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Height, Health, and Income in the US, 1984-2005

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Abstract

Height has been associated with better physical health when outcomes such as diabetes, heart disease, and obesity are considered, yet stature is rarely used in predicting comorbidities or as a proxy for physical health when analyzing outcomes such as income. Since height is a more exogenous measure than variables likely to be affected by lifestyle changes, such as obesity, observing labor market outcomes based on height may be revealing. In addition, gender and racial differences must be taken into account when analyzing the effects of height on physical health and labor market outcomes. This study utilizes the 1984 to 2005 samples of the Behavioral Risk Factor Surveillance System in estimating trends in height over time by gender and race, and in analyzing the relationship between height and physical health and labor market outcomes in the United States. Trends show that height has not changed substantially at a time when physical health, as indicated by the incidence of obesity, Type II diabetes, and cholesterol, has deteriorated, and earnings disparities across racial gaps persist. Results at mean values for males indicate that being 10 cm taller is associated with a 14-47% increase in obesity, an 8-13% reduction in cholesterol prevalence, and a $1,874-$2,306 income premium. For females, results indicate that being 10 cm taller is associated with an 8-18% reduction in cholesterol, a 14% reduction in diabetes for white females, and an $891-$2,243 earnings premium.

JEL classification: I10; I12

Keywords: Height; Income; Health production; USA; Physical stature; Anthropometry

I. Introduction

Height is an underutilized variable in predicting health outcomes across populations and yet is a strong predictor of early-life biological health (Komlos and Lauderdale 2007; Komlos and Baur 2004; Tanner 1978). Height can be used as a proxy for physical health in analyzing a variety of outcomes such as those regarding the labor market. One concern when analyzing the effect of health on income is reverse causality, in that having a lower income may affect health negatively. Thus the potential issue with having an independent variable that is not completely independent, or one that is endogenous, may be of concern. To the extent that adult height remains constant over time until circa age 45, contemporary lifestyle variables do not affect it. It can therefore be considered an exogenous measure of physical health.

Nutrition and environmental conditions in childhood are determinants of adult stature, yet are more useful in determining differences across populations than in determining how tall an individual may become within a country.[1] Genetics plays a much greater role in the latter, thus allowing for an independent factor in predicting subsequent health.

A study by Persico et al. (2004) analyzes the wage premium received by taller white men. Using data from the 1979 cohort of the National Longitudinal Survey of Youth and Britain's National Child Development Survey (NCDS), they find that adolescent height at age 16 affects the wage premium more than adult height. They mainly attribute this to self-esteem and find that the effect is partially mediated through participation in after-school activities when in high school. They do not adjust for self-reported height, which is measured to the nearest inch, raising the spectre of errors in the independent variable as height for younger individuals may be even more prone to error (Himes and Faricy 2001). Their findings are supplemented by those found by Sargent and Blanchflower (1994), who find an effect of height at age 16 on subsequent labor market outcomes using the British NCDS, and Loh (1993), who finds a positive effect using the NLSY. A recent study by Case and Paxson (2006) argues that the wage premium experienced by taller persons is largely due to height's correlation with cognitive ability. They use the NCDS in addition to the British Cohort Study (BCS), the US National Health Interview Survey (NHIS), and the US Panel Study of Income Dynamics (PSID).

Several studies have investigated the relationship between physical health and income, using measures of obesity as proxies for physical health or beauty. Averett and Korenman (1996) use a sample of 23- to 31-year-olds to analyze the effects of the body mass index (BMI) on income, marital status, and hourly pay differentials. Using the 1979 National Longitudinal Survey of Youth, they control for family background by comparing same-sex siblings and find that prior measures of BMI affect income of white but not African-American females. They find mixed results for males. Additional studies (Cawley 2004; Conley and Glauber 2005) reach similar conclusions using different methods of dealing with the endogeneity of obesity. On the other hand, some studies (Baum and Ford 2004) find little effect of obesity on labor market outcomes.

In the present study, trends in heights are analyzed using the Behavioral Risk Factor Surveillance System (BRFSS) from 1984, the year it was first launched, to 2005, the most recent year available at this time. The sample is stratified by gender and by four race/ethnicity categories.[2] The effect of height on various physical health outcomes, such as obesity, cholesterol, and diabetes, are then examined. A recent study has linked shorter height to coronary heart disease (Wannamethee et al. 2006), with which health comorbidities such as obesity, high cholesterol, and diabetes are strongly associated.[3] Regressions with income as the dependent variable are analyzed in order to estimate the effect of physical health on income. In this sense, height may serve as a proxy for the latent variable physical health; yet height may also affect income through height-specific discrimination.

II. Data and Methods

Adults 21 to 45 years of age from the BRFSS are used in this analysis, since most individuals have reached full height by age 21 and may experience declines in height after 45. Heights in this age range are constant and are thus independent of contemporary effects.[4] Since the oldest person was 45 in 1984 and the youngest person was 21 in 2005, this age range provides us with information on birth cohorts from 1939 to 1984. As the largest telephone-based health survey available, the BRFSS has tracked health conditions and risk behaviors for adults 18 years of age and older in the US. The survey is conducted by state health departments in collaboration with the Centers for Disease Control. While only 15 states participated in 1984, the number grew to 33 in 1987, to 45 in 1990, and to all 51 states (including the District of Columbia) in 1996.[5] More than 350,000 adults are interviewed each year, with response rates hovering around 50%.[6] The average number of interviews per state ranged from approximately 800 in 1984 to circa 3,500 in more recent years. These data are publicly available from the Centers for Disease Control at http://www.cdc.gov/brfss, and provide information on a variety of personal characteristics, including gender, age, education, marital status, family income, and state of residence.[7] In addition, measures of general health, cholesterol, cardiovascular illness, and diabetes are included, as well as anthropometric measures such as weight and height.[8] Before observations with missing values were deleted, the number of observations for all years was nearly 3 million. This ranges from a low of 12,258 observations in 1984 to a high of 356,112 observations in 2005.

To mitigate error due to self-reports, all heights used in this analysis are adjusted for self-report error. While opinions are mixed regarding the validity of self-reported height, it is generally agreed that men in particular tend to over-report height and women tend to underreport weight (Himes and Roche 1982; Kuczmarski et al. 2001; Spencer et al. 2002). Using the relationship between objective measures of height and self-reported values from the National Health and Nutrition Examination Survey (NHANES), the height values in the BRFSS sample were adjusted.[9] Because NHANES gathers information on both self-reported and actual weight and height, height is adjusted in the BRFSS using this information. The adjustment is done separately by age, gender, and race, and has previously been used (see, for example, Chou et al. 2004; Cawley 1999). Using NHANES III, NHANES 99-00, NHANES 01-02, and NHANES 03-04, actual height was regressed on self-reported height and its square for individuals 21 years of age and older. The coefficients obtained (reported in the Appendix), were then applied to self-reported height for the corresponding race-gender groups in the BRFSS in order to predict actual height.[10]

Between 1984 and 2005, the US experienced demographic changes in terms of racial and ethnic composition. Weighted BRFSS data reveal that white non-Hispanic Americans comprised 85% of the population in 1984, yet only 70% of the population in 2005. The percentage of individuals reporting an ethnicity of Hispanic origin almost tripled during that time, increasing from 5% in 1984 to 14% in 2005. The most stable group was the African-American one, with an increase between 1984 and 2005 of two percentage points, from 8% to 10%.[11]

III. Results

[INSERT FIGURES 1 and 2 and TABLES 1a & 1b HERE]

The trends in corrected height by birth cohort for males and females using BRFSS sampling weights are shown in Figures 1 and 2.[12] These indicate that during the period under consideration heights have increased slightly among whites but remained practically unchanged among blacks and Hispanics. This can also be seen by observing the first rows in Tables 1a and 1b, which show height for the US as a whole (and also by state of residence) for the eight race-gender groups. Height of white males increased by 2.9 cm between the 1940-44 and 1980-84 birth cohorts ($p<0.0005$). Male heights in the black and "other" racial categories increased by 1.5 cm ($p=0.027$) and 4.6 cm ($p<0.0005$), respectively. Male heights in the Hispanic category decreased but not significantly, by 0.6 cm ($p=0.372$). Heights increased for white females (+1.6 cm, $p<0.0005$) and females in the "other" racial category (+3.2 cm, $p<0.0005$), and decreased by 2.7 cm for Hispanic females ($p=0.001$). Height for black females remained unchanged (+0.1 cm, $p=0.876$).

[INSERT TABLE 2 HERE]

The top portion of Table 2 shows changes in height for the eight race-gender categories by birth cohort, combined into five-year increments. While it can be seen that height for white males and females increased significantly every decade, the trend is not as consistent for other ethnic categories. For black males, significant increases occurred for the 1970-74 and 1980-84 birth cohorts, while no significant changes in height are revealed for Hispanic males and black females.

After controlling for confounding factors such as education, income, employment status, marital status, state of residence, and year of survey, trends in heights by birth cohort do not differ dramatically, although some differences emerge (regressions are not reported here). Figure 3, which shows trends in predicted heights for males by birth cohort, is comparable to

Figure 1 in terms of overall changes: Predicted height for white males increases by 1.6 cm ($p<0.0005$) from the 1940-44 cohort to the 1980-84 cohort, and predicted height for males in the "other" racial category increases by 2.6 cm ($p<0.0005$). Predicted height for black males essentially remained unchanged (an increase of 0.3 cm, $p=0.122$), while predicted height for Hispanic males *decreased* between the 1940-44 and 1980-84 cohorts (by 0.7 cm, $p=0.010$). Trends in predicted heights for females (Figure 4) are comparable to trends in Figure 2 in terms of changes between the oldest and youngest cohorts with the exception of black females. Significant increases are seen for white and "other" category females (+1.0 cm, $p<0.0005$, and +1.6 cm, $p<0.0005$, respectively), while decreases in predicted heights occurred for Hispanic females (-0.7 cm, $p<0.0005$). Black heights remained essentially unchanged.

[INSERT FIGURES 3 & 4 HERE]

The relatively small changes in height compared to the first half of the century occurred at a time when the so-called diseases of affluence, such as heart disease, cholesterol, and diabetes, saw drastic increases in prevalence rates. Obesity prevalence from 1988 to 2005 in the sample almost tripled, cholesterol prevalence increased from 15% to 23%, and diabetes prevalence increased from 2.2% to 4.2%. It is therefore possible that the stagnation in heights is partially responsible for these outcomes. Furthermore, predicted heights for whites increased at a time when no significant change occurred for African Americans. If height has a significant effect on income, the stagnation in heights for African Americans may play a partial role in explaining the persistence of the black-white earnings gap. In our sample average real family income (in 1983 dollars) was $32,257 for white males in 1984, compared to $19,774 for African American males. This approximate $12,000 gap was reduced to $11,000 in 1988 but then again increased to almost $12,000 in 2005, with white males reporting a family income of $39,699 and

African American males an income of $27,998.[13] Trends in height may thus play a role in explaining trends in health and income. Height influences on various measures of health and income should therefore be further explored, which is the next aim of this study.

To investigate the effect of height on various measures of physical health, the following equation is estimated:

$$Health = \alpha_0 + \alpha_1 Height + \alpha_2 Height^2 + \overline{\alpha_3} X + \overline{\alpha_4}(years) + \overline{\alpha_5}(states) + \varepsilon,$$

where *Health* represents one of the following: obesity, general health, cholesterol, or diabetes; X includes education, age, income, employment status, and marital status; *years* represents indicators for year of survey; *states* represents indicators for state of residence; and ε is an error term. A quadratic term for height is included to account for the likelihood that an additional unit at higher levels will have less of an effect on the dependent variable as that of an additional unit at lower levels. Sampling weights are not employed in the regressions as stratification obviates the need for them (DuMouchel and Duncan 1983; Maddala 1983).[14] Due to the large sample size, linear probability models are estimated rather than logit or probit ones when a binary variable is the outcome (Maddala 1983). Regressions are stratified by both gender and race/ethnicity as F-tests for changes in coefficients across gender and race are statistically significant at the 1% level. Characteristics of the BRFSS sample used in this analysis (weighted) from 1984 to 2005 are shown in Tables 3a and 3b for males and females, respectively.[15]

[INSERT TABLES 3a & 3b HERE]

The potential effect that height has on income is estimated as in the above equation with ln(*Income*) as the dependent variable, where ln(*Income*) is the natural logarithm of real annual family income in 1982-84 dollars.[16] A critical disadvantage of the income variable in the BRFSS is that it measures household income rather than individual income. The sample is therefore restricted to those who are employed. While this restriction allows for personal rather than household income to be used, it prevents the estimation of the effect of height on employment and introduces bias arising from selection into employment. This will likely lead to a bias toward zero of the height coefficient, since those who are employed more likely to have been selected into employment due to the monetary benefits it provides.[17] Thus, this restriction would yield more conservative results, at least for males who are more likely to be the breadwinners in the family.[18] The sample is further restricted to those who are unmarried and who report having only one adult in the household. This further ensures that personal income is the outcome rather than family income, a limitation of the BRFSS data. Because these restrictions may be of concern to the reader, results for the unrestricted sample, which includes all respondents regardless of employment or marital status, are shown in the last row of Table 4 for comparison. Note that the aim in this exercise is to observe differences in income related to height (with its correlates), not necessarily to gauge the wage premium due to height discrimination. Correlates of height that may be related to the income premium include unobserved characteristics associated with being a certain height when younger, possible productivity differences, undetermined health status, social status, and discrimination by employers or consumers.

Ordinary least squares regression results where the probability of being obese, cholesterol probability, diabetes probability, and the log of income are the outcome variables shown in Table 4. All regressions include birth cohort; dichotomous indicators for attending some high school, graduating from high school, attaining some college education, and receiving a college diploma; employment status; marital status (married, divorced, widowed); year dummies; and state dummies. (These coefficients are not reported here.) The health regressions also include family income and its square on the RHS. Effects at the mean values of the heights in each race-gender group are reported. These are obtained through including height and its square in the regressions as independent variables, to capture possible nonlinearities, and taking the values of the coefficients at the corresponding mean height values. Sample sizes vary since the years used for income regressions (1984-2005) are slightly different from those used for health regressions (1988-2005). Since information on diabetes was not available prior to 1988 in the BRFSS, and cholesterol data not available before 1987, health regressions utilize years 1988 through 2005.[19]

[INSERT TABLE 4 HERE]

Results for males indicate that height is significant at the 5% level in all cases (Table 4). Height is consistently associated with a higher probability of being obese for males. A 10 cm increase in height for white males is associated with a 0.025 percentage point increase in obesity probability, an increase of 13.74% in obesity prevalence. This effect is greater for the other three ethnic categories. Results for cholesterol are as expected, with height consistently being associated with reductions in cholesterol prevalence. For a black male with a height of 177 cm, an increase in height of 10 cm leads to a decline in cholesterol probability of 0.015 percentage points, a 7.89% decrease. Slightly larger effects at the mean are seen for the other three ethnic categories. With the exception of black males, for whom there is a positive effect of height on diabetes probability, the effect of height on diabetes for males is negative and significant, albeit small in magnitude. Coefficients on the education and income variables (not shown) reveal these factors to have the expected positive effects on health, in line with the health economics literature (Grossman and Kaestner 1997). Being employed is consistently associated with lower obesity, lower cholesterol, and lower diabetes (also not shown). Coefficients on birth cohort exhibit the expected negative effects on adverse health outcomes; those who are younger have lower obesity, cholesterol, and diabetes probabilities. Married males of all races have higher obesity and cholesterol probabilities.

Results for females are similar in the case of cholesterol and diabetes prevalence. However, height is associated with declines in probabilities of being obese for white and black females. In particular, a 10 cm increase in height is associated with a decline in obesity probability of 0.014 percentage points for a white female approximately 5’4” tall, an 8.92% decrease from the average obesity prevalence. This decrease is also significant but much smaller in magnitude for black females (0.002 percentage points). This is not the case for females in the Hispanic and “other” racial categories who, similarly to males, show increases in obesity associated with increases in height. Again, this may be due to the nature of the components making up BMI and its debatable use in accurately measuring obesity. Other coefficients for females (not shown) reveal being married to be associated with *lower* probabilities of being obese for whites, blacks, and females in the “other” racial category. Employment status for the most part has no significant effect on health outcomes. As with males, those in higher birth cohorts have lower probabilities of obesity, cholesterol, and diabetes.

Taller individuals enjoy a wage premium after controlling for demographic and geographic characteristics (bottom section of Table 4).[20] This is true for all race-gender groups. A white male experiences a 5.4% increase in income for every 10 cm increase in height. In dollar terms, this is equivalent to an approximate increase of $1,924 in annual income. White females experience an increase of 5.4%, or $1,818. Since the sample is limited to those working, unmarried, and living alone, any difference between male and female premiums is unlikely to be due to income from other sources. Males in the unrestricted sample experience greater effects ($2,600 for white males), while females in the unrestricted sample, with the exception of

African-American females, experience smaller effects ($1,347 for white females), revealing females' higher probability of relying on spousal income.[21]

Studies estimating the effect of obesity on wages find either insignificant or slightly positive effects of obesity on wages for males (Cawley 2004; Zagorsky 2005). It is possible that height, also correlated with higher education, is what allows these individuals to provide employers with a presence that leads to higher wages (Averett and Korenman 1996; Cawley 2004; Conley and Glauber 2005). Studies for females find a negative effect of obesity on wages for the most part, and so the effect of height on income (which is *negatively* correlated with BMI for females) may more purely reflect a physical health effect. The larger effects of 10.4% and 10.7% observed for Hispanic males and females are mainly due to estimating the effects at a lower value.

IV. Discussion

Heights have essentially stagnated in US since World War II relative to Western and Northern Europe; before that time, Americans had been the tallest in the world (Komlos and Lauderdale 2007). Western European countries continued to experience an increase in heights after World War II, while heights in the US remained relatively stable (Komlos and Baur 2004). This paper corroborates the fact that heights have changed slightly or not at all during the course of the second half of the 20th century. Heights increased slightly among whites both males and females, and not at all among blacks and Hispanics (both males and females). The "other" group is a heterogeneous one, so it is difficult to interpret the increase in height observed for this group.[22] The indicators of physical health used in this study, obesity, cholesterol, and diabetes, decreased markedly during this time period for all race-gender groups in terms of increased BMI, increased cholesterol prevalence, and increased diabetes prevalence. While childhood health may aid in predicting height, it is interesting to see the potential effect that adult height may have on adult health. While height is found in this study to be an imperfect measure of physical health, it is a determinant of it and is thus a useful tool in predicting physical health and labor market outcomes.

This study reveals that effect of height on obesity is positive for men and mixed among women. For all race-gender groups with the exception of white and black females, height is associated with higher probabilities of being obese.[23] Height is associated with lower probabilities of having high cholesterol for all race-gender groups, and lower probabilities of having diabetes for all race-gender groups except black males and Hispanic females. Income regressions revealed that taller males experience a 5.4-10.4% increase in income, and taller females a 4.2-10.7% increase, for every 10 cm increase over the mean in their respective race/ethnic categories.[24] Wage premiums thus range from a low of approximately $226 per year for every inch (2.54 cm) above the mean for African-American females, to approximately $586 for every inch above the mean for Hispanic males. This increase could be due to health premiums, yet many other factors besides height strongly influence wage premiums. Factors contributing to these premiums may include discrimination (possibly statistical in nature, reflecting unintentional discrimination based on productivity statistics), sociability, and/or cognitive ability.

There are some caveats, however. If there is a stigma associated with being in the tails of the height distribution, mental health may be affected also and subsequently physical health and labor market outcomes. The analysis can be extended through the use of the more recent BRFSS years, which include comprehensive information on cardiovascular disease in addition to variables on mental health. Using alternative data sets, such as longitudinal data sets, would be particularly helpful in determining trends in health and income and the portions we can attribute to height. More research needs to be done to understand better the income premium of taller workers. This study is one of the many inputs in this process.

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Table 1a

Heights (in cm) By State and Race/Ethnicity, Males, 1940-44 and 1980-84 Cohorts

State	White		Black		Hispanic		Other	
	1940-44	**1980-84**	**1940-44**	**1980-84**	**1940-44**	**1980-84**	**1940-44**	**1980-84**
US	175.6	178.5/	176.4	177.9/	170.6	171.2	170.5	175.1/
Alabama	176.5	179.0/	178.2	178.0	172.8	175.0	170.8	172.5
Alaska	-	178.9	-	173.8	-	172.6	-	172.4
Arizona	173.6	179.7/	178.2	188.3/	170.2	170.3	171.1	177.0/
Arkansas	-	178.3	-	179.2	-	172.5	-	181.3
California	175.7	178.6/	176.4	178.5	168.9	170.4	169.5	174.5/
Colorado	-	178.3	-	178.9	-	171.7	-	178.1
Connecticut	175.8	177.7	168.3	178.9/	167.2	172.6/	166.8	178.6/
Delaware	-	178.4	-	178.1	-	173.8	-	175.4
DC	174.2	178.0/	175.0	181.4/	172.4	174.6	176.0	176.0
Florida	177.4	177.6	178.7	178.6	173.0	171.7	-	173.0
Georgia	178.1	179.1	176.1	177.9	172.3	174.3	178.2	178.3
Hawaii	176.5	177.2	-	168.4	172.2	175.2	168.9	172.2/
Idaho	178.3	179.3	-	177.1	172.6	171.9	163.1	176.3/
Illinois	174.8	178.3/	176.7	177.7	171.7	170.3	168.2	175.8/
Indiana	176.8	179.5/	176.7	177.4	173.7	169.8	167.7	176.8/
Iowa	175.2	178.6/	-	177.8	-	170.1	-	174.9
Kansas	-	179.5	-	181.5	-	172.0	-	177.3
Kentucky	177.9	180.8/	179.3	174.7	168.9	170.7	163.1	181.1
Louisiana	-	179.2	-	176.8	-	174.6	-	177.0
Maine	176.5	177.7	-	173.9	170.9	169.8	-	177.0
Maryland	177.1	178.2	176.7	177.7	-	173.7	168.6	175.3/
Massachusetts	177.4	177.3	176.0	176.3	172.8	172.9	-	173.8
Michigan	177.5	178.5	172.0	177.7	-	173.0	-	174.8
Minnesota	177.0	179.6/	182.2	179.3	183.4	169.7/	166.6	169.1
Mississippi	-	178.4	-	176.7	-	176.1	-	186.8
Missouri	178.3	178.8	172.4	176.4	172.8	175.3	171.6	178.1
Montana	176.3	178.7/	-	177.1	178.9	176.4	178.9	181.1
Nebraska	178.3	179.1	178.2	179.8	172.8	170.1/	163.1	182.3/
Nevada	-	177.4	-	179.5	-	174.1	-	180.0
New Hampshire	176.8	177.5	-	184.9	-	177.9	-	182.6
New Jersey	-	176.7	-	176.8	-	171.7	-	174.6
New Mexico	177.5	179.0	-	183.1	172.8	173.7	173.7	173.7
New York	176.3	177.2	175.0	180.2/	171.0	170.7	173.9	170.2
North Carolina	174.0	178.3/	175.7	176.0	169.4	168.6	183.4	181.8

North Dakota	177.6	179.7/	168.3	181.8/	-	175.3	178.3	178.1
Ohio	173.1	178.7/	176.3	176.4	175.9	177.1	170.8	177.9/
Oklahoma	179.1	178.3	174.4	177.7	-	170.4	161.7	178.4/
Oregon	175.0	179.2/	-	175.9	-	171.6	-	175.1
Pennsylvania	178.8	177.5	179.3	178.2	-	173.2	-	172.3
Rhode Island	175.0	177.2/	183.5	178.6	167.8	171.1	170.7	175.6
South Carolina	174.8	179.3/	177.7	177.4	175.6	173.0	169.5	175.6/
South Dakota	177.0	179.6/	180.4	181.3	173.3	177.0	181.1	180.5
Tennessee	173.2	179.0/	174.6	177.1	176.3	170.6	169.1	170.5
Texas	175.1	179.6/	178.3	178.6	169.2	171.6/	-	180.2
Utah	177.0	178.7/	179.5	184.9	170.7	170.4	164.9	178.6
Vermont	-	177.6	-	172.1	-	173.0	-	178.6
Virginia	177.0	178.3	187.2	177.1/	-	171.2	-	176.3
Washington	178.2	179.2	-	177.9	-	171.5	-	173.8
West Virginia	176.5	178.4/	178.8	182.9	175.4	168.9/	165.1	176.6/
Wisconsin	176.6	179.6/	174.0	177.6	170.9	178.1/	168.7	177.7
Wyoming	-	179.2	-	173.9	-	176.5	-	176.9

Note: A slash (/) denotes that the difference between average heights for 1940-44 and 1980-84 cohorts is statistically significant at the 5% level. Heights are adjusted for self-reports using gender- and race-specific coefficients from the National Health and Nutrition Examination Survey (see Appendix). BRFSS sample weights are used in calculating the mean.

Table 1b

Heights (in cm) By State and Race/Ethnicity, Females, 1940-44 and 1980-84 Cohorts

State	White		Black		Hispanic		Other	
	1940-44	**1980-84**	**1940-44**	**1980-84**	**1940-44**	**1980-84**	**1940-44**	**1980-84**
US	162.6	164.2/	163.6	163.7	161.0	158.3/	157.5	160.7/
Alabama	164.0	163.2	162.8	163.3	-	159.1	-	162.4
Alaska	-	164.3	-	163.3	-	157.1	-	160.4
Arizona	162.3	164.8/	173.1	164.8	161.0	159.3	158.0	161.8
Arkansas	-	163.9	-	163.9	-	158.8	-	158.0
California	163.5	164.8/	164.0	165.0	161.1	157.6/	157.4	160.8
Colorado	-	164.8	-	164.1	-	158.8	-	161.7
Connecticut	161.5	164.5/	162.4	162.5	157.4	159.4	156.6	162.5/
Delaware	-	163.7	-	162.1	-	158.6	-	159.4
DC	166.5	163.5/	165.3	163.5	158.0	161.0	162.9	163.9
Florida	161.6	164.2/	162.9	163.9	158.2	157.1	156.8	162.0
Georgia	162.2	164.0/	162.5	163.0	159.4	158.8	157.3	163.6/
Hawaii	161.8	164.8/	161.9	162.5	160.9	158.9	156.1	158.4/
Idaho	162.7	165.4/	-	159.7	155.8	159.3	161.3	162.5
Illinois	162.2	164.2/	162.9	164.6	159.5	158.6	159.4	159.7
Indiana	162.0	164.4/	164.6	162.7	157.9	161.1	153.0	158.5/
Iowa	164.0	165.4	-	164.5	-	158.9	-	160.9
Kansas	-	165.0	-	164.9	-	159.6	-	160.4
Kentucky	162.0	164.6/	164.1	163.5	161.1	158.8	150.2	163.6/
Louisiana	-	164.0	-	163.9	-	159.1	-	156.8
Maine	161.3	164.1/	-	163.1	159.5	159.8	-	162.4
Maryland	164.4	163.4	163.0	164.6	-	157.2	-	160.6
Massachusetts	161.4	162.9	168.6	162.4/	160.9	159.9	155.0	157.6
Michigan	160.8	164.1/	161.1	163.4	-	159.8	-	161.3
Minnesota	162.9	164.5/	163.0	160.0	161.1	160.1	156.8	158.7
Mississippi	-	163.4	-	163.1	-	161.1	-	162.5
Missouri	162.7	164.5/	162.4	163.4	155.5	162.7/	148.8	160.8/
Montana	162.5	164.9/	-	162.2	162.9	154.4/	164.1	164.4
Nebraska	162.9	165.8/	163.2	164.7	156.1	157.9	-	157.2
Nevada	-	163.9	-	162.7	-	157.5	-	163.3
New Hampshire	161.5	163.4/	-	163.3	-	162.5	-	162.5
New Jersey	-	163.7	-	163.3	-	159.4	-	159.0
New Mexico	163.4	164.6	-	166.7	157.7	158.5	156.7	160.5
New York	162.6	163.5	162.3	161.9	165.8	158.7	158.4	160.9
North Carolina	163.1	163.8	165.3	163.9	160.1	158.9	167.2	159.2

North Dakota	162.3	165.7/	168.0	165.0	161.3	156.6/	165.0	162.2
Ohio	162.3	163.9/	164.4	163.6	156.1	157.2	-	159.6
Oklahoma	164.6	164.4	165.9	161.9/	156.2	160.0	157.3	161.4/
Oregon	162.5	164.7	-	162.7	-	158.3	-	161.9
Pennsylvania	160.8	164.1/	-	167.0	154.4	157.4/	-	161.0
Rhode Island	161.2	163.1/	164.9	163.2	160.5	157.1	153.1	161.5/
South Carolina	162.5	163.8/	163.4	164.5	162.1	161.3	151.3	161.1/
South Dakota	161.5	165.3/	-	167.8	163.2	161.7	153.3	164.2/
Tennessee	162.8	163.4	163.7	163.8	172.6	163.6	151.7	160.2/
Texas	163.2	163.6	164.0	164.0	160.4	158.7	153.3	160.8/
Utah	163.9	165.4/	-	161.4	154.9	157.5	159.3	163.6
Vermont	-	163.6	-	159.9	-	163.6	-	162.1
Virginia	160.8	163.8/	165.9	163.9/	-	158.7	-	162.5
Washington	162.1	164.4/	156.2	162.1/	160.3	159.8	155.5	159.8/
West Virginia	163.1	163.5	159.5	160.7	163.2	163.9	155.2	155.9
Wisconsin	162.8	164.9/	166.6	163.1	-	159.8	157.1	160.6
Wyoming	-	164.4	-	155.3	-	159.0	-	161.2

Note: A slash (/) denotes that the difference between average heights for 1940-44 and 1980-84 cohorts is statistically significant at the 5% level. Heights are adjusted for self-reports using gender- and race-specific coefficients from the National Health and Nutrition Examination Survey (see Appendix). BRFSS sample weights are used in calculating the mean.

Table 2

Average and Predicted Heights Across Birth Cohorts

Birth Cohort	White	Black	Hispanic	Other
	Males, Height			
1940-1944	175.6	176.4	170.6	170.5
1950-1954	176.9/	177.0	171.4	171.7
1960-1964	177.3/	176.8	171.5	173.1/
1970-1974	178.0/	177.4/	171.5	173.8/
1980-1984	178.5/#	177.9#	171.2	175.1/#
	Females, Height			
1940-1944	162.6	163.6	161.0	157.5
1950-1954	163.0/	163.7	158.6	158.0
1960-1964	163.5/	163.7	158.3	158.9
1970-1974	164.0/	163.7	158.7	159.5
1980-1984	164.2/#	163.7	158.3#	160.7/#
	Males, Predicted Height			
1940-1944	176.1	176.7	172.1	172.5
1950-1954	177.2/	177.2/	172.0	172.6
1960-1964	177.4/	177.2	171.6/	173.6/
1970-1974	177.7/	177.2	171.6	174.1/
1980-1984	177.7#	177.0/	171.4#	175.1/#
	Females, Predicted Height			
1940-1944	163.0	163.9	159.3	159.1
1950-1954	163.3/	163.6/	158.6/	158.3/
1960-1964	163.5/	163.6/	158.5/	159.0/
1970-1974	163.8/	163.7/	158.5	159.5/
1980-1984	164.0/#	163.8/	158.6/#	160.7/#

Note: A slash (/) denotes that the difference in average heights between that and the prior birth cohorts is statistically significant at the 5% level. A number (#) beside the average height in the last cohort denotes that the difference in average heights between the 1940-44 and 1980-84 cohorts is statistically significant at the 5% level.

Table 3a

Variable Definitions and Weighted Sample Means, Males, BRFSS 1984-2005

Variable	Description	White	Black	Hispanic	Other
Height	Adjusted height in meters	1.774 (0.071)	1.771 (0.067)	1.715 (0.065)	1.734 (0.078)
Real family income	Real household income in thousands of 1982-84 dollars	35.623 (26.582)	25.371 (22.149)	22.176 (21.118)	34.072 (28.073)
BMI	Adjusted body mass index in kilograms per squared meters	26.598 (4.526)	27.055 (5.356)	27.183 (4.857)	25.561 (4.503)
Obese	Equals 1 if BMI >= 30 kg/m^2	0.182 (0.386)	0.222 (0.415)	0.213 (0.410)	0.134 (0.340)
Cholesterol	Equals 1 if has cholesterol	0.219 (0.414)	0.190 (0.392)	0.224 (0.417)	0.238 (0.426)
Diabetes	Equals 1 if has diabetes	0.016 (0.127)	0.029 (0.168)	0.025 (0.156)	0.022 (0.147)
Some high school	Equals 1 if completed between 9 and 12 years of schooling	0.055 (0.228)	0.088 (0.283)	0.152 (0.359)	0.053 (0.223)
High school	Equals 1 if completed exactly 12 years of schooling	0.306 (0.461)	0.388 (0.487)	0.305 (0.460)	0.208 (0.406)
Some college	Equals 1 if completed between 13 and 16 years of schooling	0.278 (0.448)	0.302 (0.459)	0.226 (0.418)	0.249 (0.433)
College	Equals 1 if graduated from college	0.349 (0.477)	0.206 (0.405)	0.153 (0.360)	0.471 (0.499)
Age	Age in years	33.134 (7.091)	32.580 (7.147)	31.733 (6.934)	32.447 (7.029)
Work	Equals 1 if employed	0.892 (0.311)	0.823 (0.382)	0.871 (0.335)	0.807 (0.394)
Married	Equals 1 if married	0.610 (0.488)	0.447 (0.497)	0.559 (0.496)	0.554 (0.497)
Divorced	Equals 1 if divorced or separated	0.093 (0.290)	0.125 (0.330)	0.083 (0.276)	0.066 (0.248)
Widowed	Equals 1 if widowed	0.002 (0.049)	0.004 (0.065)	0.004 (0.063)	0.003 (0.052)

Note: Standard deviation is reported in parentheses. BRFSS sample weights are used in calculating the mean and standard deviation.

Table 3b

Variable Definitions and Weighted Sample Means, Females, BRFSS 1984-2005

Variable	Description	White	Black	Hispanic	Other
Height	Adjusted height in meters	1.635 (0.064)	1.636 (0.059)	1.585 (0.052)	1.590 (0.065)
Real family income	Real household income in thousands of 1982-84 dollars	33.666 (26.145)	21.224 (20.131)	20.961 (21.016)	32.915 (27.687)
BMI	Adjusted body mass index in kilograms per squared meters	25.145 (5.462)	28.000 (6.679)	27.022 (5.645)	24.790 (5.447)
Obese	Equals 1 if BMI >= 30 kg/m^2	0.157 (0.364)	0.305 (0.460)	0.244 (0.430)	0.136 (0.342)
Cholesterol	Equals 1 if has cholesterol	0.179 (0.383)	0.172 (0.377)	0.174 (0.379)	0.160 (0.367)
Diabetes	Equals 1 if has diabetes	0.037 (0.188)	0.053 (0.224)	0.065 (0.246)	0.049 (0.216)
Some high school	Equals 1 if completed between 9 and 12 years of schooling	0.052 (0.221)	0.091 (0.288)	0.145 (0.352)	0.049 (0.216)
High school	Equals 1 if completed exactly 12 years of schooling	0.306 (0.461)	0.359 (0.480)	0.296 (0.457)	0.206 (0.405)
Some college	Equals 1 if completed between 13 and 16 years of schooling	0.299 (0.458)	0.322 (0.467)	0.238 (0.426)	0.276 (0.447)
College	Equals 1 if graduated from college	0.334 (0.472)	0.216 (0.412)	0.161 (0.367)	0.450 (0.497)
Age	Age in years	33.275 (7.090)	32.628 (7.117)	32.103 (6.975)	32.549 (7.102)
Work	Equals 1 if employed	0.716 (0.451)	0.719 (0.449)	0.585 (0.493)	0.649 (0.477)
Married	Equals 1 if married	0.665 (0.472)	0.370 (0.483)	0.591 (0.492)	0.606 (0.489)
Divorced	Equals 1 if divorced or separated	0.119 (0.324)	0.190 (0.392)	0.137 (0.343)	0.103 (0.304)
Widowed	Equals 1 if widowed	0.007 (0.085)	0.015 (0.123)	0.011 (0.105)	0.009 (0.093)

Note: Standard deviation is reported in parentheses. BRFSS sample weights are used in calculating the mean and standard deviation.

Table 4

OLS Health and Income Regressions, BRFSS Samples

	Males				**Females**			
Dep. Var:	***White***	***Black***	***Hispanic***	***Other***	***White***	***Black***	***Hispanic***	***Other***
Mean height (cm)	177.4	177.1	171.5	173.4	163.5	163.6	158.5	159.0
Obese								
Mean obese	18.2%	22.2%	21.3%	13.4%	15.7%	30.5%	24.4%	13.6%
Value at mean [% Change]	0.25*** [+13.74]	0.53*** [+23.87]	0.56*** [+26.29]	0.63*** [+47.01]	-0.14*** [-8.92]	-0.02*** [-0.66]	0.20*** [+8.20]	0.53*** [+38.97]
N	162,910	14,753	11,612	10,640	218,812	29,651	17,514	13,554
Cholesterol								
Mean cholesterol	21.9%	19.0%	22.4%	23.8%	17.9%	17.2%	17.4%	16.0%
Value at mean [% Change]	-0.28*** [-12.79]	-0.15*** [-7.89]	-0.20*** [-8.93]	-0.28*** [-11.76]	-0.32*** [-17.88]	-0.15*** [-8.72]	-0.14* [-8.05]	-0.15** [-9.38]
N	162,910	14,753	11,612	10,640	218,812	29,651	17,514	13,554
Diabetes								
Mean diabetes	1.6%	2.9%	2.5%	2.2%	3.7%	5.3%	6.5%	4.9%
Value at mean [% Change]	-0.002*** [-1.25]	0.06** [+20.69]	-0.04** [-16.00]	-0.01** [-4.55]	-0.05*** [-13.51]	-0.03* [-5.66]	0.01*** [+1.54]	-0.06 [-12.24]
N	162,910	14,753	11,612	10,640	218,812	29,651	17,514	13,554
Income								
Mean income	$35,623	$25,371	$22,176	$34,072	$33,666	$21,224	$20,961	$32,915
Value at mean [Dollar Increase]	0.54*** [$1,924]	0.77*** [$1,954]	1.04*** [$2,306]	0.55*** [$1,874]	0.54*** [$1,818]	0.42*** [$891]	1.07*** [$2,243]	0.49*** [$1,613]
N	84,595	9,491	5,369	5,154	101,665	25,593	8,970	6,202
Value at mean, unrestricted sample [Dollar Increase]	0.73*** [$2,600]	0.96*** [$2,436]	1.66*** [$3,681]	1.00*** [$3,407]	0.40*** [$1,347]	0.43*** [$913]	1.06*** [$2,222]	0.32*** [$1,053]
N	414,849	37,721	37,429	29,464	540,511	74,403	50,626	35,929

Note: Mean heights listed are descriptive statistics while the value at the mean is calculated using the regression coefficients. Percent increase in brackets refers to the percentage increase from the mean percentage of outcome associated with a 10 cm increase in height, as opposed to a 1 m increase. For income, the monetary value is reported instead of percentages. Controls for education, birth cohort, employment status, marital status, family income, state of residence, and year of survey are included in all regressions. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Figure 1

Heights in the US by Race, Males By Birth Cohort
Behavioral Risk Factor Surveillance System

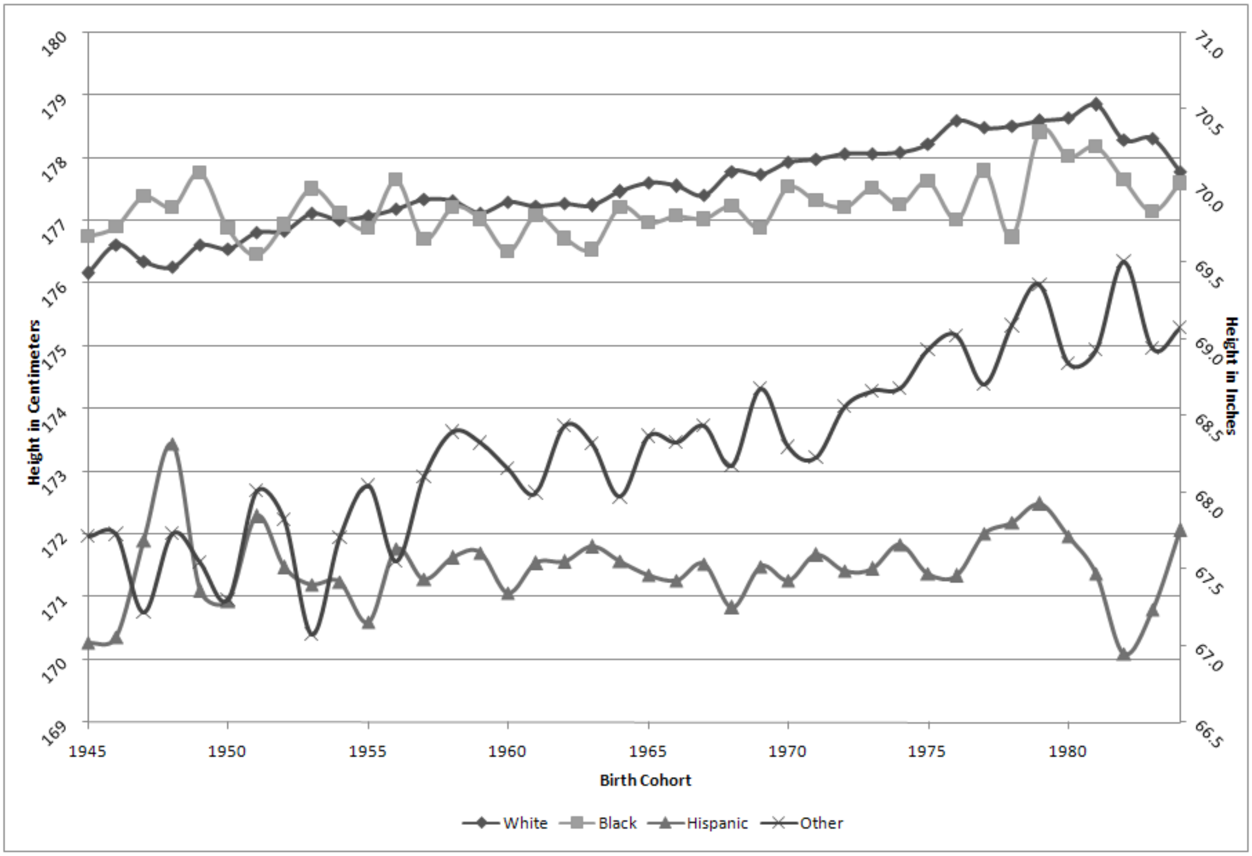


Figure 2

Heights in the US by Race, Females By Birth Cohort
Behavioral Risk Factor Surveillance System

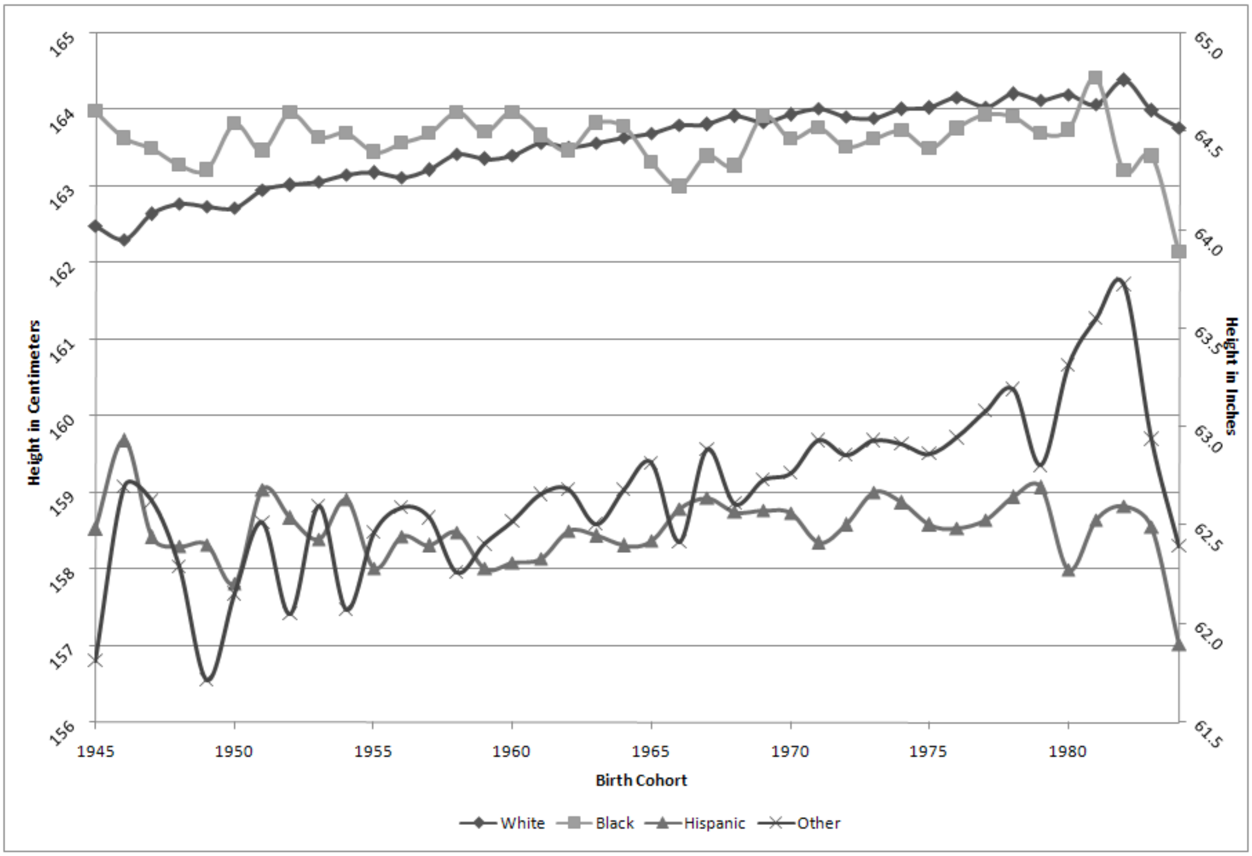
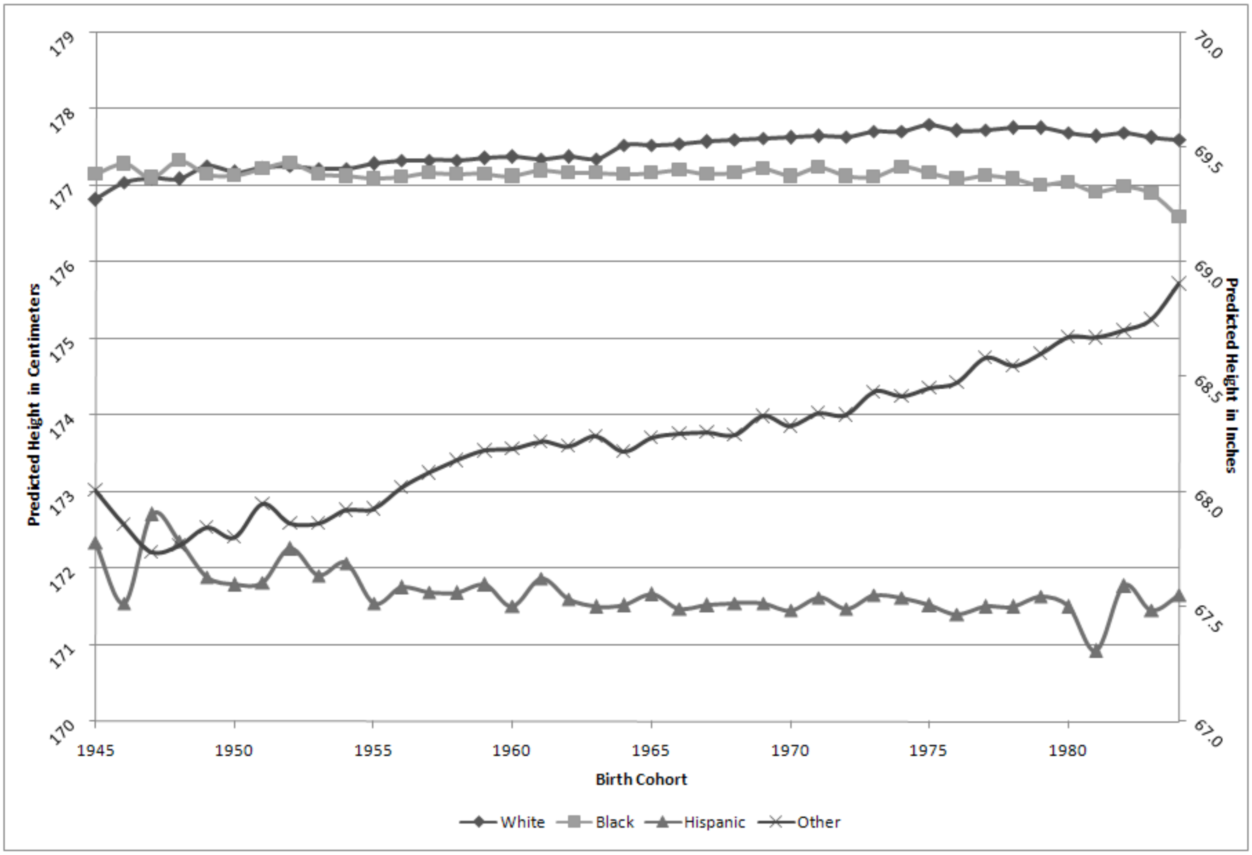


Figure 3

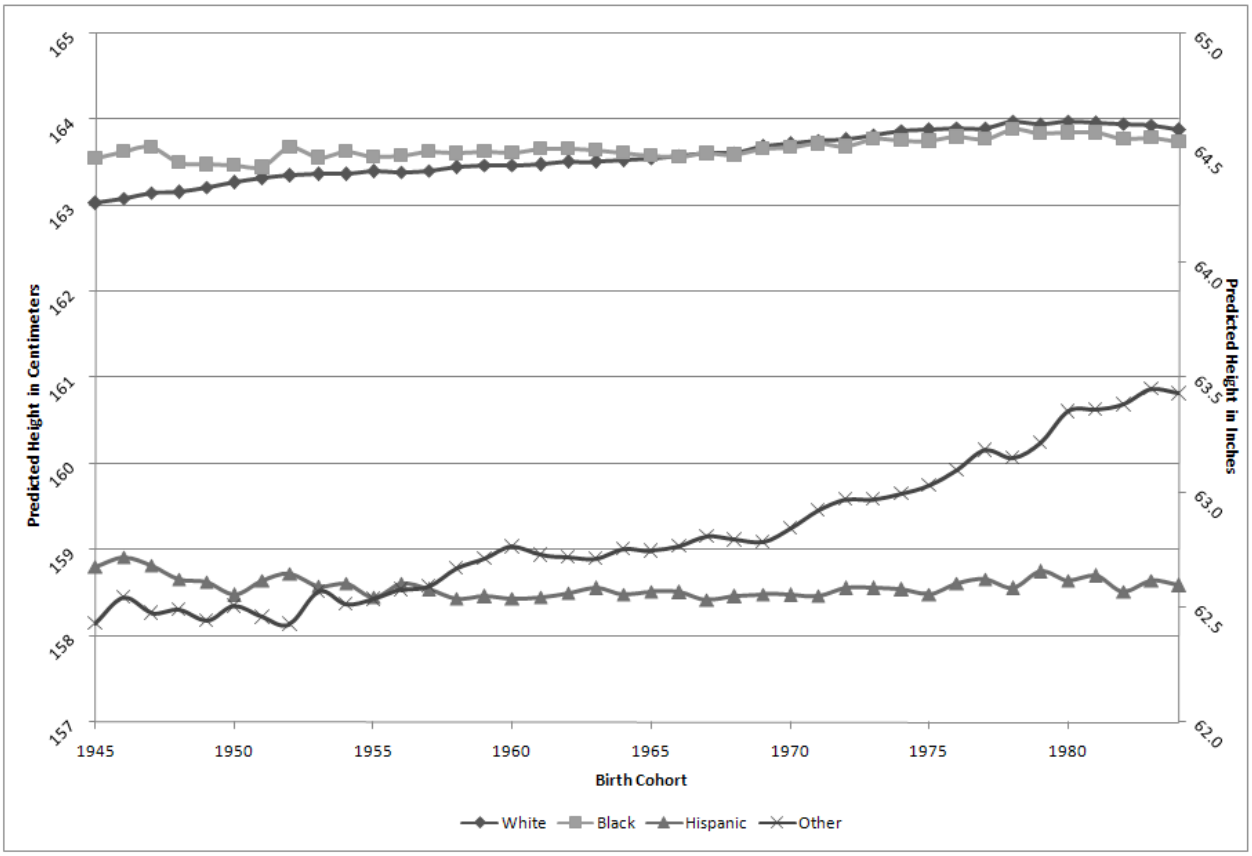
Predicted Heights in the US by Race, Males By Birth Cohort
Behavioral Risk Factor Surveillance System



Note: Trends in heights control for education, income, employment status, marital status, state of residence, and year of survey.

Figure 4

Predicted Heights in the US by Race, Females By Birth Cohort
Behavioral Risk Factor Surveillance System



Note: Trends in heights control for education, income, employment status, marital status, state of residence, and year of survey.

Appendix: NHANES Coefficients Used in Height and Weight Corrections

Variable	White	Black	Hispanic	Other
	Males			
Height	-1.682777	-.8647131	-.8661538	-3.72125
	(.1294009)	(.2117898)	(.1397209)	(.2516604)
Height squared	.7379395	.4722308	.4667847	1.333785
	(.0366227)	(.059723)	(.041066)	(.075331)
Intercept	2.413925	1.805758	1.812272	4.155952
	(.1142829)	(.1875523)	(.1190096)	(.2109661)
R^2	0.8421	0.8214	0.6948	0.8136
N	6,510	3,279	3,526	375
Weight	1.069072	.8945811	.9398536	.9586023
	(.0155597)	(.0275221)	(.0332496)	(.0876911)
Weight squared	-.0002194	.0008883	.0004349	.0003789
	(.0000814)	(.0001412)	(.0001902)	(.0005012)
Intercept	-4.493563	1.268836	1.556485	.6134271
	(.7286029)	(1.305383)	(1.428614)	(3.775684)
R^2	0.9576	0.9390	0.9189	0.9138
N	6,499	3,252	3,633	378
	Females			
Height	.3587099	-.4291474	-.6699841	-3.624355
	(.1640667)	(.1619676)	(.1261835)	(.2009858)
Height squared	.171341	.3691799	.4217256	1.395128
	(.0503763)	(.049723)	(.0402066)	(.0670898)
Intercept	.5776868	1.34064	1.569721	3.799785
	(.133494)	(.1319005)	(.0993348)	(.1512246)
R^2	0.7998	0.7462	0.5848	0.7225
N	7,295	3,837	3,564	451
Weight	1.136243	1.217982	1.085918	1.060345
	(.0170839)	(.0273555)	(.0314735)	(.0678753)
Weight squared	-.0006522	-.0010388	-.0004365	-.0002407
	(.0001061)	(.000153)	(.0002025)	(.0004333)
Intercept	-4.592627	-8.326313	-2.574925	-1.990452
	(.6617752)	(1.174805)	(1.188349)	(2.557173)
R^2	0.9420	0.9200	0.9115	0.9428
N	7,211	3,820	3,785	456

Note: Data from the 1988-2004 National Health and Nutrition Examination Survey (NHANES III, NHANES 99, NHANES 01, and NHANES 03) are used in the corrections. Samples are limited to those 21 years of age and older.

[1] While taller populations tend to be healthier, it should be noted that many other factors determine population health. Those who argue that individuals in countries such as Japan enjoy higher life expectancies need to control for nutritional and cultural differences and lifestyle factors that contribute to life expectancy. Comparing *differences* over time within populations may thus be useful. Differences in access to health care between the US and European countries may partially explain differences in height changes between these countries (Komlos and Lauderdale 2007).

[2] Due to the difficulty classifying persons into specific race/ethnicity categories that reflect genetic factors rather than social ones, to the slightly changing nature of this variable over time, and to maintain a sample size reflective of the population in each year, four general categories were chosen. These are less prone to error and are commonly used. The categories are: white non-Hispanic, black non-Hispanic, Hispanic, and other.

[3] Detailed information on coronary heart disease is not available in the BRFSS until 1996, which is why it is not used in this study. A person is medically defined as having high cholesterol when his or her total cholesterol level is 240 mg/dL and above (USDDHS 2001).

[4] Estimates vary, yet it has been suggested that individuals may shrink as much as 2-3 inches (5-8 cm) as they age. Many start to lose height in their late thirties. Cline et al. (1989) attribute 45-60% of the loss to a birth cohort effect and the rest to an actual decrease in height after the age of 40.

[5] The following 15 states were in the BRFSS in 1984: Arizona, California, Idaho, Illinois, Indiana, Minnesota, Montana, North Carolina, Ohio, Rhode Island, South Carolina, Tennessee, Utah, West Virginia, and Wisconsin. In 1985, Connecticut, the District of Columbia, Florida, Georgia, Kentucky Missouri, New York, and North Dakota entered the survey. In 1986, Alabama, Hawaii, Massachusetts, and New Mexico entered. In 1987, Maine, Maryland, Nebraska, New Hampshire, South Dakota, Texas, and Washington entered. In 1988, Iowa, Michigan, and Oklahoma entered. In 1989, Oregon, Pennsylvania, and Vermont entered. In 1989, Colorado, Delaware, Louisiana, Mississippi, and Virginia entered. In 1991, Alaska, Arkansas, and New Jersey entered. In 1992, Kansas and Nevada entered. Wyoming entered in 1994. Rhode Island, which entered the survey in 1984, was not in it in 1994. The District of Columbia, which entered in 1985, was not in the survey in 1995.

[6] Survey weights are included in the BRFSS to ensure that those included in the survey are reflective of the US population. In addition, the study shows that means for those responding and the general population are comparable. (See http://www.cdc.gov/brfss.)

[7] One weakness of the BRFSS is that family income, rather than personal income, is reported. This weakness will be addressed later in the paper.

[8] The height variable in the BRFSS prior to 1990 contains some errors for a small portion of the sample, which are corrected for by making assumptions on what should have been entered by the interviewer, and making use of demographic data on those observations. For example, heights of 5'12" (assumed to be 6') and 5'50" (assumed to be 5'5") were not uncommon. These errors appear to be nonrandom as, for example, they occur in some states much more often than others. A dichotomous variable indicating that there was an error in the original data is thus included in all regressions.

[9] Coefficients used in the correction utilize NHANES III (conducted between 1988 and 1994), NHANES 99 (conducted between 1999 and 2000), NHANES 01 (conducted between 2001 and 2002), and NHANES 03 (conducted between 2003 and 2004). They are reported in the Appendix. The NHANES surveys are publicly available from the National Center for Health Statistics at http://www.cdc.gov/nchs/nhanes.htm.

[10] There has been some concern that even correction equations do not fully correct for bias, although they lessen it (Plankey et al. 1997). In this sample, the correlation between height and adjusted height is 0.99, although individuals tend to consistently over-report height. Regression results using height and adjusted height are very similar. Previous work using adjusted measures of weight and height has revealed little difference in the resulting coefficients of BMI (Rashad 2006). For the purposes of this paper, where the focus is on predicting outcomes and identifying relationships, rather than obtaining prevalence estimates, self-reported data are likely to be reliable (Bolton-Smith et al. 2000; Kuczmarski et al., 2001; Spencer et al. 2002).

[11] These figures are comparable to those reported by the Bureau of Census. The Census reports that the percentage of persons of Hispanic origin increased from 7.5% in 1984 to 14.1% in 2004. According to the Census, while the percentage of whites decreased from 85.1% to 80.4% between 1984 and 2004, the percentage of white non-Hispanic persons decreased from 78.1% to 67.4%. The discrepancy between these latter values and those obtained in the BRFSS is expected since variables on race/ethnicity are self-reported and largely depend on the response choices available. The trends, however, are comparable.

[12] The earlier cohorts were deleted due to the small number of observations. The slight declines in the latest cohorts are partly due to decreases in height over time and partly due to their younger ages, which is not too likely to have a great effect since all subjects in the sample have reached the age of 21. Nevertheless, these two effects cannot be disentangled here.

[13] For more information on racial disparities in the United States, see, among others, Maury Gittleman and Edward N. Wolff, "Racial Wealth Disparities: Is the Gap Closing?" *Journal of Human Resources* (Winter 2004), and Kenneth Couch and March C. Daly, "Black-White Wage Inequality in the 1990s: A Decade of Progress," *Economic Inquiry* (January 2002).

[14] The qualitative nature of the results does not change when weights are employed.

[15] The heights obtained in the BRFSS sample are comparable to the objective heights obtained from NHANES, which was used to correct the self-reported heights in this study. In particular, heights for males were as follows: white-177.1 cm, black-176.7 cm, Hispanic-169.9 cm, and other-170.9 cm. For females, NHANES heights were: white-162.9 cm, black-163.1 cm, Hispanic-157.4 cm, and other-157.9 cm.

[16] In line with studies in the labor economics literature, the natural logarithm of income is taken, as income tends to be skewed to the right. This allows for the interpretation of the coefficient in percentage terms, as we have

$\frac{\partial \ln(income)}{\partial height} = \frac{\partial income / income}{\partial height}$, which is the percentage change in income given a 1 m change in height.

[17] Nevertheless, a Heckman selection model done for females in Cawley (2004) did not reveal selection to be an issue.

[18] Females may be more likely to obtain income from spouses, and so a greater portion of their reported family income could be unearned income. The unrestricted sample at the bottom of Table 4 reveals this to be the case: Male values at the mean are biased toward zero in the restricted sample compared to the unrestricted sample, which is not necessarily the case for females.

[19] Results using slightly different years to maximize sample size are very similar.

[20] It has been suggested that potentially endogenous variables such as education should not be included when analyzing effects on income (Neal and Johnson 1996; Heckman 1998; Persico et al. 2004). Although education levels are strong predictors of income, the interpretations of the height coefficients do not markedly differ in regressions where education is excluded. Results are available upon request.

[21] Average heights in the unrestricted sample are slightly lower than heights in the restricted sample, as taller individuals are more likely to be employed (not reported here).

[22] In addition, the BRFSS data set does not gather information on whether the respondent was born outside the United States, which may especially be of concern in the “other” ethnic category.

[23] This may partly reflect that body composition is a more appropriate measure of health than the body mass index (Cawley and Burkhauser 2006; Wada 2005).

[24] This is approximately equivalent to a 1.4-2.6% increase in income for males, and a 1.1-2.7% increase for females, for every inch above the mean.