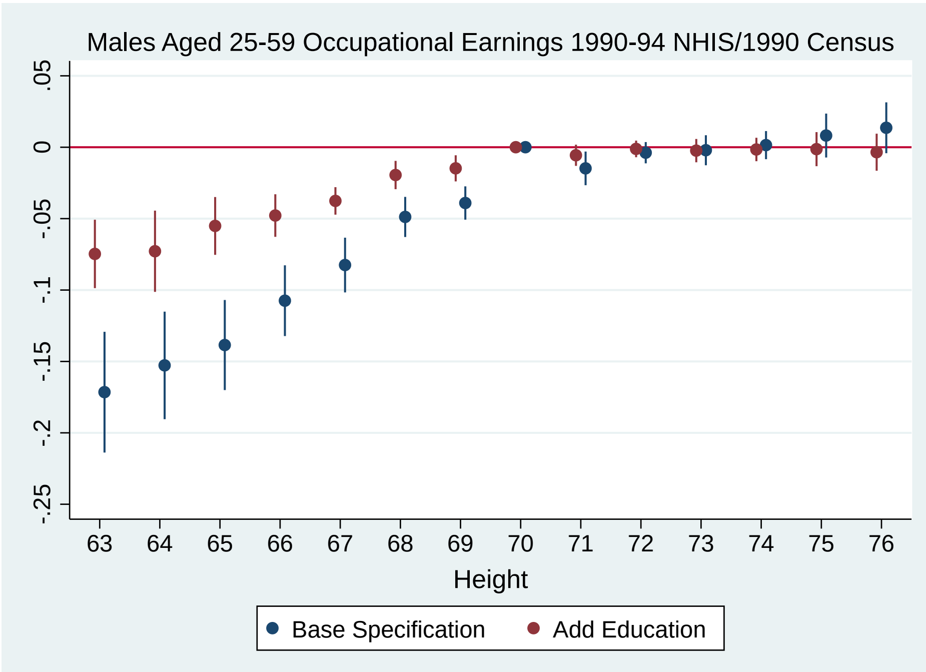
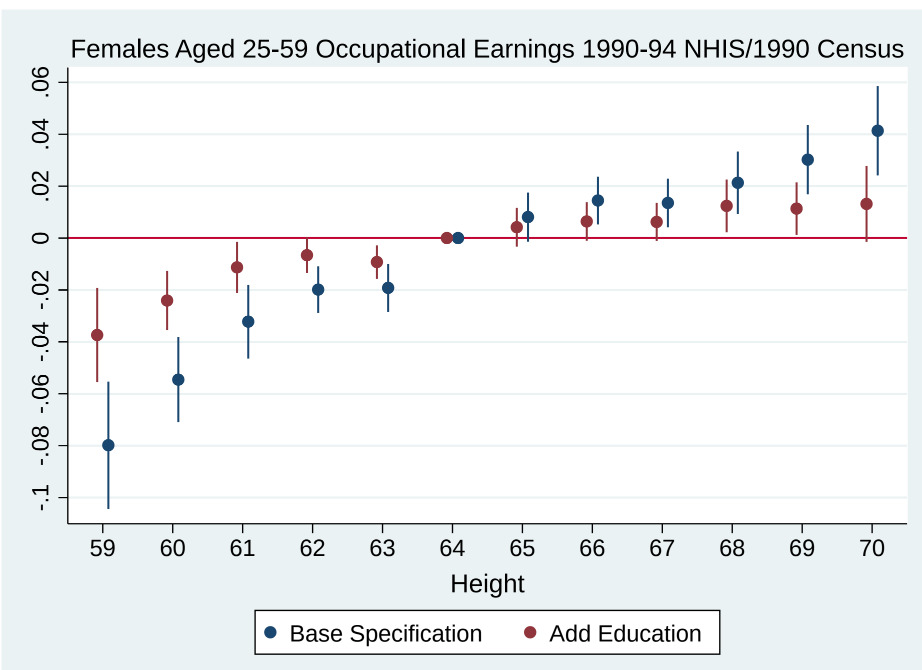
Figure 1: Males' and Females' Years of Educational Attainment by Height, NHIS



Notes: Authors calculations from 1990-94 NHIS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity (as applicable) foreign birth and indicators for survey year. Mean height (70" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

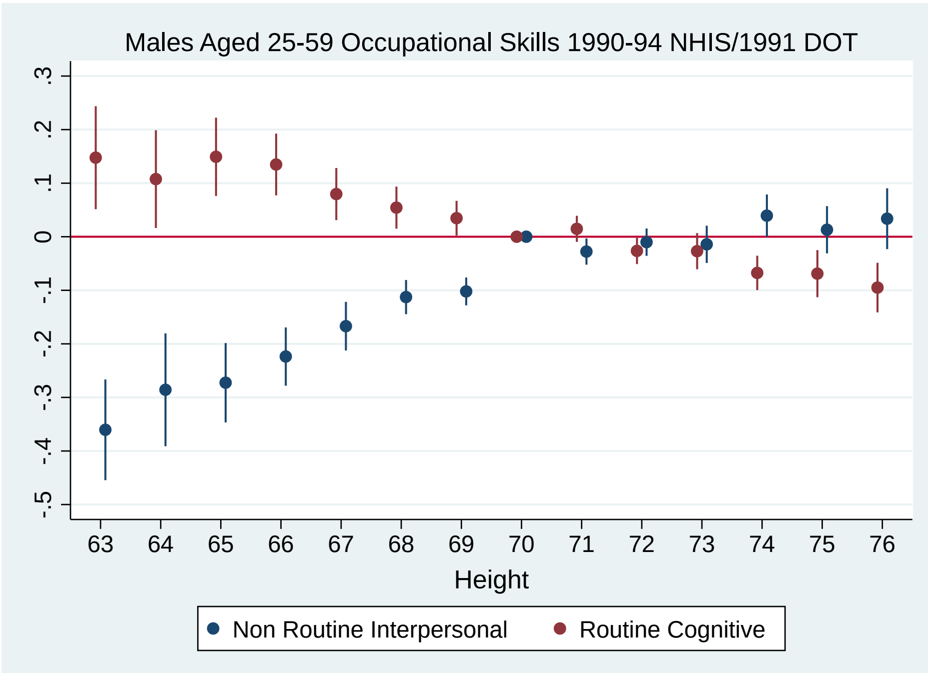
Figure 2: Males' and Females' Average Occupational Earnings by Height, NHIS and Census

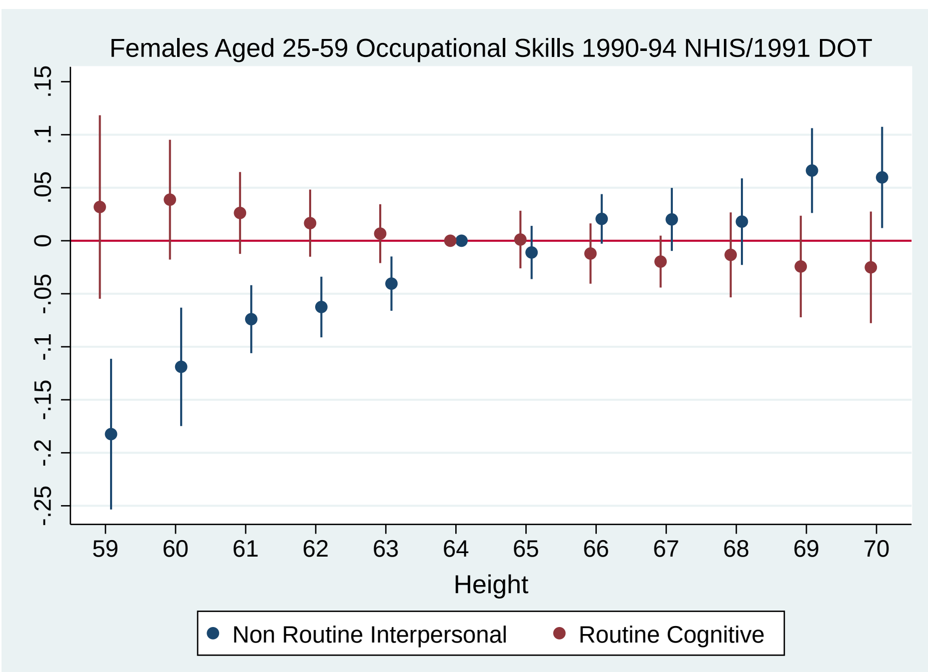




Notes: Authors calculations from 1990-94 NHIS and 1990 Census. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity foreign birth and indicators for survey year. Mean height (70" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

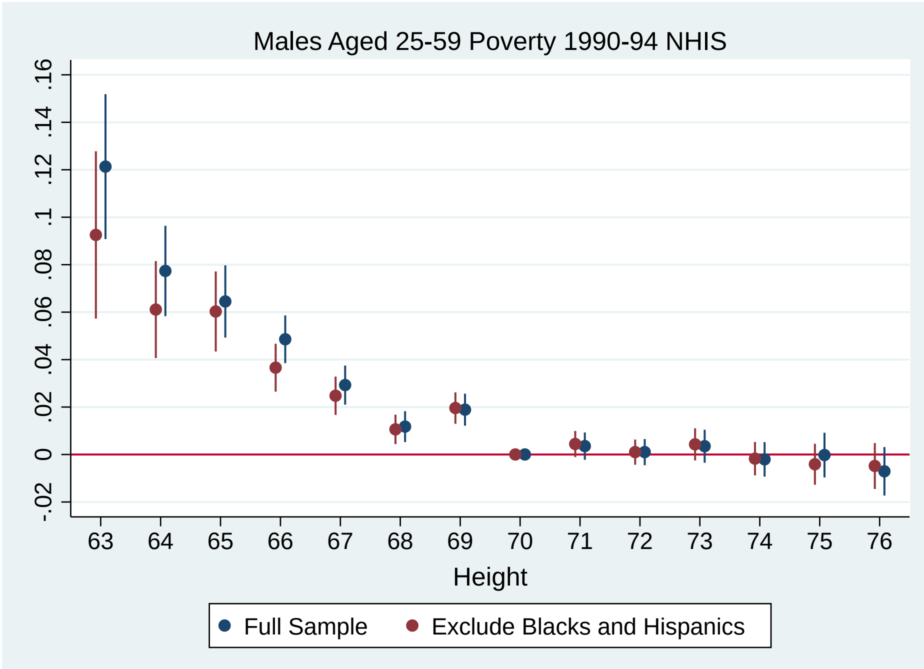
Figure 3: Males' and Females' Occupational Skills by Height, NHIS and DOT

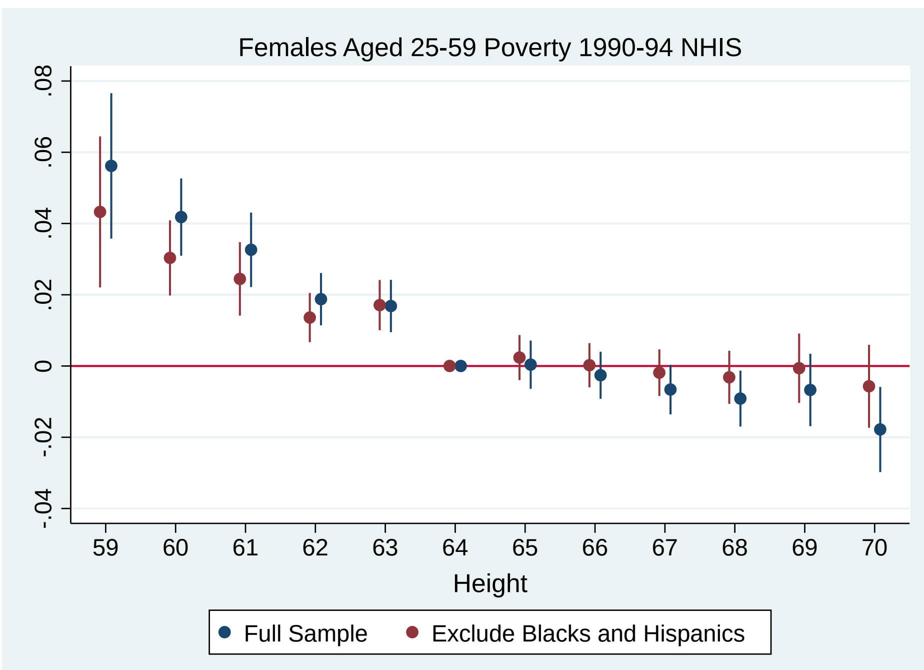




Notes: Authors calculations from 1990-94 NHIS and 1991 DOT. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity, foreign birth and indicators for survey year. Mean height (70" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

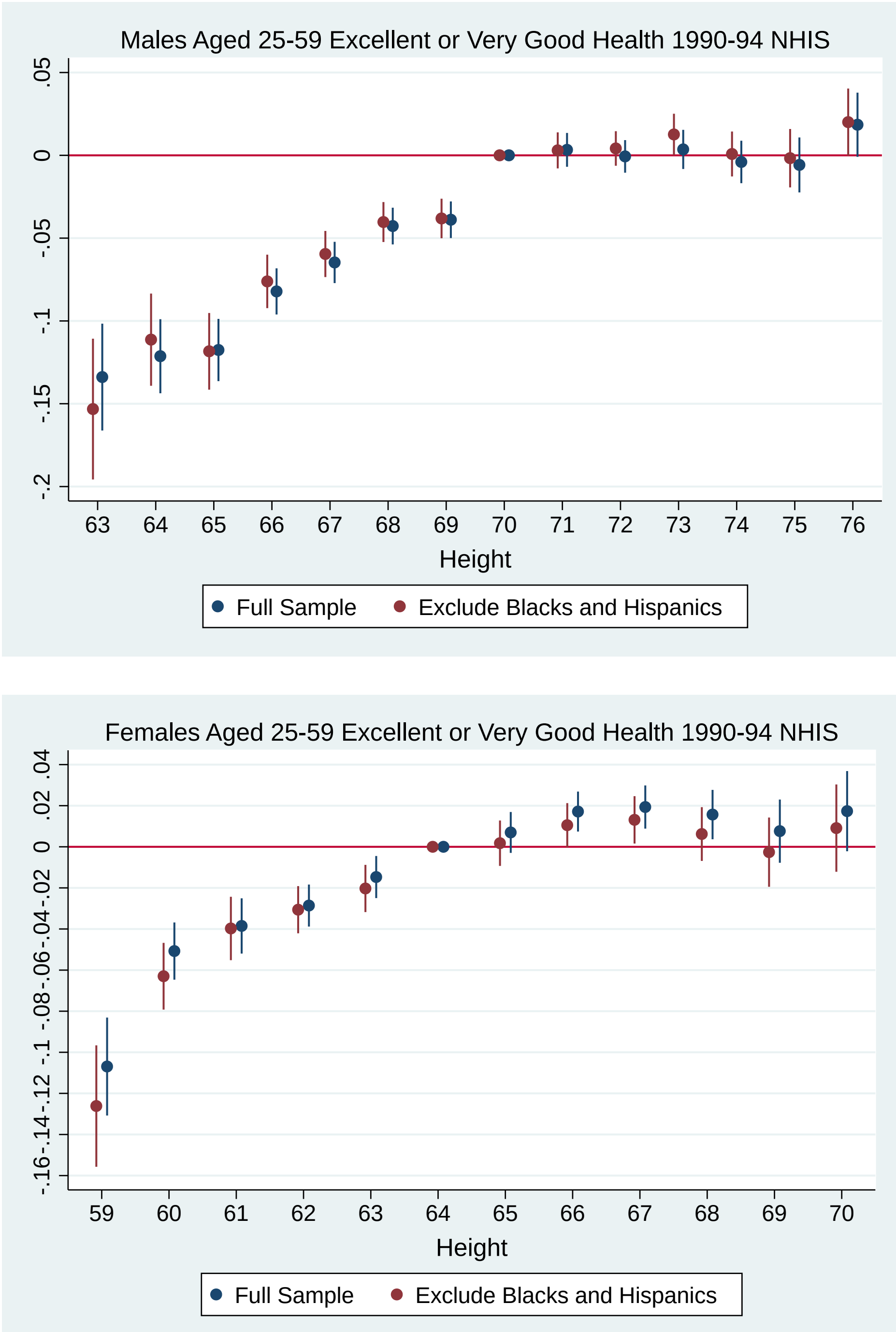
Figure 4: Males' and Females' Household Poverty by Height, NHIS





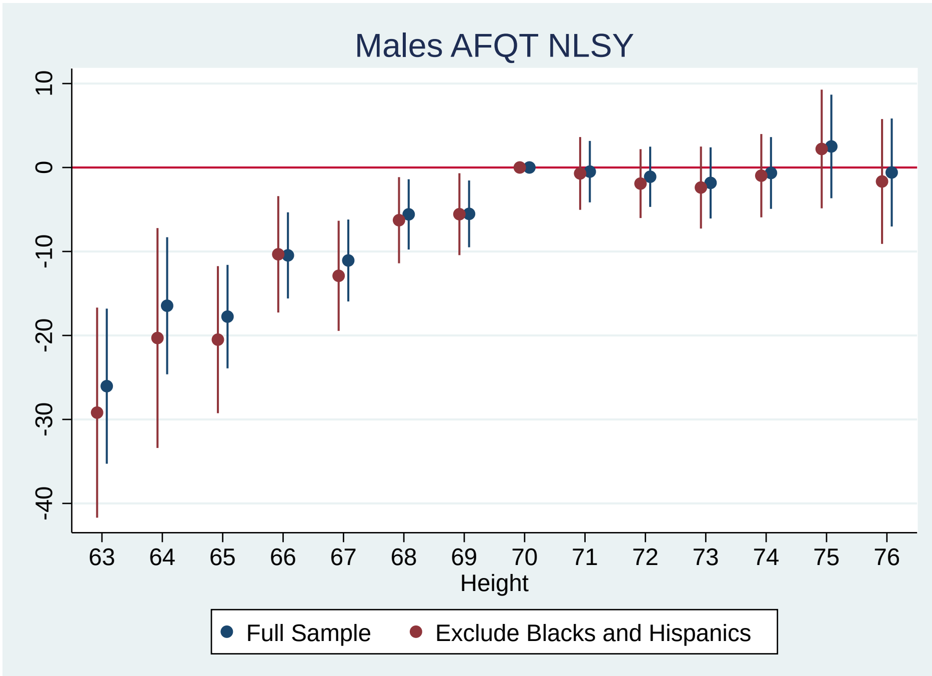
Notes: Authors calculations from 1990-94 NHIS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity (as applicable), foreign birth and indicators for survey year. Mean height (70" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

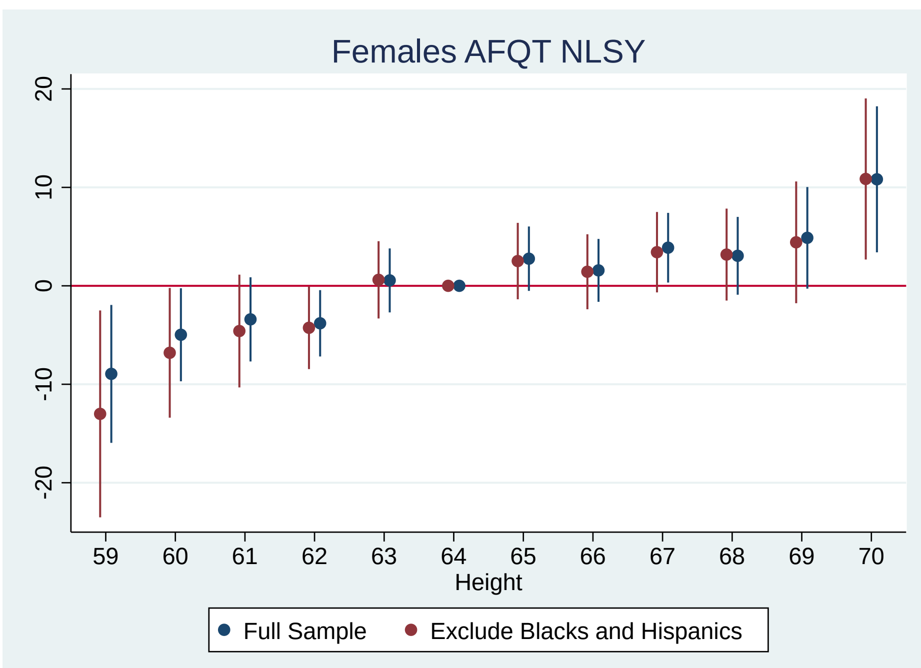
Figure 5: Males' and Females' Self Reported Health by Height, NHIS



Notes: Authors calculations from 1990-94 NHIS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity (as applicable), foreign birth and indicators for survey year. Mean height (70" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

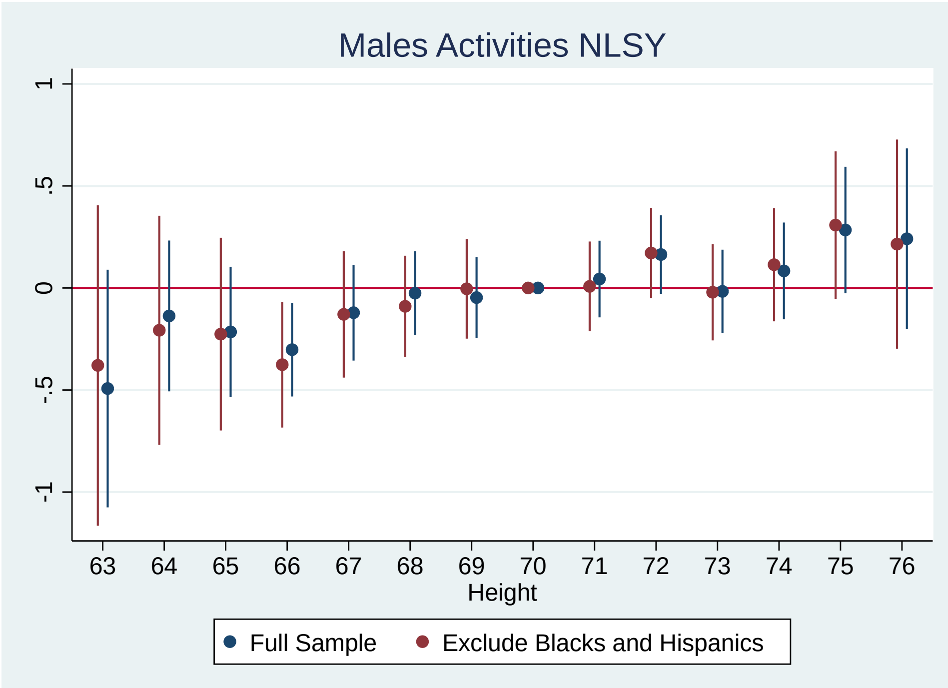
Figure 6: Males' and Females' AFQT scores by Height, NLSY79

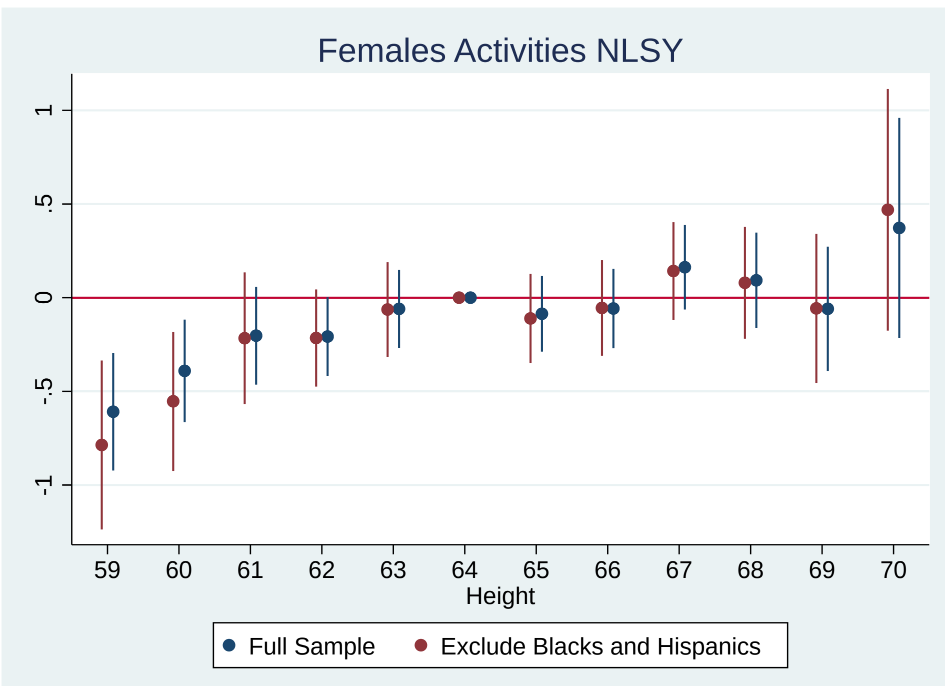




Notes: Authors calculations from the NLSY79. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height age (single year), age (single year), region, and race/ethnicity (as applicable). Mean height (70" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

Figure 7: Males' and Females' High School Activities by Height, NLSY79





Notes: Authors calculations from the NLSY79. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height age (single year), age (single year), region, and race/ethnicity (as applicable). Mean height (70" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

Table 1: Summaries of Heights in the NHIS and NLSY79 Samples

	Females		*Males*	
NHIS	1990-94	2010-13	1990-94	2010-13
Mean	64.50”	64.40	70.09”	69.97
Std. Deviation	2.78	2.55	3.06	2.82
Interquartile Range	63”-66”	63”-66”	68”-72”	68”-72”
90/10 range	61”-68”	61”-68”	66”-74”	66”-74”
N	138,221	39,631	124,552	33,333
NLSY79	*Females*		*Males*	
Mean	64.49’’		70.40’’	
Std. Deviation	2.69		2.90	
Interquartile Range	63’’-66’’		68’’-72’’	
90/10 range	61’’-68’’		67’’-74’’	
N	5,181		4,941	

Notes: Authors calculations from the 1990-94 and 2010-13 NHIS and the NLSY79.

Table 2: Socio-economic Outcomes by Height, and for African Americans and Hispanics, NHIS

	% of POP	*No High School*		*College*		*Employment*		*Health*	
Males		1990-94	2010-13	1990-94	2010-13	1990-94	2010-13	1990-94	2010-13
Height≤66”	12	0.153	0.103	-0.134	-0.138	-0.046	-0.041	-0.107	-0.105
		(0.004)	(0.007)	(0.004)	(0.008)	(0.003)	(0.008)	(0.004)	(0.009)
66”<Height ≤68”	17-18	0.055	0.035	-0.069	-0.067	-0.017	-0.038	-0.051	-0.052
		(0.003)	(0.005)	(0.003)	(0.008)	(0.002)	(0.007)	(0.003)	(0.008)
African Americans	11-12	0.079	0.030	-0.133	-0.122	-0.105	-0.123	-0.133	-0.103
		(0.004)	(0.006)	(0.004)	(0.008)	(0.003)	(0.008)	(0.004)	(0.008)
Hispanics	10-15	0.238	0.200	-0.182	-0.241	-0.028	-0.017	-0.086	-0.092
		(0.005)	(0.007)	(0.004)	(0.009)	(0.003)	(0.008)	(0.005)	(0.009)
Females									
Height≤61”	13	0.080	0.061	-0.076	-0.098	-0.046	-0.029	-0.068	-0.069
		(0.003)	(0.006)	(0.003)	(0.008)	(0.004)	(0.008)	(0.004)	(0.008)
61”<Height ≤63”	23-24	0.039	0.020	-0.042	-0.052	-0.030	-0.021	-0.031	-0.047
		(0.002)	(0.004)	(0.003)	(0.007)	(0.003)	(0.006)	(0.003)	(0.007)
African Americans	13-14	0.091	0.065	-0.095	-0.156	-0.041	-0.051	-0.178	-0.146
		(0.003)	(0.005)	(0.003)	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)
Hispanics	10-14	0.264	0.181	-0.134	-0.230	-0.119	-0.058	-0.140	-0.121
		(0.005)	(0.006)	(0.004)	(0.008)	(0.005)	(0.008)	(0.005)	(0.008)

Notes: Authors calculations from the 1990-94 and 2010-13 NHIS. This table shows the estimates of dummy variables for the indicated height and ethnic/race groups from a regression of the indicated dependent variable on these dummy variables, height, age (single year), region, foreign birth and indicators for survey year. The regressions for males also include an additional dummy variable for height equal to 69”. Regressions are weighted using sampling weights. Robust standard errors in parentheses. All estimates statistically significant at the 1 percent level.

Table 3: The Association of Height and Cognitive skills or Non-cognitive Skills, NLSY79

NLSY79			
	AFQT	*Social Activities*	*Rosenberg*
Males			
<68"	-13.311**	-0.219*	-0.809**
	(1.846)	(0.092)	(0.277)
68"-69"	-5.541**	-0.032	-0.207
	(1.745)	(0.092)	(0.265)
71"-72"	-0.819	0.104	-0.089
	(1.605)	(0.087)	(0.246)
>72"	-0.882	0.107	0.077
	(1.681)	(0.092)	(0.254)
N	4,641	4,641	4,513
Females			
<62"	-5.087**	-0.354*	-0.320
	(1.609)	(0.101)	(0.273)
62"-63"	-1.609	-0.103	-0.018
	(1.426)	(0.092)	(0.239)
65"-66"	2.153	-0.059	0.318
	(1.400)	(0.092)	(0.231)
>66"	4.341**	0.145	0.331
	(1.442)	(0.094)	(0.237)
N	4,952	4,952	4,833

Notes: Authors calculations from the NLSY79. This table shows estimates on dummy variables for the indicated height intervals (mean height excluded), from regressions of the indicated variables on height and controls for age, region and race/ethnicity (as applicable). Non-cognitive skills are high school social activities and the Rosenberg self esteem index. Regressions are weighted using sampling weights. Robust standard errors in parentheses. †, * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively.

Table 4: The relationship between Height and Log Wages with and without Controls for Cognitive and/or Non-cognitive Skills, Males NLSY79

Full Sample (N=4,249)				
Height	0.018**	0.010**	0.013**	0.009**
	(0.003)	(0.003)	(0.003)	(0.003)
AFQT		0.0054**		0.0042**
		(0.0003)		(0.0004)
School Activities			0.065**	0.031**
			(0.007)	0.008)
Rosenberg			0.019**	0.012**
			(0.002)	(0.002)
Full Sample (N=4,249)				
<68"	-0.109**	-0.034	-0.078*	-0.033
	(0.033)	(0.031)	(0.032)	(0.031)
68"-69"	-0.053†	-0.023	-0.048†	-0.027
	(0.031)	(0.029)	(0.030)	(0.029)
71"-72"	-0.005	-0.002	-0.008	-0.001
	(0.029)	(0.027)	(0.028)	(0.027)
>72"	0.039	0.045	0.031	0.040
	(0.031)	(0.030)	(0.030)	(0.029)
AFQT		0.0055**		0.0042**
		(0.0003)		(0.0004)
School Activities			0.066**	0.031**
			(0.007)	(0.008)
Rosenberg			0.019**	0.012**
			(0.002)	(0.002)
Non Hispanic Whites (N=2,450)				
<68"	-0.114**	-0.033	-0.078*	-0.032
	(0.042)	(0.040)	(0.040)	(0.039)
68"-69"	-0.066*	-0.036	-0.060*	-0.040
	(0.036)	(0.035)	(0.036)	(0.035)
71"-72"	-0.008	-0.001	-0.008	-0.000
	(0.033)	(0.032)	(0.033)	(0.032)
>72"	0.037	0.046	0.028	0.040
	(0.036)	(0.034)	(0.035)	(0.034)
AFQT		0.0055**		0.0041**
		(0.0004)		(0.0004)
School Activities			0.068**	0.032**
			(0.008)	(0.009)
Rosenberg			0.017**	0.012**
			(0.003)	(0.003)

Notes: Authors calculations from the NLSY79. This table shows the estimates on height or dummy variables for the indicated height intervals (mean height excluded), from regressions of log wages on height, controls for age (single month) and region, and skills as indicated. Regressions are weighted using sampling weights. Cognitive skills are AFQT percentile scores. Non-cognitive skills are high school social activities and the Rosenberg self esteem index. Regressions are weighted using sampling weights. Robust standard errors in parentheses. †, * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively.

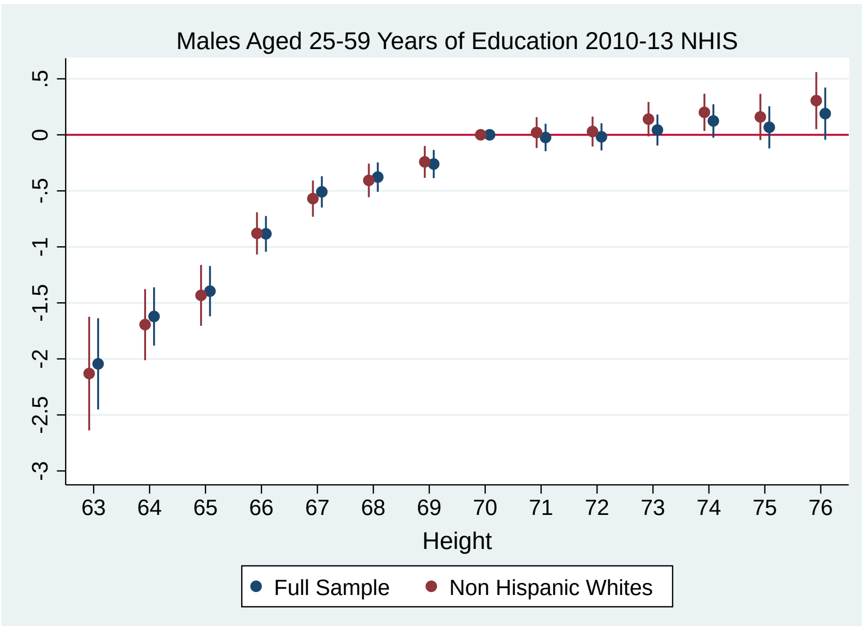
Table 5: The relationship between Height and Log Wages with and without Controls for Cognitive and/or Non-cognitive Skills, Females NLSY79

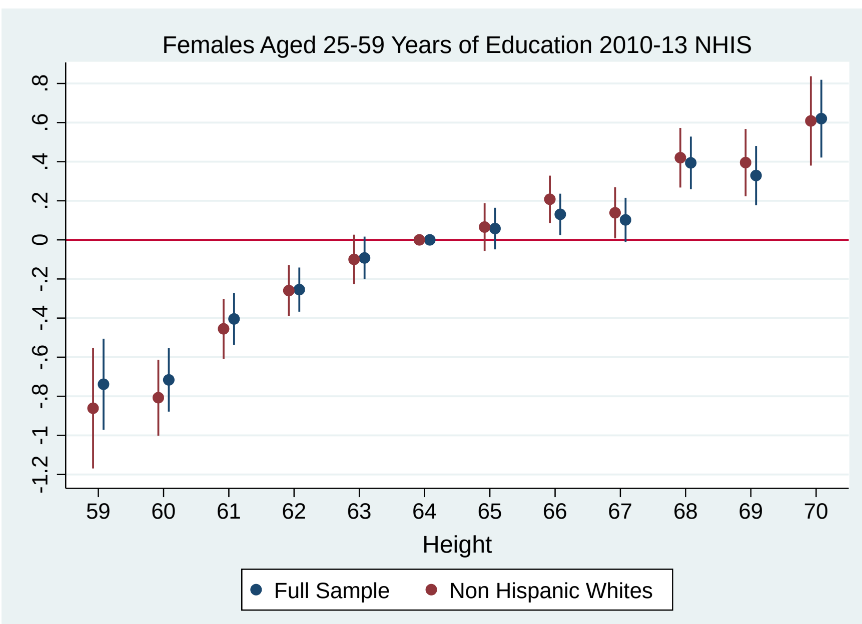
Full Sample (N=4,217)				
Height	0.021**	0.013**	0.016**	0.012**
	(0.003)	(0.003)	(0.003)	(0.003)
AFQT		0.0080**		0.0065**
		(0.0004)		(0.0004)
School Activities			0.072**	0.031**
			(0.007)	(0.007)
Rosenberg			0.020**	0.012**
			(0.003)	(0.003)
Full Sample (N=4,217)				
<62”	-0.059†	-0.022	-0.027	-0.015
	(0.036)	(0.034)	(0.035)	(0.034)
62”-63”	-0.029	-0.015	-0.019	-0.013
	(0.034)	(0.032)	(0.033)	(0.032)
65”-66”	0.054	0.041	0.054	0.043
	(0.034)	(0.032)	(0.032)	(0.032)
>66”	0.098**	0.070*	0.085**	0.069*
	(0.033)	(0.031)	(0.032)	(0.031)
AFQT		0.0081**		0.0065**
		(0.0004)		(0.0004)
School Activities			0.073**	0.031**
			(0.007)	(0.007)
Rosenberg			0.020**	0.012**
			(0.003)	(0.003)
Non Hispanic Whites (N=2,486)				
<62”	-0.074	-0.026	-0.035	0.017
	(0.046)	(0.043)	(0.045)	(0.043)
62”-63”	-0.020	-0.005	-0.011	-0.003
	(0.041)	(0.038)	(0.039)	(0.038)
65”-66”	0.058	0.048	0.060	0.050
	(0.039)	(0.038)	(0.039)	(0.038)
>66”	0.110**	0.086*	0.097**	0.084*
	(0.038)	(0.036)	(0.038)	(0.036)
AFQT		0.0078**		0.0063**
		(0.0004)		(0.0004)
School Activities			0.075**	0.034**
			(0.008)	(0.008)
Rosenberg			0.019**	0.011**
			(0.003)	(0.003)

Notes: Authors calculations from the NLSY79. This table shows the estimates on height or dummy variables for the indicated height intervals (mean height excluded), from regressions of log wages on height, controls for age (single month) and region, and skills as indicated. Regressions are weighted using sampling weights. Cognitive skills are AFQT percentile scores. Non-cognitive skills are high school social activities and the Rosenberg self esteem index. Regressions are weighted using sampling weights. Robust standard errors in parentheses. †, * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively.

Appendix A: Results from the 2010-13 NHIS

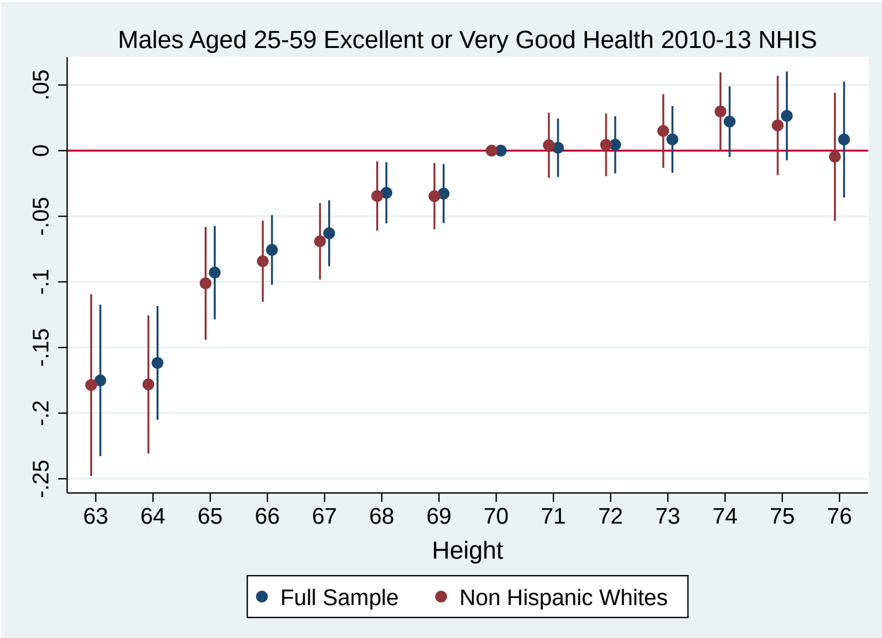
Figure A1: Males' and Females' Years of Educational Attainment by Height, NHIS

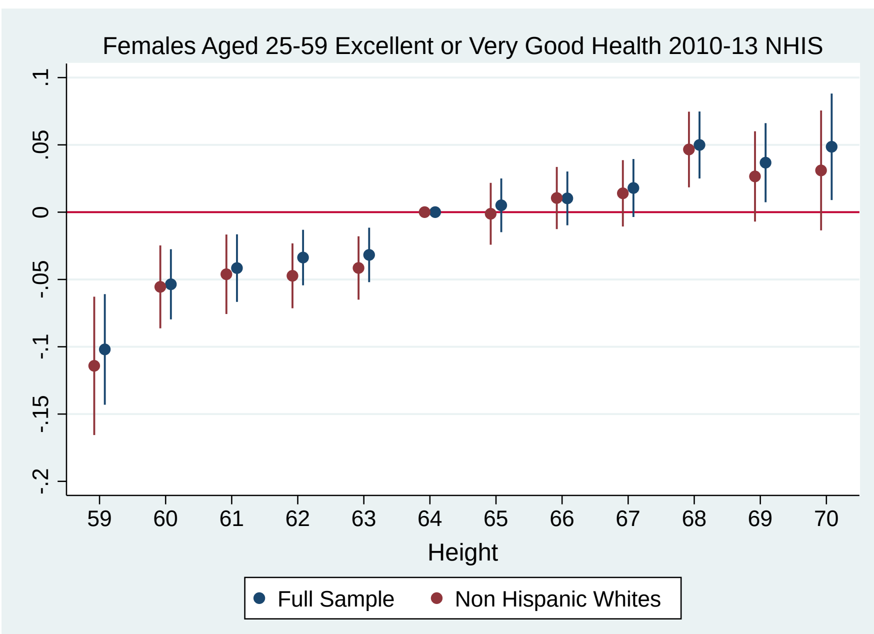




Notes: Authors calculations from 2010-13 NHIS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity (as applicable) foreign birth and indicators for survey year. Mean height (70' males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

Figure A2: Males and Females Self Reported Health by Height, NHIS





Notes: Authors calculations from 2010-13 NHIS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity (as applicable) foreign birth and indicators for survey year. Mean height (70' males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

Appendix B: A Comparison of Self Reported and Exam Recorded Health in the NHANES

We use data from the 1999/2000 through 2013/2014 waves of the NHANES to investigate the potential implication of using self reported height in our NHIS analysis. We draw data from the "Demographic", "Body Measures" and "Weight History" files in each wave, and again select the sample of respondents between the ages of 25 and 59. NHANES is a much smaller survey of health outcomes, which includes both examination and survey components. Because height is captured in both components, the NHANES offers evidence of the error in self reported height, and has been used for this purpose in the past (e.g., Sahyoun et al. 2008, Merrill and Richardson 2009). That said, the NHANES has a complex sampling design and therefore depends significantly on weights to generate population levels estimates[25], and has a lower response rate than other health surveys (Czajka and Beyler 2016). Also, differences in the survey response reports of medical conditions in the NHANES have been shown to differ from those in other health surveys (Czajka and Beyler 2016).

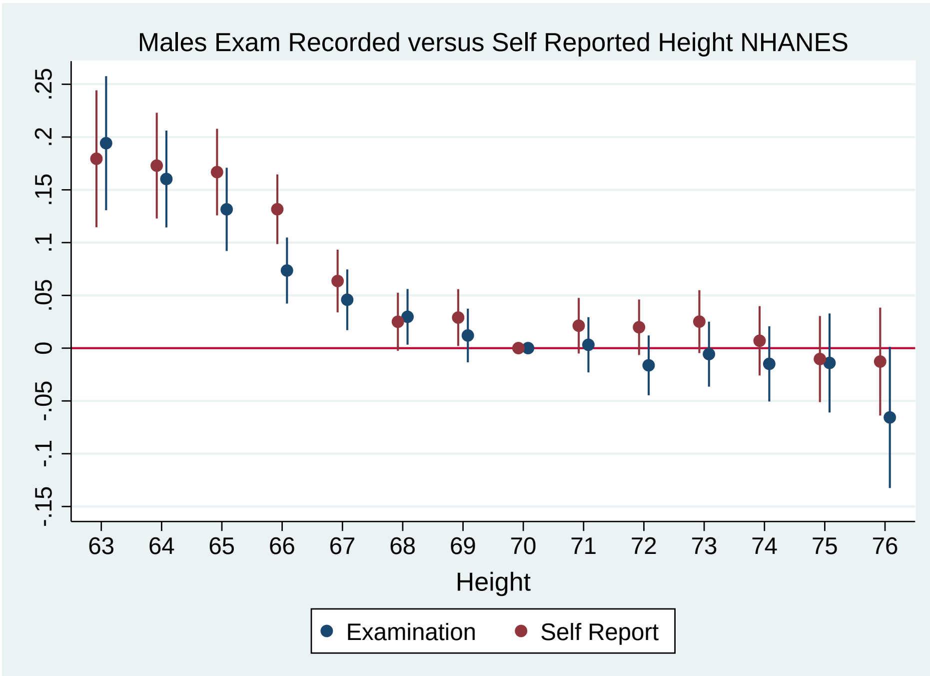
Our primary concern is that the non linear height profiles we have uncovered are a result of errors in self reported height. In figure B1 we report height profiles, for males and females, of the proportion of respondents reporting less than a high school education, using alternatively examination recorded and self reported heights. As a point of comparison in figure B2 we report the corresponding profiles form the 1990-94 NHIS. Note that the comparison of the NHIS and NHANES figures is complicated by the wide span of survey cohorts we need to include from the NHANES data to generate sufficient sample sizes.

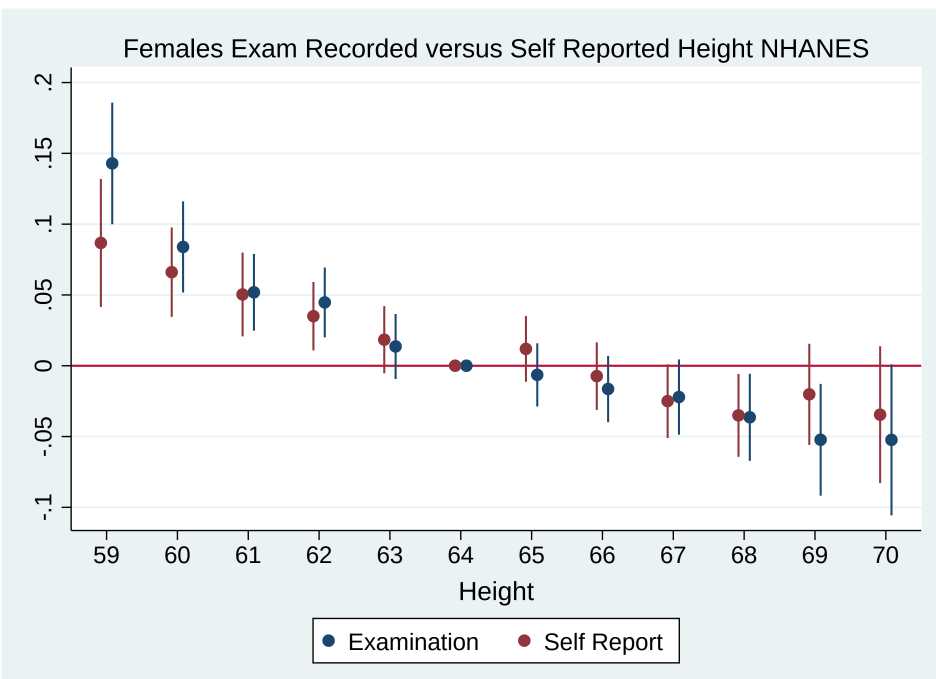
[25] For example, Hispanics and African American make up roughly one quarter each of the unweighted sample aged 25-59.

The NHANES source figure for males displays a similar non linear profile as in the NHIS data, regardless of the measure of height used. In terms of levels, the profile using self reported height lies above the exam recorded height profile, more often than not, especially at some of the shorter heights and the heights just above mean height.

For females the profile using either measure of height is more linear than for males, as it is the NHIS.   If anything the profile using examination height displays more non linearity at shorter heights, but more generally both profiles tell a similar story

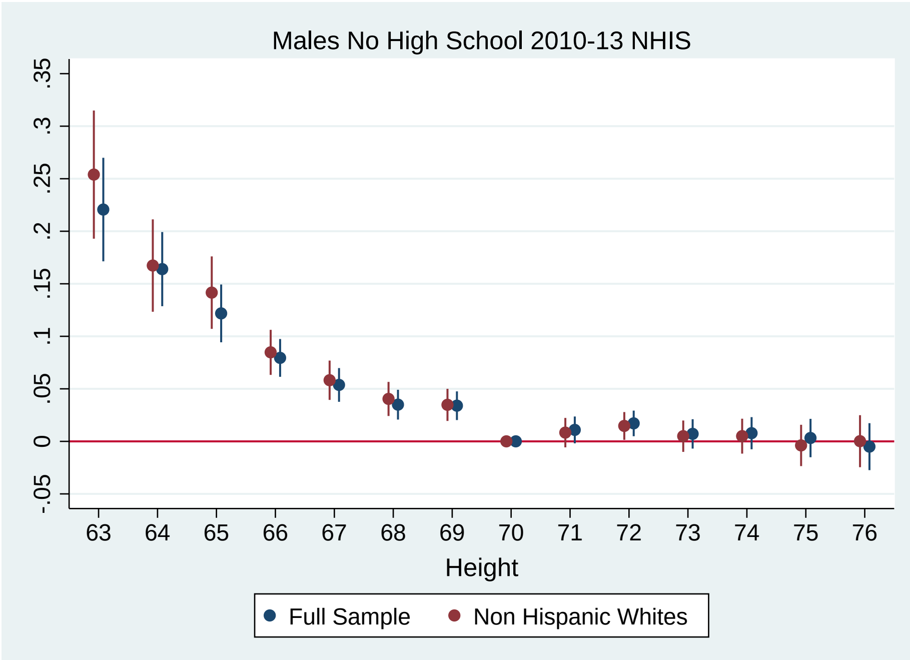
Figure B1: Males and Females Proportion with No High School by Height, NHANES

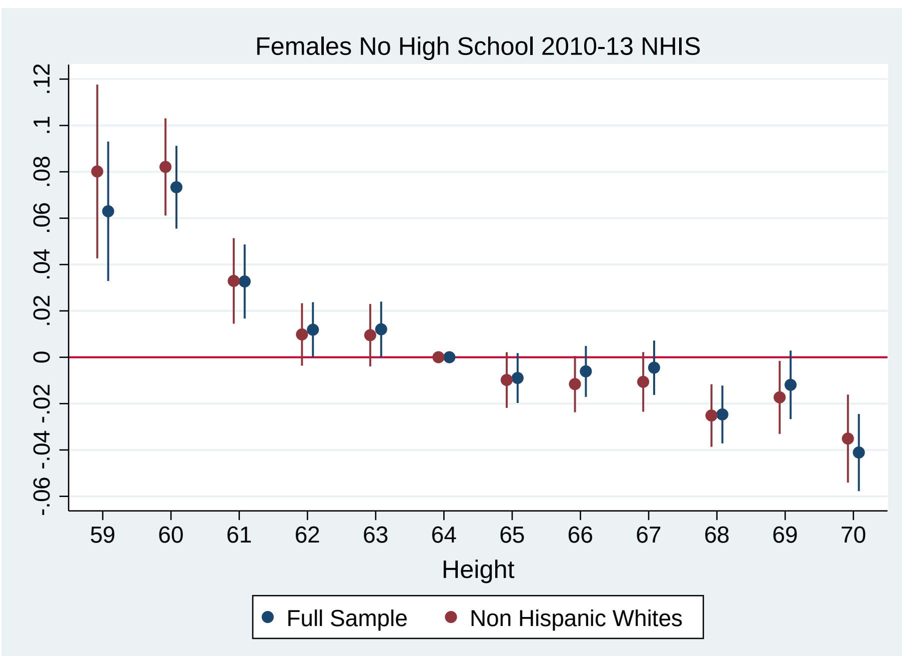




Notes: Authors calculations from the 1999/00 through 2013/14 NHANES. The reported parameters are estimates of height dummy variables from a regression of the indicated outcome on height, age (single year), race/ethnicity and indicators for survey year. Mean height (70' males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

Figure B2: Males and Females Proportion with No High School by Height, NHIS





Notes: Authors calculations from 2010-13 NHIS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age (single year), region, race/ethnicity (as applicable) foreign birth and indicators for survey year. Mean height (70' males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

Appendix C: Does Parental Income or School Quality Mediate the AFQT/Height Relationship in the NLSY79?

To investigate the impact of family environmental factors on the adult height/AFQT profile we estimate (2) with AFQT as the dependent variable, with and without controls for 1979 family income, using the NLSY79 data. To help ensure that family income is capturing childhood inputs, we restrict the sample to respondents who were living in their parents' homes in 1979. The baseline estimates for this sample, with no control for parental income, are presented in columns (1) and (3) of table C1. The non-linear relationship between height and AFQT for males displays less of a less plateau at mean height, perhaps due to the select sample. Controlling for parental income, the estimates change very little for either sex. This evidence suggests that parental income plays a limited role in the relationship between height and AFQT scores in this sample.

Next we test whether school quality mediates the height/AFQT profile. In table C2 we present a corresponding set of regression estimates, this time conditioning on measures of the fraction of students who are disadvantaged; the fraction of students in different racial groups; dropout and attendance rates; enrollment; the number of teachers and counsellors; the number of books in the library; the fraction of teachers with graduate degrees; the fraction of teachers who left the school in the previous year; and starting teacher salaries.[26] Once again the addition of these controls has a limited effect on the estimates of the height profile for AFQT.

[26] The school quality measures are from the "background" section of the NLSY79 school transcript survey.

Table C1: The Association of Adult Height and AFQT controlling for parents' income

	Males			Females	
<68"	-9.587*	-8.603*	<62"	-6.160†	-6.371†
	(4.046)	(4.046)		(3.679)	(3.632)
68"-69"	-5.562	-4.371	62"-63"	-3.613	-3.959
	(4.029)	(3.980)		(3.166)	(3.130)
71"-72"	4.139	3.933	65"-66"	-1.404	-1.657
	(3.781)	(3.744)		(3.266)	(3.220)
>72"	-0.261	-0.792	>66"	4.378	3.714
	(3.988)	(3.900)		(3.145)	(3.112)
Parents' income		0.001**			0.000*
		(0.000)			(0.000)
N	1,139	1,139		1,085	1,085

Notes: Authors calculations from the NLSY79. This table shows estimates on dummy variables for the indicated height intervals (mean height excluded), from regressions of AFQT on height, controls for age, region and race/ethnicity, and family (1979) income as indicated. Regressions are weighted using sampling weights. The sample is restricted to individuals who were living in their parents' home in 1979. Regressions are weighted using sampling weights. Robust standard errors in parentheses. †, * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively.

Table C2: The Association of Adult Height and AFQT controlling for school characteristics

	Males			Females	
<68"	-12.736**	-11.772**	<62"	-2.496	-1.817
	(2.794)	(2.794)		(2.645)	(2.621)
68"-69"	-5.522*	-5.880*	62"-63"	-0.162	0.219
	(2.603)	(2.570)		(2.117)	(2.057)
71"-72"	-0.868	-0.271	65"-66"	3.860†	3.700†
	(2.388)	(2.370)		(2.113)	(2.038)
>72"	-0.231	-0.351	>66"	5.740**	5.765**
	(2.535)	(2.535)		(2.193)	(2.109)
School characteristics		X			X
N	2,049	2,049		2,165	2,165

Notes: Authors calculations from the NLSY79. This table shows estimates on dummy variables for the indicated height intervals (mean height excluded), from regressions of AFQT on height, controls for age, region and race/ethnicity, and school characteristics as indicated. Regressions are weighted using sampling weights. Robust standard errors in parentheses. †, * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively.

Appendix D: The Adult Height Profile in Age 7 Math, Reading and Behavior Scores in the NCDS

Previous studies have argued that the AFQT scores available in the NLSY79 may be better measures of socio economic advantage or completed education than of underlying cognitive skills. To cleanly address this issue, we use data from the NCDS. The NCDS has figured prominently in past research on the relationship between height and wages, and in addition offers cognitive and non cognitive scores from much earlier ages. We examine standardized math and reading scores from age 7 to measure cognitive skills,[27] and a standardized teacher reported index of behavior, the Bristol Social Adjustment Guide,[28] also for this age as a measure of non cognitive skills

The adult height profiles of the standardized math and reading scores following (1) from the NCDS are reported in figure D1.[29] For males we observe the non linearity at mean height (here 69") observed in the US AFQT scores, especially for reading scores. For females, while the non linearity at mean height is attenuated relative to the evidence for the US, there is evidence of higher scores at the tallest heights.

In figure D2 are the adult height profiles for the age 7 standardized behavior scores. Here a higher score indicates lower skills. For males there is little systematic pattern in the height profile indicating higher or lower skills relative to mean height. For females there is perhaps a

[27] The tests are the Southgate Reading Test and the Problem Arithmetic Test. See http://doc.ukdataservice.ac.uk/doc/5805/mrdoc/pdf/CognitiveAssessmentVariables.pdf accessed September 10, 2019.

[28] This Guide canvases children's behaviors, including withdrawal, depression, anxiety, hostility towards adults, restlessness, and nervousness. We use the survey provided total score for all "syndromes".

[29] We restrict the sample to "Euro-Caucasians" who are paid employees, and also, following the literature (Persico et al 2003, Schick and Steckel 2015), to full time workers. For males this latter restriction makes little difference as few within this ethnic group work part time.

gentle gradient indicating better behaviour at taller heights, and significantly better behavior among the top 1 percent of heights.

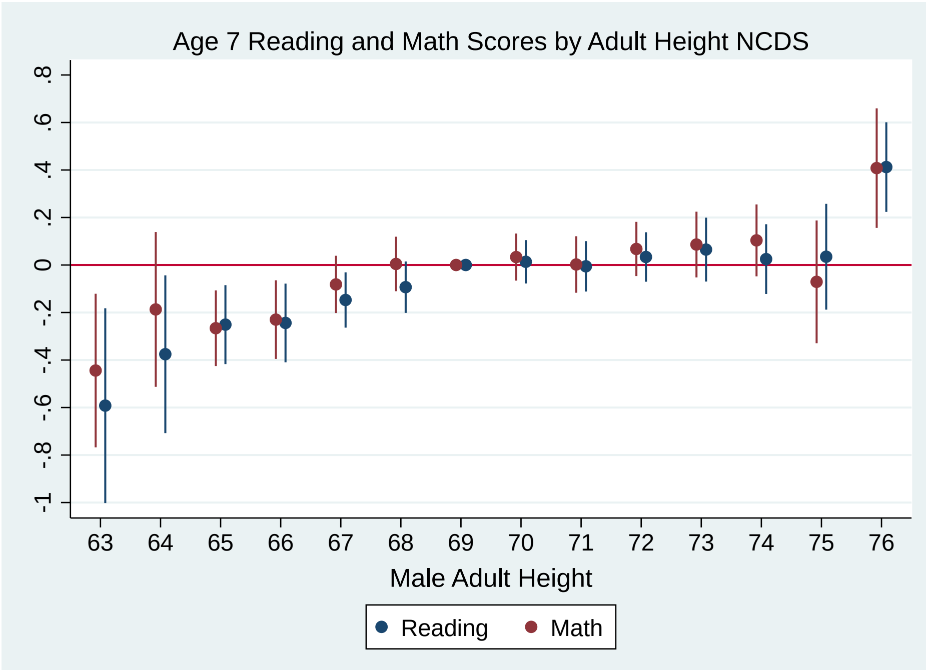
This inference is formalized in table D1 where we estimate the height profiles for these measures of skills following (2). For the cognitive scores the estimate for the shortest height group is in excess of one quarter of a standard deviation for males and just under one fifth a standard deviation for females. For males there is also a difference in the reading score in excess of 10 percent of a standard deviation at heights just below the mean. For females the estimate for the tallest interval is 10 to 15 percent of a standard deviation. For both genders the height profile for the behavior score displays little resemblance to the profiles in the NHIS or the AFQT profiles from the NLSY. There is a marginally significant difference of 10 percent of a standard deviation in the shortest height interval for males.

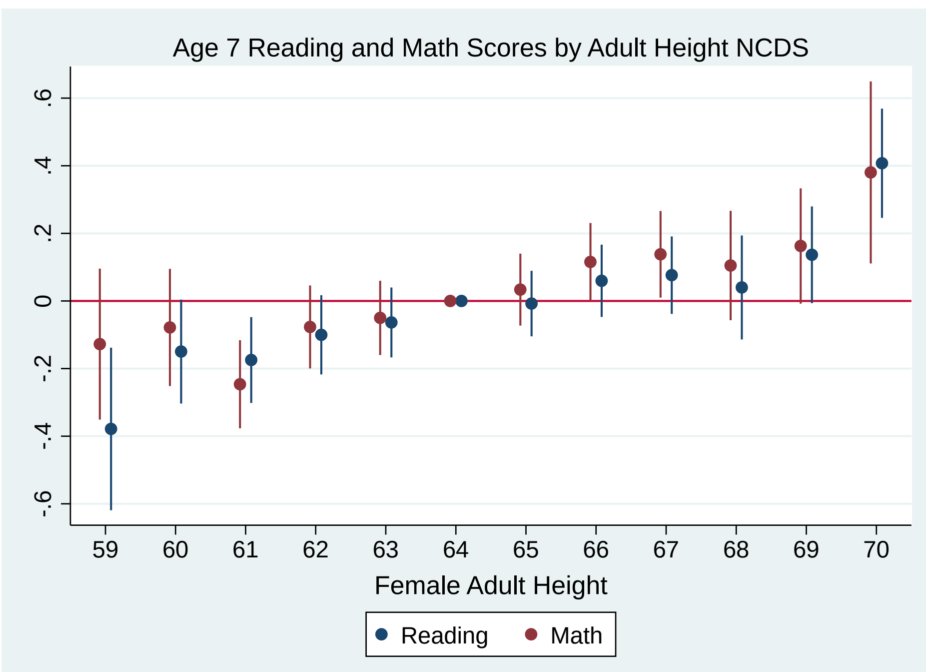
Table D1: The Relationship between Adult Height and Age 7 Cognitive skills or Non-cognitive Skills, NCDS

	Math	Reading	Behavior
Males			
<67”	-0.253**	-0.290**	0.109†
	(0.060)	(0.061)	(0.058)
67”-68”	-0.034	-0.118*	0.035
	(0.049)	(0.046)	(0.047)
70”-71”	0.022	-0.007	0.028
	(0.046)	(0.042)	(0.044)
>71”	0.089*	0.057	0.060
	(0.047)	(0.043)	(0.046)
N	4,136	4,153	4,134
Females			
<62”	-0.182**	-0.199**	0.010
	(0.057)	(0.054)	(0.057)
62”-63”	-0.060	-0.077	-0.023
	(0.051)	(0.048)	(0.051)
65”-66”	0.064	0.018	-0.054
	(0.049)	(0.045)	(0.049)
>66”	0.155**	0.100*	-0.020
	(0.054)	(0.048)	(0.054)
N	4,320	4,331	4,325

Notes: Authors calculations from the NCDS. This table shows the results from regressions of the indicated variables on dummy variables for the indicated height intervals (mean height excluded), along with controls for age, region and race/ethnicity (as applicable). The measure of non-cognitive skills—behavior score—is based on the Bristol Social Adjustment Guide. †, * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively.

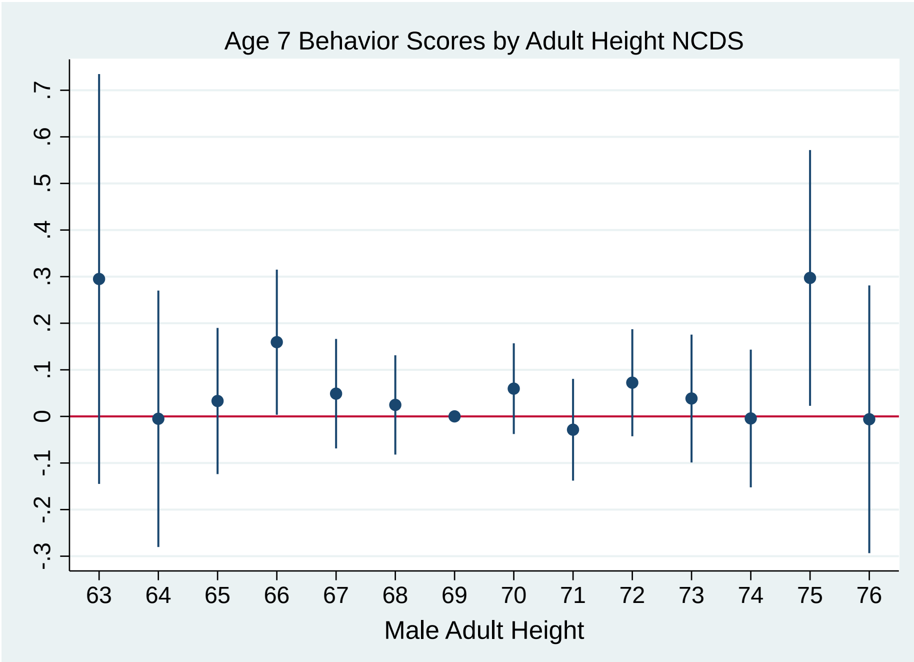
Figure D1: Males' and Females' Age 7 Cognitive Scores by (Adult) Height, NCDS

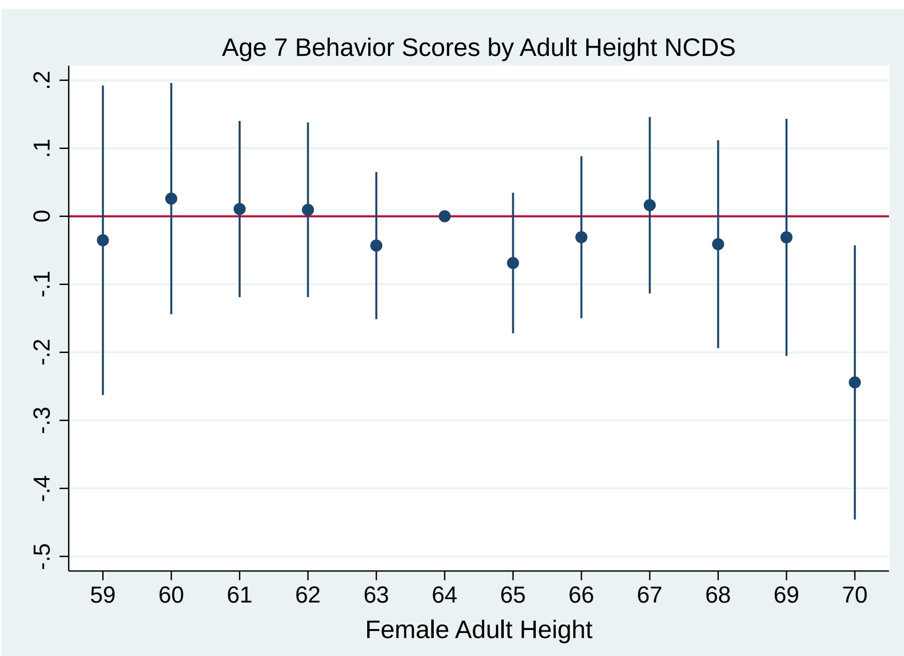




Notes: Authors calculations from the NCDS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age at which the indicated test was taken (months), region. Mean height (69" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.

Figure D2: Males' and Females' Age 7 Behavior Scores by (Adult) Height, NCDS





Notes: Authors calculations from the NCDS. The reported parameters are estimates of single inch height dummy variables from a regression of the indicated outcome on height, age at which the indicated test was taken (months), region. Mean height (69" males, 64" females) is the omitted category. Robust 95 percent confidence intervals.