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RECENT TRENDS IN HEIGHT BY GENDER AND ETHNICITY IN THE US IN
RELATION TO LEVELS OF INCOME

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Recent Trends in Height by Gender and Ethnicity in the US in Relation to Levels of Income
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ABSTRACT

Height trends since World War II are analyzed using the most recent NHANES survey released in 2006. After declining for about a generation, the height of adult white men and women began to increase among the birth cohorts of c. 1975-1986, i.e., those who reached adulthood within the past decade (1995-2006). The increase in their height overcame the prior downturn that lasted between ca. 1965 and 1974. The height gap between white and black men has increased by only 0.43 cm (0.17 in.) during past decade compared to the previous quarter century to reach 1.0 cm (0.39 in.). However, the height of black women has been actually declining absolutely by 1.42 cm (0.56 in.) and relative to that of white women. Black women of the most recent birth cohort are (at 162.3 cm, 63.9 in.) shorter than almost all Western-European women including Spain and Italy. As a consequence, a very considerable wedge has developed between black and white women's height of 1.95 cm (0.77 in.). The decline in their height is most likely related to the obesity epidemic caused by inadequate dietary balance. Black women in the age range 20-39 weigh some 9.5 kg (21.0 lb) more than their white counterparts. It appears that black females are experiencing a double jeopardy in the sense that both their increasing weight and the diminution of their physical stature are both substantial and are both probably associated with negative health consequences.

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Introduction

Prior to reaching adulthood, the physical stature of children and youth is determined by the balance between the intake of nutrients and expenditure of energy, called net nutritional status. Attained height essentially provides a historical record of nutritional status experienced from conception to late adolescence. In addition to genetic influences, adult stature is determined by the balance between the intake of nutrients and expenditure of energy in childhood and adolescence which, in turn, is determined by economic variables such as real family income and food prices. However, net nutritional status is also affected by the claims on the nutrient intake from incidence of diseases. Though quite complex in detail, growth is basically affected by food consumption as well as by the availability, effectiveness and accessibility of medical care. The private cost of medical services are therefore important as well as how the medical sector is organized, because that affects transaction costs, entitlements to health services as well as externalities, thereby determining quality and quantity of care. The distribution of income within a society also matters to average height because of Engel's Law, and because the production of height is concave with respect to nutrient intake. Furthermore income distribution also affects the accessibility of medical services with impact on height. Thus, the political economy of the health care system, education, transfers to the poor, and government policy toward equality (hence taxation policy) all matter. Genetics have a large effect at the individual level, but tend to be unimportant in the aggregate as long as the ethnic composition of the population is held constant (Fogel 1994, Tanner 1978, 1986; WHO, 1995). Hence, height is a measure of the biological well being of children and youth, whereby conditions in utero, in infancy, and during adolescence are particularly salient. Height of a population is a useful indicator of its general biological well being and correlates negatively with all-cause mortality risk until about 185 cm among men and 170 cm among women (Waalder 1984).

Why should economists be concerned about the physical stature of a population? Why does income not suffice? The answer is that children do not earn income themselves and therefore their well-being is affected only indirectly through household income. Their dependent status implies that money measures of their living standard have severe errors-in-variables bias and thus, other indicators should provide useful complementary perspectives on their living standard. Admittedly, height is neither a perfect nor comprehensive measure of welfare. Nonetheless, it is a useful marker of biological well being insofar as it is associated positively both with subsequent earnings as well as with health and longevity (Case and Paxson, 2006; Persico et al., 2004). Health is an essential component of the standard of living. For most people, health is so important to their quality of life that it is useful to refer to the “biological standard of living” (Steckel 2008). In sum, height is a marker of the biological well being of children and youth, whereby conditions in utero, in infancy, and during adolescence are particularly salient and are of course mediated by lifestyle choices of the parents such as the amount of fast-food consumption (Deaton, 2007, 2008; Fogel 1994; Komlos; 1998; Persico et al., 2004; Schulz, 2002; Steckel 1995).

While height obviously leaves many aspects of well-being out of consideration, in some respects it is actually more accurate than is usually the case with income. How much of household income accrues to children is not easily measured, for instance. Converting nominal income into real income tends to be fraught with uncertainty over time as well as cross-sectionally as the availability of spatial price indexes is limited. Furthermore, income is an input measure into well-being whereas height is an outcome indicator, generated with the inputs of food and medical services. Hence, it does need not go through a “black-box” prior to generating well being.

The newly released data of the NHANES 2005-2006 cycle enables us to consider the most recent trends in US heights stratified by gender and ethnicity. We use the National Health and Nutrition Examination Surveys to estimate trends in height, thereby extending the

work of Komlos and Lauderdale (2007a) by two years to 2006 using the newly available data. Several aspects of the results of the previous study warrant updating on the basis of the new evidence: a) the height of white men and women born 1975-79 began to increase after stagnating for c. two decades; b) a gap of about 1 cm (0.39 in.) emerged between the height of black and white men of the 1980s birth cohorts in favor of the latter; and c) The height of black females diminished substantially beginning with the 1975 birth cohort so that a 1.8 cm (0.71 in.) gap opened up relative to that of white women. These are recent and controversial findings based on relatively small samples; hence it is worthwhile to reconsider these results based on the newly released data. In addition, we compare recent differences in trends by income in order to gain some insights into the evolution of one aspect of biological inequality.

Data and Method

The NHANES data sets collected by the United States National Center for Health Statistics (NCHS) contain information on a cross section of the U.S. population. We analyze three of the later surveys – as we are interested in the more recent developments - NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2006) by concatenating them.¹ We adjust the given survey weights according to the formula given in Korn and Graubard (1999).² We limit the analysis to adults defined as those between the ages of 20 and 45, ages at which height is relatively stable at the individual level for both men and women. To ensure comparability both over time and with studies on other countries and to reduce uncontrolled heterogeneity³ (Rosenbaum 2005) through immigration, we confine our analysis to non-Hispanic blacks and non-Hispanic whites born in the United States. (Henceforth, we drop the designation non-Hispanic for sake of brevity); this leaves a working-sample of some 14,700 observations⁴ (Table 1).

Table 1 about here

We estimate the trend (by quinquennium) stratified by gender and ethnicity using regression analysis controlling for educational attainment and income (not reported here except

graphically). We use four categories for educational attainment: elementary school, some high school (w/o diploma), high school with diploma, and at least some college. The poverty income ratio (PIR) controls for household income.⁵ After the baseline regressions we estimate trends separately within three income strata: low (below 1.7 PIR), middle (1.7-3.4 PIR) and high (3.4-5.0 PIR).⁶ Because of the smaller number of observations in these regressions we estimate decadal averages.⁷ Unless otherwise mentioned, time generally refers to birth cohorts except when the reference is made to the year the survey was conducted.

Results

The overall trend: Men

The baseline trends are obtained from regression estimates with the levels of height calculated at the average level of education and of income for the particular group in the sample. The recent increase in white heights found in the earlier sample (up to 2004) (Komlos and Lauderdale 2007a) is substantiated by the inclusion of the new (2005-2006) data. After stagnating/declining for ca. two decades (1950-1974) white male heights began to increase with the 1975-79 birth cohorts reaching ca. 179 cm (70.5 in.) for the first time and then remaining at that level during 1980-86 (Figure 1). The increase of 0.85 cm (0.33 in.) in the height of the 1975-86 cohorts relative to those born in 1950-74 is statistically significant⁸ ($p=0.009$). However, compared to the previous peak of reached by the 1960-64 cohort the increase in 1975-86 of 0.48 cm (0.19 in.) is not statistically significant ($p=0.243$).⁹

Figure 1 about here

The height of black men stagnated between ca. 1960 and 1979 (Figure 1) but also started to increase recently although the uptick started a quinquennium later than that among whites. The increase of 0.71 cm (0.28 in.) among the 1980-86 birth cohorts relative to those of the 1960-1979 cohort is statistically insignificant ($p=0.239$). Furthermore, the gap that opened up between the height of white and black men in the previous sample among the birth cohorts of 1975-79 narrowed again after 1980. Nonetheless, there exists a 1.00 cm (0.39 in) gap ($p=0.053$) between

whites and blacks born 1975-86 in contrast to the 0.57 cm (0.22 in.) gap ($p=0.012$) that was obtained among the prior generation (born 1950-74).¹⁰ In other words, the gap has increased even if slightly.

The overall trend: Women

Similarly to the trend among white men, the height of white women has also increased recently to reach 164.76 cm (64.9 in.): among those born during the period 1975-1986 the height of white females increased by 1 cm (0.39 in.) ($p=0.000$) relative to those born between 1950 and 1974. However, their height was so low in the 1960s that the recent increases have only brought their height back to the approximate level of the late 1950's birth cohorts (Figure 1). The decline in height between the 1955-59 and 1965-69 cohorts was 1.07 cm (0.42 in.) and statistically significant ($p=0.010$). The difference in the height between the 1975-86 and the 1955-59 birth cohorts is a negligible 0.15 cm (0.06 in.) ($p=0.677$).¹¹

Only black women's height among the four (gender-ethnic) groups being considered has been decreasing during the last decade even though it had been practically constant between 1950 and 1974 even as white women's height was decreasing in the 1960s (Figure 1). Thus, black women born in the late 1960s were about as tall as were their white counterparts. However, the decline in black female's height noted earlier (Komlos and Lauderdale 2007a) has continued with the inclusion of new evidence (for 2005-06) and has become substantial. Relative to 1955-74 the decline among the 1975-79 cohort of 0.61 cm (0.24 in) was still insignificant ($p=0.338$) but diminution of the height of the 1980-86 cohort of 1.42 cm (0.56 in.) (relative to heights in 1955-74) did become significant ($p=0.003$).¹² As a consequence, the white - black difference in female height has been increasing markedly. While among those born 1945-1974 the gap was 0.53 cm (0.21 in) ($p=0.021$), the same as among men, after the 1975 birth cohorts it widened substantially to 1.95 cm (0.77 in.) ($p=0.000$) which is ca. twice as much as that among men.

Height by income groups: Men

We consider the trends in height within three income categories separately using regression analysis controlling for education (in three categories) as well as for PIR (within the income group). Among low-income men white-black height difference among the 1965-74 birth cohort was 0.87 cm (0.34 in.) in favor of blacks and insignificant ($p=0.146$). The height of white men increased by 1.2 cm (0.47 in.) more than that of blacks in the most recent decade, but the difference in the trend was also insignificant ($p=0.264$) (Figure 2). The largest height advantage of white men relative to that of blacks is found among the middle income group. The difference in this group widened substantially in 1965 and remained so in 1975 (Figure 3). Among the middle income group white men born 1965-1986 were 1.5 cm (0.59 in.) ($p=0.003$) taller than blacks, whereas those born in 1955-64 were ca. the same height (Figure 3). Among upper income men the height of blacks and whites remained unchanged and about the same (Figure 4).

Figures 2 - 4 about here

Considering height inequality among white men by themselves across the three income strata, we find that differences in height among the middle and upper income groups have been slight or nonexistent throughout the period considered (Figure 5). However, the differences between their height taken together and those of the lower income group were and remained substantial and statistically significant: 1.9 cm (0.75 in.) ($p=0.002$) in 1955-64 increasing to 2.8 cm (1.10 in.) ($p=0.000$) in 1965-74 and declining subsequently to 1.4 cm (0.55 in.) ($p = 0.043$) in 1975-1986. Only among low income white men did heights increase significantly between 1955 and 1975 (by 1.55 cm (0.61 in.) $p=0.031$). Thus there has been some convergence in height among white men across income groups in contrast to the white-black gap which has not converged.

Figure 5 about here

We next consider height inequality among black men by income group: we find that the difference in height was large between the low- and high-income groups (1.4 cm (0.55 in.), $p=0.004$) during the whole three decades considered (Figure 6). In contrast, the height of middle-income black men born in 1965-74 approached that of their low-income counterparts and increased parallel to them thereafter. The height of low-income black men increased between 1955-64 and 1975-86 by 0.78 cm (0.31 in.) but this was statistically insignificant ($p=0.328$) as was that of high-income men 0.42 cm (0.17 in.) ($p=0.627$). The decrease in the height of middle-income black men born 1965-74 relative to those born 1955-64 was 1.13 cm (0.44 in.) and statistically significant ($p=0.050$) but they recouped some of the decline by the third period under consideration so that the net decline experienced by those born in 1975-86 relative to 1955-64 was merely 0.26 cm (0.10 in.) and insignificant ($p=0.768$).

Figure 6 about here

Height by income groups: Women

White women were taller than blacks in all categories with the exception of low income women born 1965-1974 when blacks were actually taller than whites (by 1.61 cm (0.63 in.), $p=0.001$) (as were men) (Figure 2). Yet, during the following decade the advantage turned substantially in favor of whites also among the low income group as the latter increased by 3.9 cm (1.54 in) ($p=0.000$) more than blacks¹³ so that white women became 2.30 cm (0.91 in.) taller ($p=0.001$) in this group. Thus, the recent diminution in the relative height of blacks in the low-income stratum was considerably greater among females than among males.

Among middle-income women black and white heights were essentially the same until a considerable wedge of 2.12 cm (0.83 in.) ($p=0.015$) opened up in the most recent decade, i.e., the one beginning with 1975 (Figure 3). Among the high-income group the white height advantage has been greater than in the other income groups during the first two decades under consideration (Figure 4). During the period 1955-1986 the average height advantage of white women was 0.95

cm (0.37 in.) ($p=0.035$) but greater among the 1966-74 birth cohort. Thus, among women the relative height of blacks declined among the low and middle income strata.

Among white women the difference in height among high- and middle-level income groups was slight (0.37 cm (0.15 in.), $p=0.203$) during the period considered (Figure 5). However, the height of low-income women declined among the 1965-74 birth cohorts so that the gap relative to the middle-income group reached 1.56 cm (0.61 in.) ($p=0.015$) and then vanished among the subsequent cohort. Hence, the decline in heights in the late 1960s – early 1970s was primarily due to the decline obtained among the low-income group.

Among black women alone the ordinal stratification of height does not correspond to the income levels insofar as in the decade 1965-74 black women with the highest income were actually the shortest (Figure 6). However, during the 1975-86 decade the stratification of height by income becomes as expected with the highest income women being the tallest. The recent substantial diminution in height among black women is due primarily to that obtained among the low- and middle-income groups.

The ethnic differences in height by gender and income are summarized in Figure 7.¹⁴ Inequality in height among men is significant among the middle income group in the middle decade, while among women inequality rose significantly during the most recent decade among the low- and middle-income groups.

Figures 7 about here

Discussion

The inclusion of the 2005-06 wave of the NHANES data essentially substantiates the findings reported in Komlos and Lauderdale (2007a). After declining/stagnating for about a generation, the height of adult white men and women have begun to increase among the birth cohorts of c. 1975-1986, i.e., those who reached adulthood within the past decade (1995-2006) (Figure 1). Yet, the recent increase in height among white adult men and women brought them only slightly above the previous peak reached c. 1960 (by 0.48 cm (0.19 in.) for

men, and 0.15 cm (0.06 in.) for women). In other words, the recent increases basically overcame the prior downturn/stagnation in heights that lasted between ca. 1965 and 1974 among white men and between ca. 1960-1974 among white women. Hence, in spite of some recent improvements in the biological quality of life, the heights of US white adults have barely passed those obtained by their parent's generation and continue to be shorter than most Western- and Northern European populations (Komlos and Lauderdale 2007a). The decline in height among whites experienced by the birth cohorts of the 1960s was essentially confined to the low-income group both male and female, while the recent increase in height was also experienced by this group (Figure 5). The height of high- and middle-income white men and women has not changed appreciably during the three decades considered.

Among black men the recent upswing in height (0.71 cm (0.28 in.)) began a quinquennium later than among whites and is statistically insignificant compared to the prior two decades (Figure 1). The height gap between white and black men has increased by 0.43 cm (0.17 in.) during past decade compared to the previous quarter century. However, this increase is insignificant ($p=0.43$) although the white-black gap itself has been significant throughout the period considered. The 1 cm (0.39 in.) gap of the most recent decade is due mainly to the differences in height in the middle income group (Figure 7). The size of this gap is only slightly smaller than the one existed in Georgia at the time of the Emancipation Proclamation (Komlos and Coclanis 1997, 439).

The height of black women alone has been declining during the most recent decade both absolutely and relatively to that of white women, and did so substantially (Figure 1). The decline of 1.42 cm (0.56 in.) during the past quinquennium relative to those of the birth cohorts of 1955-74 is statistically significant and is due mostly to the decline in height among the low- and middle-income groups (Figure 2 and 3). Such steep decline in height is practically unprecedented in modern US history.¹⁵ As a consequence, a very considerable wedge has developed between black and white women's height of 1.95 cm¹⁶ (0.77 in.), which

is about twice as large as that among men and well above differences obtained earlier in the 20th century of below 1 cm (0.39 in.) (Figure 1). In fact, the birth cohorts of 1965-69 were the same height as whites, but the gap has successively widened since then. Black women of the most recent birth cohort are, at 162.3 cm (63.9 in.), shorter than almost all female populations in Western Europe including that of Spain and Italy (Komlos and Lauderdale 2007b).

Considering inequality, there has been some convergence in height among white men across income groups due primarily to the significant increase obtained among low income men (Figure 5). In contrast, among black men there has not been a convergence in height across income groups (Figure 6). The difference between the height of low and high income black men has remained about 1.4 cm (0.55 in.) throughout the period considered.

Among women the height of blacks relative to whites deteriorated most among the low and middle income strata but not among the high income group (Figure 7). Among white women the difference in the height of the high and middle income groups has remained practically unchanged throughout the three decades considered (Figure 5). In contrast, the height of low-income women has declined markedly among the 1965-74 birth cohorts but then increased sufficiently to converge to the height of the middle income group. Among black women height has declined among the low and middle income groups substantially during the most recent decade (Figure 6).

In sum, black women's height has been diminishing during the final decade under consideration in both the low and middle income groups (but not among the high income group) both absolutely and relatively to those of white women (Figures 6 and 7). The white-black height gap is also quite large among the low and middle income groups, reaching or exceeding 2 cm (0.8 in.). Among men the white height advantage is not so blatant.

The substantial increase in income inequality in the US during the last quarter of the 20th century is extensively documented (Autor et al. 2008). For example, the gini coefficient

of household income inequality increased between 1975 and 1992 by some 9% (Jones and Weinberg 2000). Some biological indicators followed suit: relative mortality rate disparities narrowed until 1980 and then widened among those younger than age 65 (Krieger et al. 2008). There is also an increasing socio-economic gap in mortality among children (Singh and Kogan 2007). In this light, the trends in height inequality are puzzling in as much as black-white height inequality has risen substantially only among females but not among males which is not evident in the income inequality data. Moreover, considering whites and blacks separately one does not discern a widening of the height gap across the three income groups which is also contrary to income inequality trends.

A possible reason for this divergence could be that, “consumption inequality has increased much less” than income inequality (Krueger and Perri, 2006) and that the inequality of spending on essentials such as food and medical services for children could have increased less than that of average consumption. Moreover, social mobility is an omitted variable in this analysis that could affect the results. The reason is that if someone whose parents are in the lower income group moves up the income gradient and she herself has a middle-level income then she might bring down the average height of the middle income group. After all, her height would have been affected by the environment provided by her low-income parents. Thus, upward social mobility decreases mean heights in the receiving group, while downward social mobility would increase heights in the receiving income class for similar reasons.¹⁷ That could be a reason, for example, why the height of lower-income white men rose in the most recent period and hence there is some convergence in height among white men in spite of the rise in inequality.

The black-white height inequality is also a conundrum in light of the fact that the gap in longevity is higher among men than among women and the gap has not changed substantially between 1983 and 2007¹⁸ (Harper et al. 2007). Moreover, the contribution to the

white-black longevity gap of children between the ages of 0 and 14 years is also slightly higher among boys than among girls and the gap in this age group has declined by 27% among boys and 24% among girls (Harper et al. 2007). Thus, there appears to be a convergence in the longevity rates by ethnicity in contrast to the pattern obtained for height and for income. The distribution of life satisfaction has also been considered from the viewpoint of inequality. Stevenson and Wolfers (2008) find that two-thirds of the black-white happiness gap has disappeared since 1972, and that the male-female gap has vanished entirely.

Although there is some evidence that white-black height inequality increased recently, the evidence is confined in the main, to women, while among men the increasing gap is slight and not convincing. However, the gap between white and black women is truly phenomenal. The finding is suggestive of the fact that the difference between the median income of white and black families increased from \$18,400 in 1975 to \$25,000 in 2005 (in 2004 dollars) (Isaacs, 2007). Furthermore, the trend is probably exacerbated by poor nutritional balance associated with the obesity epidemic which affect black females more than whites (Chou et al., 2004, Cutler et al., 2003; Komlos and Breitfelder 2008; Komlos, Breitfelder and Sunder, 2009; Philipson and Posner, 2003; Rashad et al., 2006). Black females in the age range of 20-39 weigh some 9.5 kg (21 lbs) more than their white counterparts, whereas the weight of males is practically identical (Ogden et al., 2004, Table 11). It is quite likely that the greater incidence of obesity induces an earlier onset of puberty and premature closure of the epiphyses among black teenage girls, which in turn is associated with a shorter adult height (Biro et al., 2001, Komlos and Breitfelder, 2007, Rogol et al. 2002, Sunder, 2008). This is a useful hypothesis for further research as black girls are taller than white girls until the age of 15 when their growth decelerates rapidly whereas among black boys adolescent growth persists longer so that they do not fall behind by as much as girls relative to their white counterparts (Komlos and Breitfelder 2008, p. 14).

In sum, an important finding based on the recently released NHANES data is that the height of white men and women recovered all of the losses experienced by the birth cohorts of the 1960s and early 1970s even if their height did not exceed markedly the previous peaks reached c. 1960. The second crucial finding is that the height of black women deteriorated both absolutely as well as relatively to that of white women. In other words, the substantial difference between white and black female heights that was already evident in the last NHANES survey that ended in 2004 has become even more striking with the inclusion of the 2005-06 data, reaching nearly 2 cm (ca. 0.8 inch). This finding implies a striking setback for the biological well being of black females, the causes of which need to be addressed in clinical research. It appears that black females are experiencing a double jeopardy in the sense that both their increasing weight and the diminution of their physical stature are substantial and are both probably associated with negative health consequences. The size of the effects is such that public health intervention to “bailout” the American diet might well be considered.

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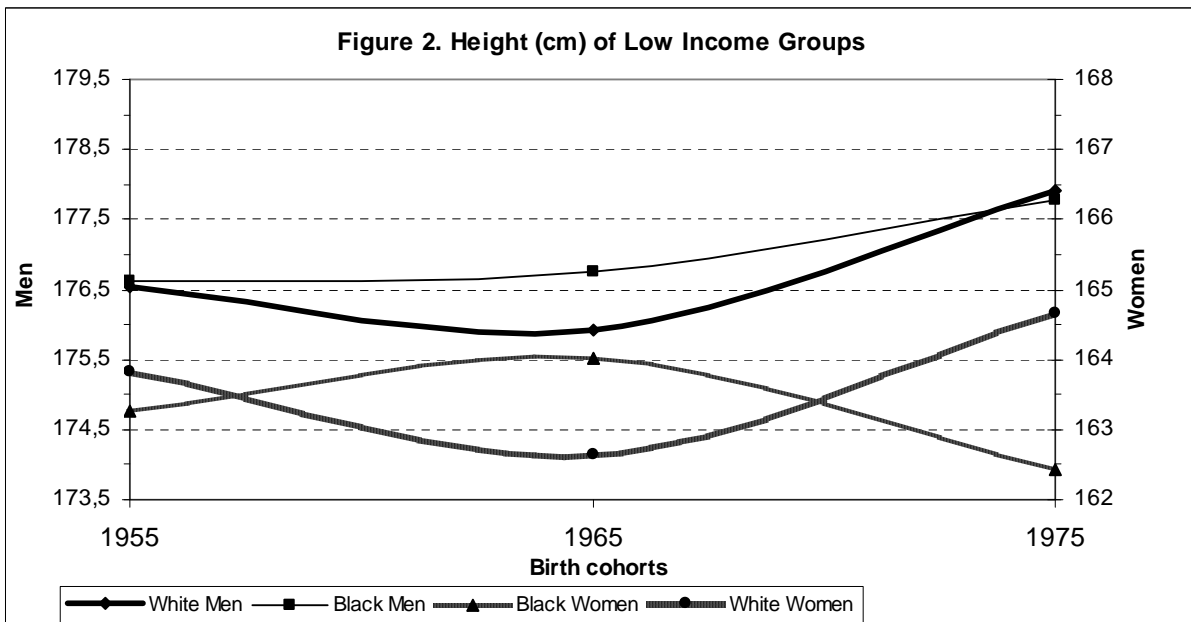
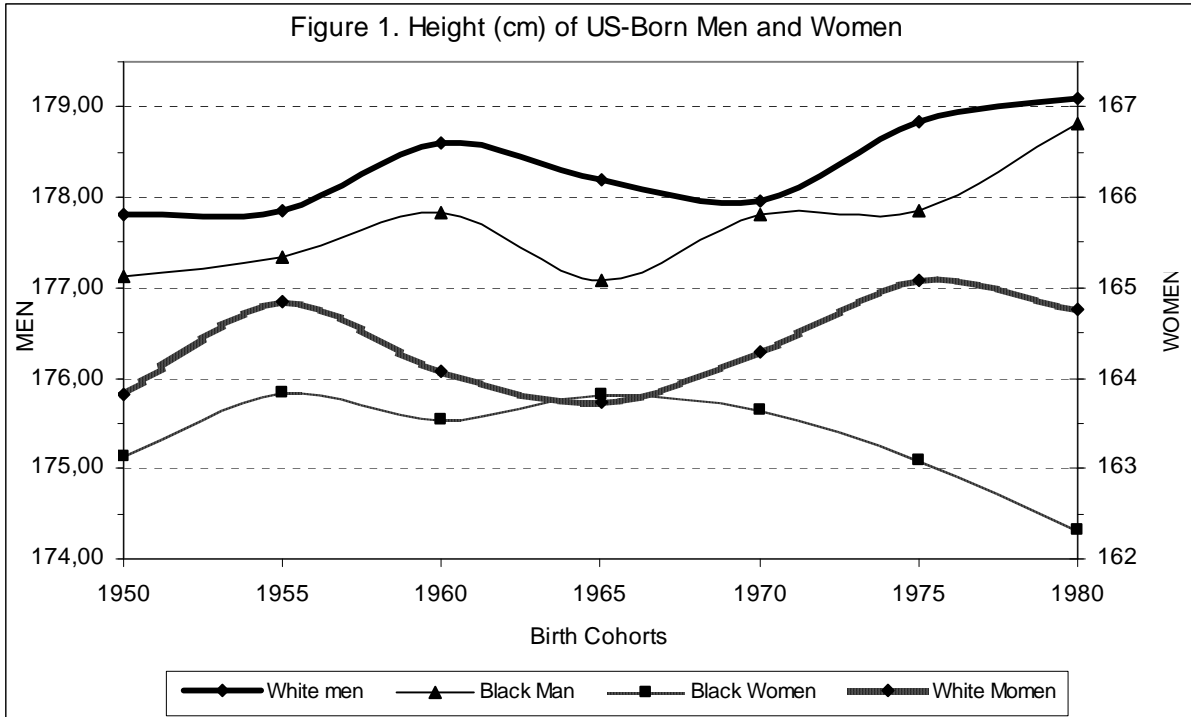
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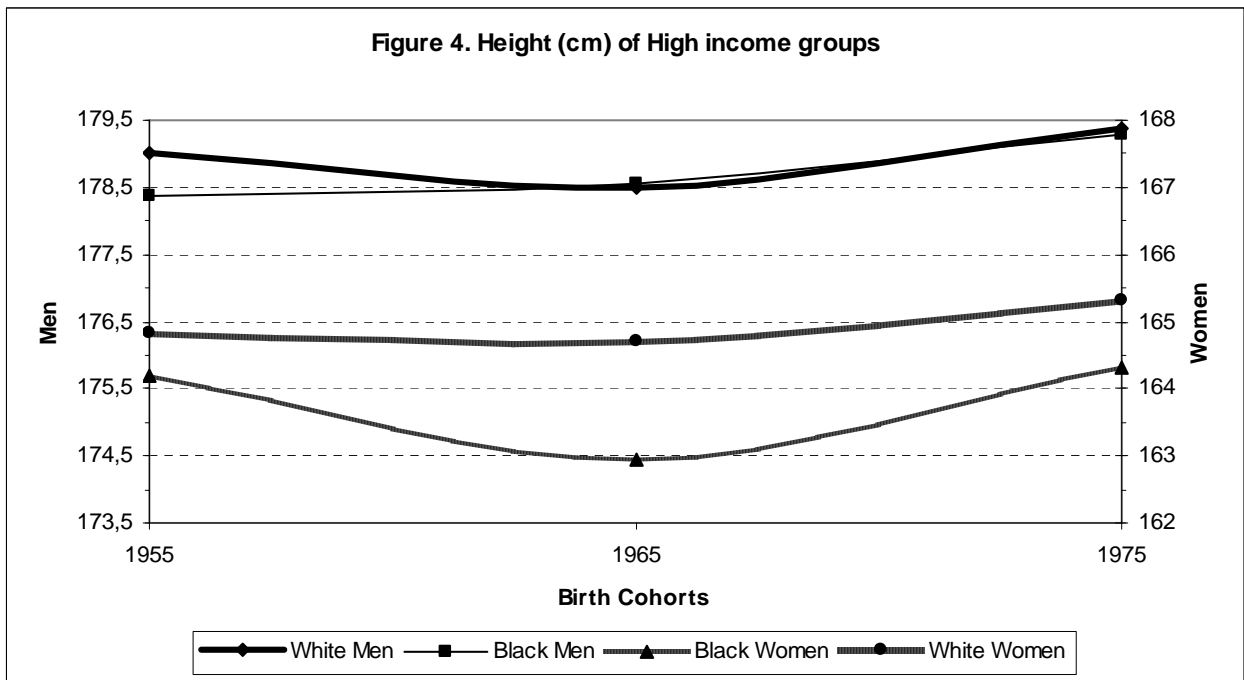
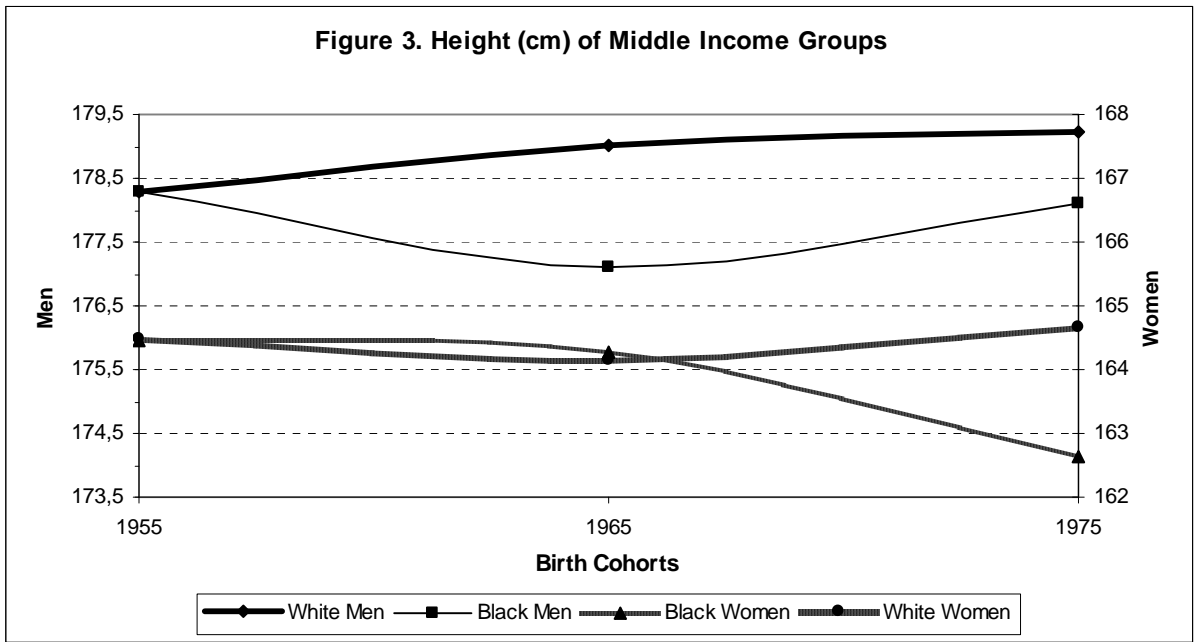
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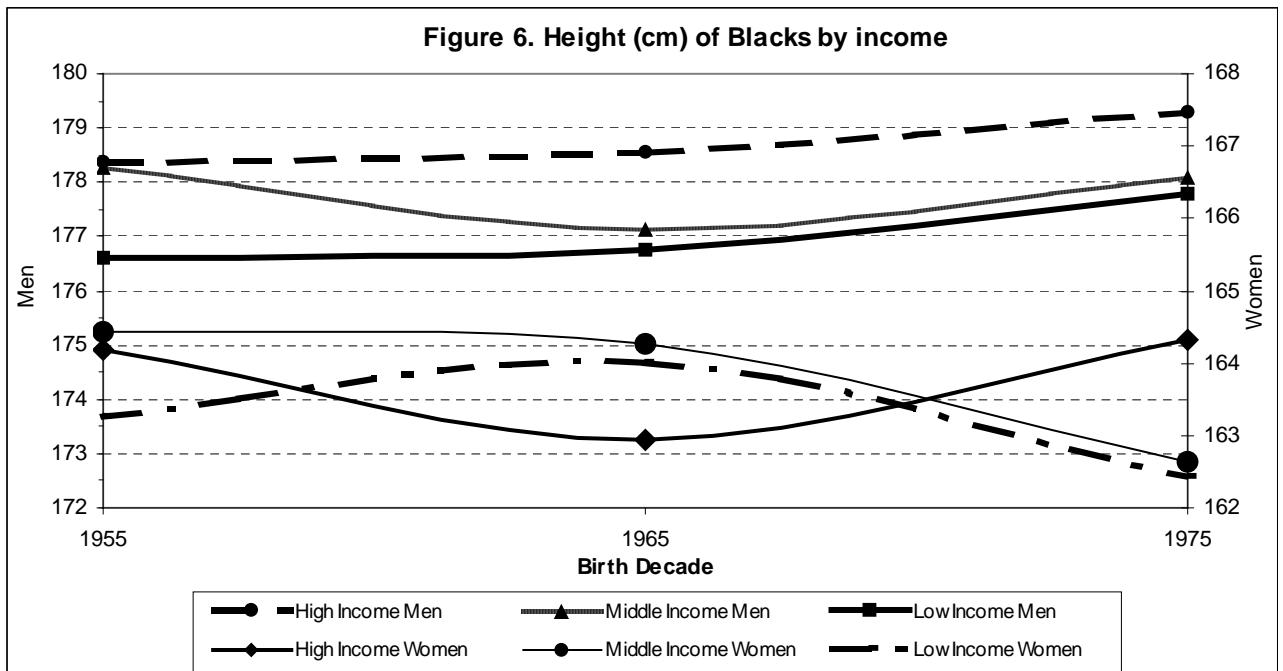
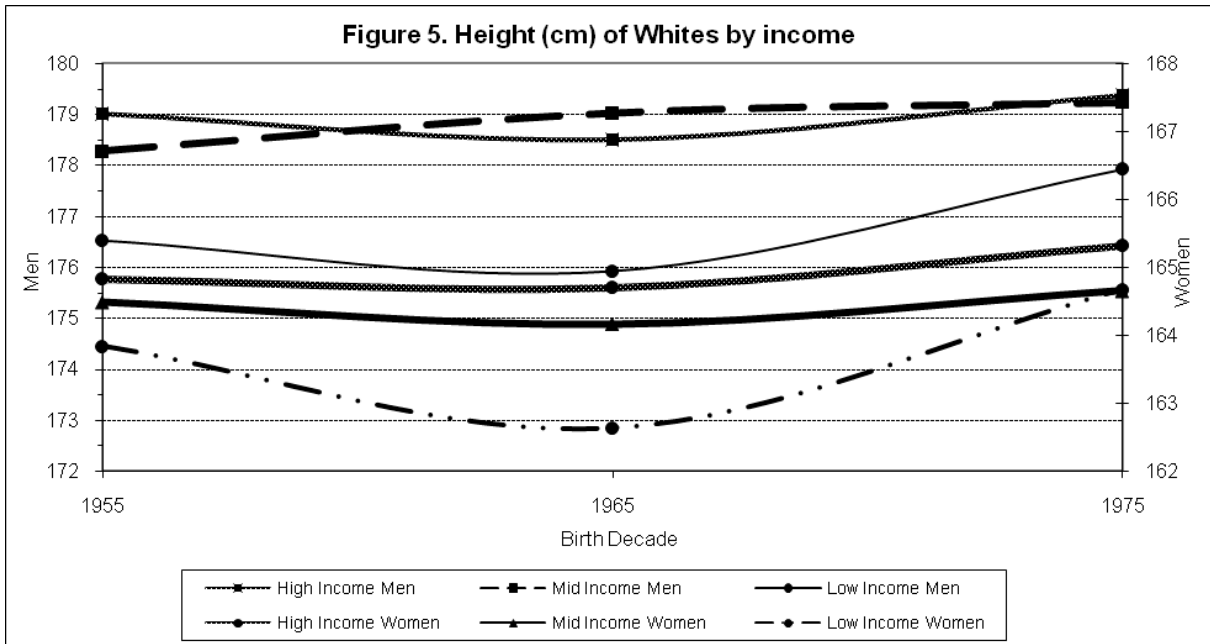
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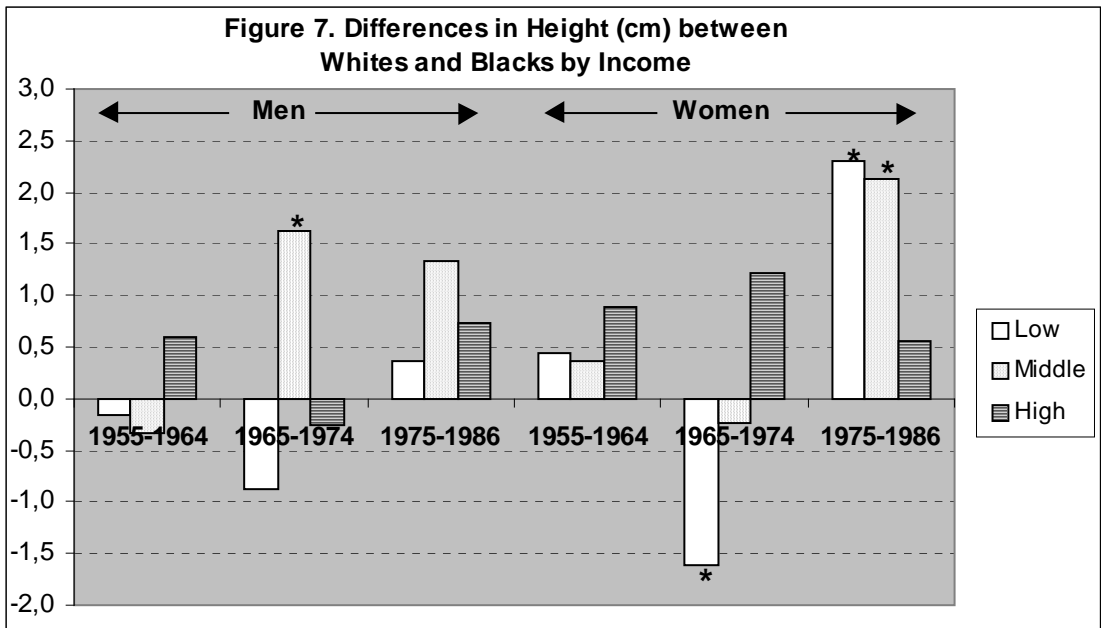
Birth Cohorts	Men		Women	
	White	Black	White	Black
1930	150	12	152	34
1935	274	30	302	46
1940	316	38	362	40
1945	549	194	640	218
1950	697	272	726	336
1955	646	348	758	436
1960	534	354	599	441
1965	481	374	586	448
1970	358	207	505	279
1975	283	135	429	164
1980	254	154	352	204
Total	4542	2118	5411	2646

Sources: Nhanes 2-3 and Nhanes 1999-2006.









Endnotes

¹ Data are compiled from <http://www.cdc.gov/nchs/nhanes.htm>

² The survey weights have to be recalculated separately for the four ethnic/gender combinations using formula 8.2-4 (p. 282).

³ Information on Hispanic ethnicity is only available for NHANES III and Current NHANES. Lack of information in earlier surveys does not constitute a major problem, though, inasmuch as Hispanics were not intentionally oversampled before NHANES III. In order to further limit the effect of immigration, we also exclude those persons who spoke a language other than English at home.

⁴ PIR values are missing for 780 observations that are also not taken into consideration in the regression analysis.

⁵ One can make a relatively stable income comparison over time using PIR as it adjusts nominal income for family size and inflation. Ideally we would like to have education and income of the subject's parents, because those are salient during the time the child is growing. However, the trends are similar if the income variable is left out of the regression. Lacking that information we use his/her current income in adulthood as well as his/her educational attainment as a proxy variable. In any event, there is a high correlation between father's and son's socio-economic status. Only 9% of sons whose fathers were in the lowest quartile of the income distribution ended up in the top quartile during the second half of the 20th century (Blanden, 2005; Perrucci and Wysong, 2003; Wysong and Perrucci, 2006) and intergenerational social mobility has diminished over time (Schmitt, 2005). Hence, it is not so far-fetched to include the subject's own income in the regression as a proxy variable for parental socio-economic status.

⁶ In many of the samples PIR is top coded at 5.

⁷ In these regressions we reduce the number of educational variables to three by combining those with an elementary school education and those with some high school but without a diploma into a low educational category.

⁸ Throughout the paper the p values reported are calculated using robust standard errors adjusted for clustering using STATA/IC 10.0's *svyset* command identifying a complex survey data (designating strata and primary sampling units (cluster)).

⁹ The decline in heights among the 1970-74 cohorts of 0.58 cm (0.23 in.) was also not statistically significant compared to the 1960-64 cohort (p=0.247).

¹⁰ This estimate is not controlled for income or educational attainment in contrast to the values found in Figure 1.

¹¹ However, the increase in height 1975-86 relative to the long prior period 1945-74 (during which heights were essentially constant) is 0.88 cm and is statistically significant (p=0.001).

¹² The substantial decline in height among black females 1980-1986 cohorts is not due to age effects. The height of 20-22 year olds in this cohort is 162.46 cm (63.96 in.) (N=129) whereas that of 23-26 year olds is 162.62 cm (64.02) (N=71).

¹³ The height of blacks decreased by 1.6 cm (0.63 in.) while that of whites increased by 2.3 cm (0.91 in.).

¹⁴ The slight and scattered difference between these results and those depicted in Figures 2-4 stem from the differences in the estimation models. The estimates in Figure 7 are pair wise without controlling for education (or income variation within the income groups) whereas the latter set of estimates are made separately for whites and blacks controlling for both education and for income variation within the income group. In spite of differences in estimation technique, the pattern remains essentially unchanged.

¹⁵ The height of white men of the antebellum South born in the 1840s who experienced the ravages of the Civil War declined at a faster pace of 2 cm (0.79 in.) per decade (Komlos and

Coclanis 1997). The decline in height in Europe during the Industrial Revolution of the 18th century was at a rate of about 1.3 cm (0.51 in.) per decade (Komlos 1989).

¹⁶ The difference in height during slavery was about 2.6 cm (1.02 in.) (Komlos and Coclanis 1997, 438).

¹⁷ Sheila Johansson has pointed out that differential rates of fertility would have similar results. That is to say, if tall parents have a lower birth rate than shorter parents then the mean height of the population might decline as more shorter genes are passed on to the next generation. She refers to this phenomenon as “sub-group heterogeneity in unstable forms” (Johansson and Kasakoff 2000, Johansson 2000).

¹⁸ Factoring out the effect of external causes.