Geography, Insolation, and Institutional Change in 19th Century African-American and White Stature in Southern States

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Abstract

The use of height data to measure living standards is now a well-established method in the economic literature. While much is known about 19th century black legal and material conditions, less is known about how 19th century biological conditions were related to the physical environment and institutional change. Although modern blacks and whites reach similar terminal statures when brought to maturity under similar biological conditions, 19th century African-American statures in Southern states were consistently shorter than whites, indicating a uniquely 19th century phenomenon may have influenced black stature growth. It is geography and direct sunlight (insolation) that present a striking attribute of 19th century black and white statures, and greater insolation is documented here to be associated with taller black and white statures.

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Keywords: nineteenth century Southern black and white statures, insolation, vitamin D.

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1. Introduction

The use of height data to measure living standards is now a well-established method in economics (Fogel, 1994, p. 138). A populations' average stature reflects the cumulative interaction between nutrition, disease exposure, work, and the physical environment (Steckel, 1979, pp. 365-367; Tanner, 1962, pp. 1-27). By considering average versus individual stature, genetic differences are mitigated, leaving only the influence of economic and physical environments on stature. When diets, health, and physical environments improve, average stature increases and decreases when diets become less nutritious, disease environments deteriorate, or the physical environment places more stress on the body. Therefore, stature provides considerable insights into understanding historical processes and augments other welfare measures for 19th century blacks and whites. By using a new source of 19th century US state prison records, the present study contrasts Southern-born black and white statures.

An ironic finding is that modern blacks and whites come to comparable statures when brought to maturity under similar biological conditions (Eveleth and Tanner, 1976; Tanner, 1977; Steckel, 1995, p. 1910; Barondess et al., 1997, p. 968; Komlos and Bauer, 2004, pp. 64 and 69; Nelson et al., 1993, pp. 18-20; Godoy, 2005, p. 475-478; Margo and Steckle, 1982, p. 519; Komlos and Lauderdale, 2005). However, 19th century blacks

were consistently shorter than whites, and compositional effects can not explain the difference (Margo and Steckel, 1983; Sünder, 2004; Carson, 2006). Moreover, any explanation must account for a robust geographical finding: Southern blacks were shorter than Southern whites, and Northern blacks were shorter than Northern whites (Margo and Steckel, 1992, p. 516). One common explanation for taller mulatto statures is that 19th century social and economic forces favored fairer complexions over lighter complexions, and lighter colored blacks benefited from these social and economic institutions (Margo and Steckel, 1982, p. 521; Bodenhorn, 1999, p. 983).

A second explanation for the black stature deficit is that blacks were shorter than whites because of subtle biological differences between how black and white physiology interacts with the physical environment, and the 15th through 18th century's forced Black Diaspora to northerly climates put blacks into physical environments in which they were not biologically suited. Statures are related to access to calcium and vitamin D, which are two chemical elements required throughout life for stature growth and healthy bone formation; however, their abundance are most critical for healthy skeletal development at younger ages (Wardlaw, Hampl, and Divilestro, 2004, p. 394-396; Tortolani et al, 2002, p. 60; Loomis, 1967). Calcium typically comes from dietary sources; however, 19th century black Southern diets were low in dairy consumption, and many blacks were lactase intolerant, which further discouraged calcium consumption and absorption (Kiple and King, 1981, pp. 84-85, 195).

The primary source of vitamin D is not dietary, but the synthesis of sunlight and cholesterol in the epidermis' stratum granulosum (Loomis, 1967, p. 501; Holick, 2007, pp. 266). In order of importance, the primary sources of vitamin D in humans are the

amount of time exposed to sunlight, skin pigmentation, and nativity (Holick et al., 1981, p. 590). Greater direct sunlight produces more vitamin D, and vitamin D is related to adult terminal stature (Xiong et al, 2005, pp. 228, 230-231; X-ZLiu et al, 2003; Ginsburg, 1998; Uitterlinden et al, 2004). However, vitamin D production also depends on melanin in the stratum corneum. Greater melanin (skin pigmentation) in the stratum corneum interferes with cholesterol's synthesis into vitamin D in the stratum granulosum, and darker pigmentation filters between 50 to 95 percent of the sunlight that reaches the stratum granulosum (Loomis, 1967, p. 502). Therefore, darker skin is considerably less efficient than lighter skin at producing vitamin D, yet darker skin is more common in Southern latitudes, where more hours of direct sunlight offsets inefficient vitamin D production. Moreover, since blacks relative to whites are less efficient at producing vitamin D, black statures may be more sensitive to direct sunlight than white statures.

It is against this backdrop that this paper introduces a sample of over 95,000 black and white male inmates born in the American South and covers from the antebellum period through slavery, Reconstruction, and the end of the 19th century. These records include both individuals who remained in the South and those born in the South but emigrated northward. Two issues are considered. First, how did Southern black and white statures vary with direct sunlight, therefore, vitamin D production, and were lighter colored blacks taller than darker colored blacks? Darker complected blacks were shorter than darker complected mulattos and whites, and the black rate of stature increase with insolation was greater than mulattos and whites. Second, how did black and white statures vary with respect to Southern institutional change? Southern black stature ironically increased during the final years of the antebellum period but temporarily

decreased with emancipation, and black statures increased more than whites in the early 20th century. White stature, however, decreased throughout the 19th century.

2. Nutrition, Income, and Wealth in the 19th Century American South

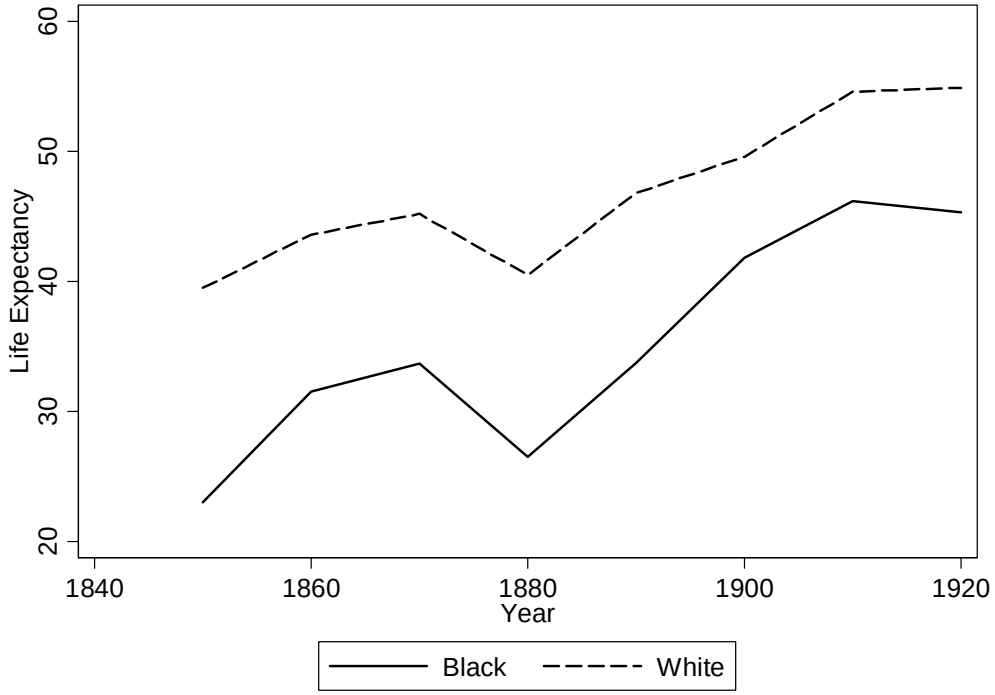
Under slavery, Southern black and white material and biological conditions varied considerably, and whites with higher socioeconomic status benefited from their institutionalized economic and social advantage. These advantages concerned different access to nutrition, income, wealth, life expectancy, and disease. Before the Civil War, the South was nearly self-sufficient in food production. However, the Civil War created significant social and economic displacement, and the South went from being a net food exporter before the War to a net food importer after the War (Ranson and Sutch, 1977, p. 156; Komlos and Coclanis, 1997, p. 441; Cuff, 1992, pp. 61-62).

Primary staples in Southern diets were corn and pork (Hilliard, 1972; Fogel, 1994, p. 136; Bodenhorn, 1999, p. 989), and a notable characteristic of Southern farm diets was the large proportion of calories supplied by meat and animal proteins (Fogel, 1994, pp. 132-137; Bodenhorn, 1999, p. 988). Southern diets under slavery were not, however, distributed equally between blacks and whites. Slave adolescent diets were particularly meager, and slave children were fortunate to receive meat allocations, which, when received, were of inferior quality and were provided proportional to the plantation work they performed (Steckel, 1986, p. 734; Higgs, 1977, p. 105). Adult slave diets were considerably more nutritious than young slave diets and frequently exceeded the calorie and nutrition allocations provided to comparable Southern whites (Fogel and Engerman, 1974, pp. 107-117; Fogel, 1989. pp. 132-138). To be allocated adult-size food rations,

slave children also sought to enter adult labor forces as soon as they were able (Steckel, 1986, p. 740).

Before the Civil War, southern white incomes and wealth were among the highest in the US (Soltow, 1975, pp. 65 and 67; Easterlin, 1971, p. 41; Rosenblum, 2002, pp. 50-55; Margo, 2000; Fogel, 1994, pp. 85-87). After the War, income and wealth shifted northward, Southern wealth declined, and blacks were left to fend for themselves. The end of slavery improved material and biological conditions for Southern blacks, and black per capita income increased substantially with the end of slavery (Postell, 1951, pp. 85-86; Higgs, 1977, p. 102). After the War, black incomes increased, and blacks also devoted a higher proportion of their incomes than whites to the accumulation of food (Higgs, 1977, pp. 105-108), indicating black material and biological conditions in lower socioeconomic groups likely improved at the end of the 19th century.

Figure 1, Nineteenth-Century Black and White Life Expectancy at Birth



Source: Haines, Michael, 2006, "Fertility and Mortality by Race: 1800-2000," Table Ab1-10, *Historical Statistics of the United States: Earliest Times to the Present;* Meeker, Edward, 1976, "Mortality Trends of Southern Blacks, 1850-1910: Some Preliminary Findings," *Explorations in Economic History 13.*

Notes: Life expectancy is for both males and females. White life expectancy is from Haines 2006; 1850, and 1900-1920 black life expectancy is also from Haines 2006; 1860 and 1880 black life expectancy are from Meeker, 1976, pp. 20 and 24; 1870 and 1890 black life expectancy are from Elben, 1974.

Stature is positively associated with life expectancy at birth (Steckel, 2005, pp. 230-232, 238; Costa and Steckel, 1997, pp. 50-51), and US life expectancy increased

throughout the 19th century (Figure 1); white life expectancy was about 30 percent longer than black life expectancy. In 1840, black and white life expectancies were about 20 and 40 years, respectively; by 1920, black and white life expectancies at birth approached 40 and 60 years, respectively (Higgs, 1977, p. 20-21; Fogel, 2004, p. 99; Haines, 2004, pp. 252-258). Nineteenth century US disease environments varied regionally. Prominent nineteenth century Southern diseases were water-borne, such as diarrhea, typhoid fever, and malaria (Crimmens and Condran, 1983, p. 33), and higher 19th century Southern disease rates may have resulted in more calorie expenditures devoted to fending off disease rather then directed toward stature growth. Blacks were also more vulnerable than whites to nutrient deficient diseases, such as beriberi (thiamine deficiency), pellagra (niacin deficiency), rickets (vitamin D deficiency) and kwashiorkor (protein deficiency) (Fogel, 1994, p. 137; Kiple and King, 1981, pp. 121-123; Kiple and Kiple, 1977a; Kiple and Kiple, 1977b; Bishai and Nalubola, 2002, p. 41).

Slavery's demise changed the income and dietary lot of Southern households, and lower class Southern whites may have been even more adversely effected by slavery's removal than Southern blacks, likely due to increased competition from free black labor and a backward industrializing sector that disproportionately favored white labor (Woodward, 1951, p. 43; Komlos and Coclanis, 1997, p. 442). As the post-bellum South developed, lower class white workers found greater access to manufacturing jobs and were employed as mill operatives and perhaps for the first time were exposed to the deleterious aspects of industrialization (Woodward, 1951, p. 134). For example, preferences to employ lower class white labor inadvertently placed whites into cotton mills and manufacturing plants where disease was more readily propagated, putting lower

class whites at a biological disadvantage after slavery. Preferences to employ lower class white labor also placed whites into indoor environments shielded from the beneficial attributes of insolation and vitamin D production.

3. Nineteenth Century Southern Prison Data

Data used to study Southern statures is a subset of a much larger 19th century US data set.[1] Data for Southern-born inmates used for this study are from Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Missouri, Mississippi, North Carolina, Tennessee, Texas, and South Carolina. These Southern-born individuals could then migrate to any of the other 48 continental states and are used here to assess the relationship between stature and observable characteristics. All historical height data have selection biases, and prison and military records are the most common sources of historical height data. One common concern with military samples is a truncation bias imposed by minimum stature requirements (Fogel et al, 1978, p. 85; Sokoloff and Vilaflour, 1982, p. 457). Fortunately, prison records do not suffer from such a constraint and the subsequent truncation bias observed in military samples. However, prison records are not above scrutiny. One potential bias inherent in prison records is they may be drawn from lower socioeconomic groups, although this bias may itself be an

[1] All available records from American state prison repositories have been acquired and entered into a master file. These records include Arizona, California, Colorado, Idaho, Illinois, Kansas, Kentucky, Missouri, New Mexico, Ohio, Oregon, Pennsylvania, Texas, and Washington. Prison records may be particularly valuable for making black and white stature comparisons because they are more likely to come from lower socioeconomic groups, that segment of society most vulnerable to economic change (Bogin, 1991, p. 288; Komlos and Baten, 2004, p. 199).

advantage to prison records, because lower socioeconomic groups are more vulnerable to economic change (Bogin, 1991, p. 288; Komlos and Baten, 2004, p. 199).

Fortunately, inmate enumerators were quite thorough when recording inmate complexion and occupation.[2] For example, enumerators recorded black inmates' race in a complexion category as black, light black, dark black, and various shades of mulatto.[3] Enumerators recorded white inmate complexions as light, medium, and dark. The white inmate complexion classification is further supported by the complexion of European immigrants, who were always of fair complexion and were also recorded as light, medium, and dark.[4] While mulatto inmates possessed genetic traits from both European and African ancestry, they were treated as blacks in 19th century America and are grouped here with black inmates; however, when appropriate, mulattos are treated separately from blacks in the analysis that follows.[5] Blacks were more common than

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[2] Although the Texas Prison data set allows access to a large and valuable set of inmates of Mexican nativity residing in Texas, the focus of this paper is the comparison between white and black inmates.

[3] Like Komlos and Coclanis (1997), inmates with complexions recorded as black, brown, copper, dark brown, dark mulatto, ginger, light brown, light mulatto, mulatto and yellow are considered as black. Inmates with complexions recorded as fair, florid, dark, light, ruddy, sallow, sandy and swarthy are considered as from European ancestry.

[4] I am currently collecting 19th century Irish and British prison records. Irish prison enumerators also used light, medium, dark, fresh and sallow to describe white prisoners in prisons from a traditionally white population. To date, no inmate in an Irish prison has been recorded with a complexion consistent with African heritage.

[5] While some studies in 19th century African-American anthropometric history find a "mulatto advantage," there is little evidence that farer skinned African-Americans in the Texas prison had a distinct stature advantage over darker skinned African-Americans.

whites in Southern prisons; 52 percent of the Southern prison sample was black, but there is little evidence that blacks were targeted by law enforcement officials. Rather, their disproportional representation is likely due to no legal representation at trial (Walker, 1988, pp. 114-115).

Enumerators recorded a broad continuum of occupations and defined them narrowly, recording over 200 different occupations. These occupations are classified here into four categories. Workers who were merchants and high skilled workers are classified as white-collar workers; light manufacturers, carpenters, and craft workers are classified as skilled workers; workers in the agricultural sector are classified as farmers; laborers are classified as unskilled workers.[6] Occupations were recorded when inmates were received into the prison, therefore, reflect pre-incarceration occupational status and not prison occupations. Because the purpose of this study is to compare 19th century Southern black and white male statures, females and immigrants are excluded from the analysis.

[6] Prison guards who recorded occupation did not distinguish between farm and common laborers. This potentially overestimates the biological benefits of being a common laborer and underestimates the advantages from being a farm laborer, since common laborers typically came to maturity under less favorable biological living conditions. The occupation classification system used here replicates that used by Ferrie "Entry into U.S. Labor Markets," p. 325; *Yankeys Now*, 1999. See the appendix for the occupation classification system used here.

Table 1, Southern Stature by Age, Birth Decade, Occupation and Nativity

	White				*Black*			
Ages	N	Percent	Mean	S.D.	N	Percent	Mean	S.D.
Teens	6,463	14.18	170.76	6.75	9,640	19.33	168.09	7.51
20s	23,391	51.31	173.11	6.57	26,713	53.57	171.32	6.88
30s	9,576	21.00	173.07	6.53	8,560	17.17	171.46	6.68
40s	3,935	8.63	172.92	6.55	3,260	6.54	170.91	6.79
50s	1,647	3.61	172.49	6.37	1,185	2.38	170.42	6.97
60s	495	1.09	172.37	6.76	415	.83	169.94	6.47
70s	84	.18	171.41	6.01	88	.18	169.13	5.95
Birth Decade								
1800s	249	.55	173.63	6.70	88	.18	170.15	6.82
1810s	688	1.51	173.36	6.51	323	.65	170.76	6.58
1820s	1,302	2.85	173.71	6.85	541	1.08	169.68	6.88
1830s	2,330	5.10	173.09	6.68	1,164	2.33	170.24	6.87
1840s	5,006	10.96	172.56	6.66	3,660	7.34	170.38	6.89
1850s	7,816	17.12	172.53	6.80	8,493	17.03	170.86	7.16
1860s	7,580	16.63	173.04	6.71	9,969	19.99	171.04	7.21
1870s	9,266	20.32	172.93	6.44	11,474	23.01	170.70	7.08
1880s	6,875	15.08	172.37	6.55	8,955	17.96	170.40	7.00
1890s	4,223	9.26	172.26	6.53	4,791	9.61	170.38	7.01
1900s	255	.56	170.92	6.28	403	.81	169.66	7.37
Occupation								
White-Collar	4,116	9.03	172.02	6.43	1,483	2.97	170.16	6.82
Skilled	9,207	20.20	172.15	6.41	4,695	9.42	170.31	3.97
Farmer	7,760	17.02	173.72	6.43	5,429	10.89	171.77	6.88
Unskilled	24,507	53.75	172.80	6.73	38,254	76.72	170.58	7.10
Nativity								
Middle Atlantic	1,662	3.65	170.63	6.31	929	1.86	168.43	6.61
Plains	13,570	29.77	171.84	6.39	6,953	13.94	169.26	6.86
Southeast	21,144	46.38	172.93	6.66	21,783	43.69	170.26	7.01
Southwest	9,214	20.21	173.93	6.70	20,196	40.50	171.67	7.11

Source: Data used to study black and white anthropometrics is a subset of a much larger 19th century prison sample. All available records from American state repositories have been acquired and entered into a master file. These records include Arizona, California, Colorado, Idaho, Illinois, Kansas, Kentucky, Missouri, New Mexico, Ohio, Oregon, Pennsylvania, Texas, Utah and Washington. Only prison records for inmates incarcerated in the Pennsylvania prison are used in this project.

Notes: Stature is in centimeters. The occupation classification scheme is consistent with Ferrie (1997); The following geographic classification scheme is consistent with Carlino and Sill (2000): New England= CT, ME, MA, NH, RI and VT; Middle Atlantic= DE, DC, MD, NJ, NY, and PA; Great Lakes= IL, IN, MI, OH, and WI; Plains= IA, KS, MN, MO, NE, ND, and SD; South East= AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, and WV; South West= AZ, NM, OK, and TX; Far West= CA, CO, ID, MT, NV, OR, UT, WA, and WA. Stature difference is average white stature less average black stature. Proportion difference is white proportion less black proportion.

Age percentages demonstrate that black inmates were incarcerated in younger ages, and white inmates were incarcerated in older ages (Table 1).[7] Southern slave law evolved to favor plantation law, which generally allowed slave-owners to recover slave labor on plantations while a slave was punished (Komlos and Coclanis, 1997, pp. 436; Wahl, 1996 and 1997; Friedman, 1993, pp. 84-106). As a result, birth decades indicate that black inmates born before the Civil War took up smaller shares of Southern prison populations than white inmates. However, with the 13th Amendment's passage, slave-

[7] Higgs, *Competition and Coercion,* p. 1, indicates that effective discrimination by public institutions during the 19th century, which suggests that young blacks may have been targeted by law enforcement. Higgs, *Competition and Coercion*, 10, also indicates that Blacks were more likely to be convicted and receive longer sentences or larger fines than comparable white offenders. Friedman, *Crime and Punishment*, pp. 90, 94, 96, and 156 indicates that 19th century blacks may have been targeted by prejudiced public institutions.

owners no longer had claims on black labor, and free-blacks who broke the law were turned over to state penal systems to exact their social debt.

Whites were overwhelmingly more likely than blacks to be listed as white-collar and skilled workers. White inmates were 204 percent more likely than blacks to occupy white-collar occupations and 114 percent more likely than blacks to occupy skilled occupations. Even in agriculture, whites were 56 percent more likely than blacks to occupy planting and stock raising occupations. The difference, of course, was in the unskilled category. Incarcerated blacks were 43 percent more likely than whites to occupy unskilled occupations, making occupations for Southern-born inmates segregated; white-collar, skilled, and agricultural occupations were filled by whites and unskilled occupations were filled by blacks. Southern inmate nativities within US prisons were predominantly North American and were largely from the lower South, although some came from the upper South.

Table 2, Southern Census and Prison Population Race, Residence and Occupations by Decade

Occupations	*1860*		*1870*		*1880*		*1900*		*1910*		*1920*	
Prisons	Black	White	Black	White	Black	White	Black	White	Black	White	Black	White
White-Collar	4.12	5.53	2.05	5.15	2.71	8.19	3.01	9.67	2.96	12.60	4.39	11.95
Skilled	11.39	19.30	6.59	16.88	7.27	15.78	9.31	21.01	12.26	25.12	11.40	11.95
Farmer	9.47	16.47	4.23	9.99	9.85	16.20	10.51	16.61	15.55	19.16	14.04	29.20
Unskilled	75.02	59.04	87.12	67.98	80.17	59.82	77.17	52.71	69.24	43.12	70.18	32.30
IPUMS	Black	White	Black	White	Black	White	Black	White	Black	White	Black	White
White-Collar	1.24	7.66	.41	4.82	1.09	7.08	1.60	8.64	2.09	12.20	2.10	12.19
Skilled	5.34	15.24	1.58	8.84	2.14	11.98	2.46	14.96	3.07	19.04	4.39	22.76
Farmer	7.24	30.88	8.17	17.26	19.59	24.91	21.82	18.34	25.02	18.33	26.04	18.23
Unskilled	86.17	46.11	89.84	69.07	77.17	56.02	74.13	58.07	69.83	50.43	67.47	46.82

Notes: See Table 1 for prison sources. For IPUMS data, see Ruggles, Steven Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam

King, and Chad Ronnander. *Integrated Public Use Microdata Series: Version 3.0* [Machine-readable database]. Minneapolis, MN: Minnesota Population Center [producer and distributor], 2004.

How well Southern-born prison populations reflect the South's general population is addressed by comparing prison to census population occupational and residential distributions. Table 2 illustrates that Southern-born blacks in American censuses were predictably less likely than whites to be white-collar, skilled workers, and farmers, and were more likely to be unskilled workers. However, comparing two historical series from different sources may be problematic because prison and census enumerators followed different recording guidelines. In spite of the differences with the census, it is highly probable that the penitentiary sample mirrors the attributes of lower class blacks during the period considered (Riggs, 1994 p. 64).

4. Nineteenth Century Southern Black, and White Statures

The timing and extent of stature variation not only reflects the cumulative relationship between diet and disease, but also the distribution of wealth, population change, sectoral shifts in production, and migration (Steckel, 1994, p. 16; Lynch and Kaplan, 1997, pp. 305-308; Steckel, 2005, p. 235). In the 19th century American South, changes in black and white statures also reflected changes in social, legal, and economic institutions. Nineteenth century black and white biological conditions were related to age, birth cohorts, socioeconomic status, and nativity; they may have also been related to insolation, which is the primary determinant of vitamin D production. We test which of these variables were associated with the height of 19th century Southern black and white

statures. To start, stature for the i[th] individual is assumed to be related with age, birth period, socioeconomic status, nativity, migration status, and insolation.

$$Centimeter_i = \beta_0 + \beta_1 Race_i + \sum_{j=12}^{70s} \beta_j Age_{i,j} + \sum_{t=1800}^{1900} \beta_t Birth_{i,t} + \sum_{l=1}^{4} \beta_l Occupation_{i,l} +$$

$$\sum_{n=1}^{6} \beta_n Nativity_{i,n} + \beta_{Mig} Migrant_{i,Mig} + \sum_{d=1}^{4} \beta_d Migrant\,Direction_{i,d} + \beta_{Insol} Insolation_{i,Insol} +$$

$$B_{Insol^2} Insol^2_{i,Insol} + \beta_{Race \times Insol} Race \times Insol_i + \varepsilon_i$$

Dummy variables are included for individual youth ages 12 through 22; adult age dummies are included for ten year age intervals from the 30s through the 70s. Birth decade dummies are in ten year intervals from 1800 through 1899. Occupation dummy variables are for white-collar, skilled, farmers, and unskilled occupations. Nativity dummy variables are included for birth in Northeast, Middle Atlantic, Great Lakes, Southeast, Southwest, and Far West regions. A dummy variable accounts for migration status and directional migration dummy variables are included to account for North-South migrations.[8] Continuous insolation and insolation difference variables between

[8] North1 is an intermediate move from Southern to Central or Central to Northern states. North2 is a long distance move from Southern to Northern states. South1 is a move from a Northern to Central or Central to Southern state. South2 is a move from Northern to Southern states. Northern states include Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Michigan, Wisconsin, Iowa, Minnesota, North Dakota, South Dakota, Wyoming, Montana, Idaho, Oregon, and Washington. Central states include Delaware, Maryland, Virginia, Wes Virginia, Kentucky, Indiana, Illinois, Missouri, Nebraska, Kansas, Colorado, Utah, Nevada, and California. Southern states include North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas, New Mexico, and Arizona. The binary variable North1 is an intermediate move from Southern to Central or Central to Northern states. North2 is a long distance

receiving and sending locations are added to account for insolation and vitamin D production. Race and insolation interactive variables are included to account for differences between how blacks and whites process vitamin D. Lastly, a pre-1860 birth dummy variable is included to assess how biological conditions varied between the ante-bellum and free-labor American South.

To isolate stature differences by race, Model 1 presents regressions for combined black and white statures on observable characteristics. Model 2 presents regressions for stature on white male characteristics, while Model 3 does the same for blacks. Because antebellum social and economic conditions were unique to the South, Model 4 restricts the sample to only Southern-born males who did not internally migrate.

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move from Southern to Northern states. South1 is a move from a Northern to Central or Central to Southern state. South2 is a move from Northern to Southern states.

Table 3, Nineteenth Century Southern Stature Model

	Model 1, Total Sample	*S.D.*	*Model 2, White Only*	*S.D.*	*Model 3, Black Only*	*S.D.*	*Model 4, Persisters*	*S.D.*
Intercept	164.01***	.412	164.15***	.432	157.85***	.496	161.61***	.523
Race								
Black	-4.84***	.525			Refer.		-4.66***	.676
Mulatto					3.60***	.861		
White	Refer.						Refer.	
Ages								
12	-19.67***	1.45	-15.13***	4.19	-20.42***	1.52	-19.66***	1.58
13	-15.81***	.821	-15.11***	2.42	-15.91***	.837	-16.81***	.886
14	-11.47***	.496	-11.75***	1.03	-11.39***	.559	-11.69***	.518
15	-8.28***	.311	-7.89***	.688	-8.43***	.346	-8.42***	.353
16	-5.45***	.165	-5.07***	.282	-5.62***	.203	-5.48***	.203
17	-3.22***	.125	-3.05***	.194	-3.30***	.163	-3.09***	.154
18	-2.27***	.100	-2.02***	.148	-2.42***	.137	-2.16***	.125
19	-1.39***	.099	-1.26***	.141	-1.49***	.138	-1.31***	.123
20	-.556***	.097	-.590***	.142	-.505***	.132	-.484***	.121
21	-.183	.094	-.120	.132	-.209	.134	-.197	.120
22	-.046	.090	.176	.131	-.217*	.123	-.033	.117
23-29	Refer.		Refer.		Refer.		Refer.	
30s	-.007	.062	-.158**	.086	.171*	.090	-.093	.088
40s	-.485***	.090	-.460***	.121	-.420***	.135	-.856***	.136
50s	-1.07***	.135	-1.06***	.171	-.880***	.217	-1.48***	.225
60s	-1.54***	.228	-1.37***	.313	-1.52***	.335	-2.06***	.426
70s	-2.72***	.469	-2.60***	.650	-2.35***	.664	-2.77***	.987
Birth Cohort								
1800	1.41***	.396	1.68***	.472	.581	.767	4.20***	1.05
1810	1.17***	.261	1.14***	.333	1.09**	.436	2.69***	.569
1820	.831***	.225	1.29***	.289	-.417	.377	1.78***	.410
1830	.230***	.194	.499*	.259	-.392*	.302	.751**	.321
1840	-.344**	.170	-.299	.236	-.446*	.245	-.144	.260
1850	-.192	.162	-.433*	.229	.026	.229	-.438*	.234
1860	Refer.		Refer.		Refer.		Refer.	
1870	-.154**	.070	-.161	.104	-.166*	.095	-.166*	.092
1880	-.585***	.076	-.715***	.113	-.504***	.102	-.561***	.096
1890	-.336***	.091	-.610***	.133	-.160	.124	-.303***	.111
1900	.546***	.280	-.390	.410	1.10***	.378	.643	.322
Occupations								
White Collar	-.871***	.093	-.912***	.110	-.710***	.179	-.957***	.145
Skilled	-.722***	.064	-.734**	.080	-.701***	.107	-.836***	.093
Farmer	.744***	.065	.810***	.085	.640***	.100	.671***	.086
Unskilled	Refer.		Refer.		Refer.		Refer.	
Migration Status								
Migrant	.513***	.058	.356***	.077	.661***	.090		

Non-Migrant	Refer.		Refer.		Refer.			
Migration Direction								
North1	-.723***	.071	-.861***	.094	-.601***	.111		
North2	-.716***	.133	-.551***	.187	-.870***	.190		
South1	.982***	.120	.789***	2.16	1.42***	.191		
Sunlight								
Insolation	2.17***	.094	2.16***	.096	3.02***	.099	2.73***	.117
Black×insolation	.599***	.120					.507***	.151
Mulatto×insolation					-.673***	.193		
Emancipation								
Pre-1860 birth	.056	.162	.124	.230	-.027	.228	.378*	.232
N	95,451		45,590		49,861		52,408	
R^2	.0911		.0492		.0914		.1143	
F	224.70		60.65		114.45		178.79	

Source: See Table 1.

Notes: Because US historical is unavailable, a modern index (1993-2003) is constructed, and monthly values are measured from January thru June. The index measures the hours of direct sunlight per day at county centroids in each state and is weighted by a county's square miles relative to square miles in the state.[9] While this index is a rough approximation for historical , it provides sufficient detail to capture state latitudinal variation and consequently, vitamin D production.

Three general patterns emerge when comparing 19th century Southern black and white statures. First, it is striking the degree to which white statures exceed black statures. This is even more significant because modern black and white statures reach comparable levels when brought to maturity under similar biological conditions (Eveleth

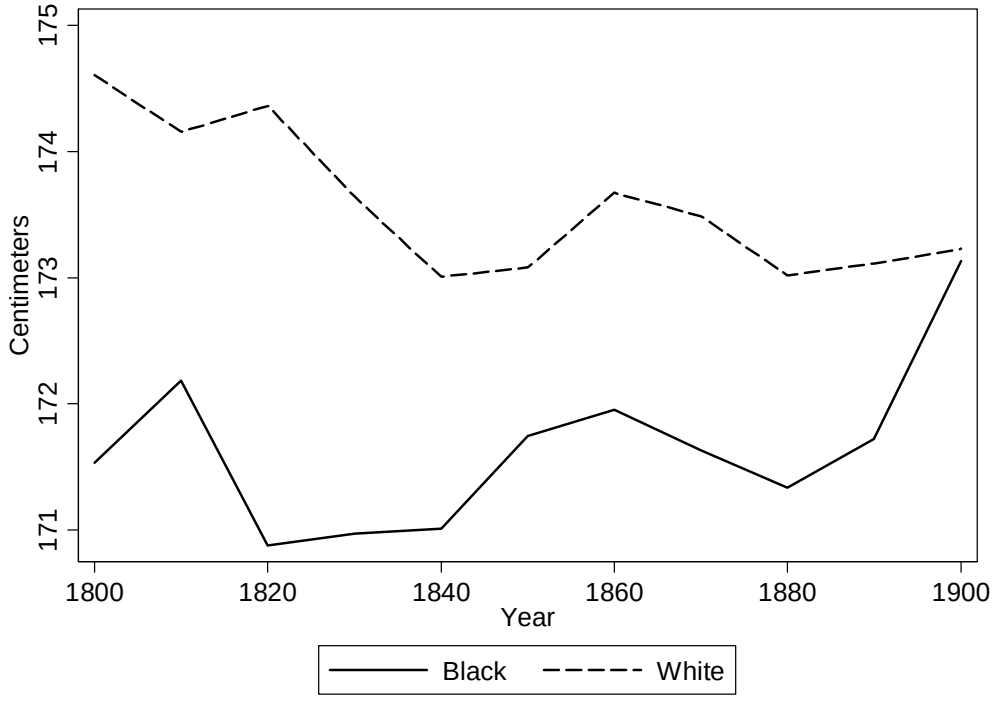
[9] is not the in the county that surround's the state's centroid, but in each county's geographic center. The range of state values extends from Maine's minimum of 3.43 hours of direct sunlight to Arizona's maximum of 5.22 hours of direct sunlight per day.

and Tanner, 1966; Tanner, 1977; Steckel, 1995, p. 1910; Barondess, Nelson and Schlaen, 1997, p. 968; Komlos and Baur, 2004, pp. 64, 69; Nelson et al., 1993, pp. 18-20; Godoy et al, 2005, pp. 472-473). Margo and Steckel (1982, p. 519) and Sunder (2004, p. 78) demonstrate that antebellum Southern whites were nearly 2 inches taller than Southern blacks, and adult male slaves were shorter than northern whites (Margo and Steckel, 1982, p. 519). Moreover, compositional effects can not explain the black-white stature difference, which was due, in part, to white's access to meat and better nutrition (Margo, and Steckel, 1982, p. 514-515, 517 and 519).

Table 3's second general pattern is that black and white statures varied significantly with insolation. Adult terminal stature is related to access to vitamin D (Xiong et al, 2005, p. 228, 230-231; X-ZLiu et al, 2003; Ginsburg, 1998; Uitterlinden et al, 2004), and vitamin D deficiency is less prevalent in geographic regions that receive more hours of direct sunlight (Norman, 1998, p. 1109; Holick, 1995, pp. 641S-642S). Models 1 and 4's negative and significant black dummy variables indicate blacks were shorter than whites, and the positive black- interactive term illustrates that blacks at North American latitudes experienced larger stature gains from insolation than whites. Model 3's positive and significant mulatto dummy variable indicates mulattos were taller than darker blacks, and the negative mulatto- interactive term indicates darker blacks were more responsive than their mulatto counterparts to comparable insolation levels. The black stature deficit may also be evidence of a previously neglected aspect of slavery's consequences on human biology: the forced migration of Africans to northern climates placed blacks into biological environments in which, due to higher melanin levels in their

skin, they were less likely to produce sufficient vitamin D and grow as tall as whites (Loomis, 1967, pp. 501-504; Neer, 1979, p. 441).

Figure 2, Southern Black-White Stature Comparison



Source: See Table 1.

Notes: African-American and white stature graphs made from national, northern and southern imputed values from Tables 4 and 5. Northern states are MN, IA, WI, MI, IL, IN, OH, PA, NJ, NY, CT, RI, MA, NH, VT, and ME. Southern states are AL, AR, FL, GA, KY, LA, MO, NC, TN, TX, and SC.

Table 3's third pattern is that both black and white statures approximately varied with institutional change (Figure 2; Conrad and Meyer, 1964, pp. 50 and 75). An

unexpected finding in the physical statures of 19th century male African-American slaves is that their physical statures increased during the antebellum period (Margo and Steckel, 1982, p. 520; Komlos and Coclanis, 1997, pp. 438-442; Komlos, 1998, p. 787). However, if Southern planters and overseers rationally allocated slave nutrition and medical allocations to maximize slaveowner wealth, the slave system would have shielded blacks from industrialization's deleterious effects, and slave statures would have increased with antebellum slave values and probably decreased with the removal of slavery (Komlos, 1998; Rees et al., 2003; Steckel, 1995; Komlos and Coclanis, 1997; Carson, 2008, p. 825).

Nineteenth century Southern black stature increases are consistent with the Komlos-Rees hypothesis that Southern slave masters and overseers consciously controlled slave food and health allocations to maximize slave-owners' wealth (Komlos, 1998; Rees et al., 2003). Between 1840 and 1860, Southern black statures increased by nearly one cm; however, by 1880 black statures declined by one cm, only to increase by one cm in 1900, which occurred despite agricultural disruptions caused by the boll weevil and increased racial hostility from whites (Higgs, 1977, pp. 6-9, 127). Southern white statures also changed around the time of the Civil War, and were more pronounced than Southern black stature declines. After emancipation, racial preferences to employ white labor over black labor in the South's emerging textile industry increasingly put working class into labor market competition with free Southern black labor, and white statures also declined with emancipation (Komlos and Coclanis, 1997, p. 439; Higgs, 1977, pp. 32, 39 and 48-49).

For several other categories, expected patterns hold. During the 19th century, farmers were taller than white-collar, skilled, and unskilled workers, due partly to the nearness of nutrients. Farmers traditionally had greater access to superior diets, nutrition, and received more sunlight (Bodiwala, et al, 2003, pp. 659-660; Tangpricha, et al, 2002, p. 662; Holick, 1981, p. 590). Farming is also an outdoor occupation, which exposes farmers to more direct sunlight, and 19th century farmers were taller than workers in other occupations (Komlos and Coclanis, 1997, p. 441; Komlos, 1987, p. 902; Steckel and Haurin, 1994, p. 170; Sokoloff and Villaflor, 1982, p. 463; Margo and Steckel, 1983, pp. 171-172). Islam, et al (2007, pp. 383-388) demonstrate that children exposed to more direct sunlight produce more vitamin D, and if there is little movement away from parental occupation, 19th century occupations may also be a good indicator for the occupational environment in which individuals came to maturity (Costa, 1993, p. 367; Margo and Steckel, 1992, p. 520; Wannamethee et al., 1996, pp. 1256-1262; Nystrom-Peck and Lundberg, 1995, pp. 724-737). That unskilled workers were also tall suggests that many unskilled workers were possibly agricultural workers, who received more abundant calorie and nutrition allocations, and worked in environments conducive to stature growth.

5. Explaining the Relative White Stature Advantage

To more fully account for the source of the white-black stature differential and to isolate the relative importance of insolation, a Blinder-Oaxaca decomposition is imposed on the white-black stature differential (Oaxaca, 1973). Let S_w and S_b represent the statures of whites and blacks, respectively; α_w and α_b are the autonomous stature components that accrue to whites and blacks; β_w and β_b are the white and black stature

returns associated with specific stature enhancing characteristics, such as age and occupation. X_w and X_b are white and black characteristic matrices, and white statures are assumed to be the base structure.

$$\Delta S = S_w - S_b = (\alpha_w - \alpha_b) + (\beta_w - \beta_b)X_b + \beta_w(X_w - X_b)$$

The second right hand-side element is that component of the stature differential due to differences in stature returns and for most characteristics was likely positive. Hence, if white stature advantages were due to inferior black biological conditions, the stature returns to whites, β_w, will be larger than stature returns to blacks, β_b. If, however, blacks at North American latitudes received larger relative stature gains than whites, the returns to the stature gap from insolation will be negative. The third right-hand side element is the stature differential component due to differences in characteristics and is undetermined because whites probably had characteristics associated with taller statures, but blacks lived in the South with greater exposure to insolation.

Table 4, Nineteenth Century Southern Prison Stature Oaxaca Decomposition

Levels	$(\beta_W - \beta_B)X_B$	$\beta_W(X_W - X_B)$	$(\beta_W - \beta_B)X_W$	$\beta_B(X_W - X_B)$
Sum	2.16	-.113	2.25	-.199
Total		2.05		2.05
Proportions				
Intercept	2.67		2.67	
Age	.020	.112	4.8^{-4}	.131
Birth	-.059	.034	-.022	-.003
Occupations	1.5^{-4}	-.041	-.009	-.033
Migration	-.076	.022	-.109	.056
Insolation	-1.53	-.186	-1.47	-.247
Pre1860	.022	.006	.028	-9.2^{-4}
Sum	1.06	-.055	1.10	-.097
Total		1		1

Source: See Table 3, Models 2 and 3.

Using coefficients from the stature regressions (Table 3, Models 2 and 3), the stature decomposition indicates that the majority of the white stature advantage arose from non-identifiable characteristics, such as better nutrition and higher socioeconomic status that disproportionately favored whites (Table 4); however, the majority of the stature differential due to observable characteristics is associated with insolation. Measured in levels, the share of the stature gap attributable to characteristics illustrates that 19th century blacks lived in areas that received more insolation.[10] Measured in proportions, black returns to insolation at North American latitudes were greater than whites. Observable characteristics beyond insolation did not contribute to the white-black stature differential. Therefore, at North American latitudes, black stature gains from insolation were larger than for whites, and blacks lived in states that received more insolation; however, the majority of the white-black stature differential is explained by non-identifiable characteristics, such as differences in access to nutrition, overt forms of racial prejudice, and economic exclusion.

6. Discussion

This paper investigates a new explanation for the 19th century black and white stature differential—vitamin D and insolation—and stature was positively associated with hours of direct sunlight, therefore, vitamin D production. Southern black and white statures also reflect 19th century institutional change, and multiple explanations that

[10] Blacks in the prison sample lived in states that received 4.37 hours of direct sunlight per day compared to whites in the sample who lived in states that received 3.95 hours of sunlight per day, or blacks lived in states that received about 11 percent more insolation than whites.

reflect distinctively Southern institutions emerge as possible reasons for black and white stature variations. These explanations center on two themes: declining Southern wealth and agricultural output, and disease environments (Coelho and McGuire, 2000). Before the Civil War and emancipation, the South—especially the lower South—was among the wealthiest regions in the United States and nearly self-sufficient in food production, and self-sufficiency enhanced biological conditions (Ransom and Sutch, 1977, p. 156; Komlos and Coclanis, 1997, p. 441; Steckel and Haurin, 1994, p. 123; Margo and Steckel, 1983, p. 170; Sokoloff and Villaflor, 1982, p. 463). After the War, the South was no longer self-sufficient in food production and experienced a sustained decrease in basic food production, which persisted throughout the second half of the 19th century (Ransom and Sutch, 1977, p. 153; Wright, 1978, p. 164; Fite, 1986, p. 41). Moreover, with the destruction of more than one third of the South's stock of hogs, a vital source of animal protein, the Civil War itself may have contributed to Southern stature declines.[11] After 1872, there was a persistent downward trend in hog weights, which lasted through 1900 (Wright, 1978, p. 62); during Reconstruction, corn yields declined and higher corn prices made feeding hogs relatively more expensive, making less pork available for consumption (Cuff, 1992, pp. 61-62). Therefore, Southern nutrition declined during Reconstruction and probably inhibited stature growth among the working class.

The second explanation for the decline in Southern agriculture suggests that the sharp decline in Southern agricultural output after the War was partially the result of

[11] Wright, *The Political Economy of the Cotton South,* p. 164. After the Civil War, the South continued to lose livestock through a series of animal epidemics—especially equine glanders and hog cholera—which killed thousands of horses and pigs. The Civil War destroyed one-third of Southern horses and mules, further reducing Southern agricultural productivity, Woodward, *Origins,* p. 177.

disease (Breeden, 1988), and hookworm may have been responsible for part of this decline (Bleakley, 2003; Brinkley, 1997, pp. 125-136;). However, the timing and extent of black stature gains at the end of the 19th century does not favor a disease-only explanation for black stature variation. While most cities received water lines and sewer treatment facilities by 1899, most Southern blacks were rural, and black stature increases predate the installation of public water and sewage treatment facilities to rural blacks (Troesken, 2004, Figures 2.1, 2.2, 2.3, and 2.4; Harris, 2006, p. 98). On the other hand, blacks born in the South's stature increases coincide with increased antebellum wealth and prosperity; black stature diminutions coincide with decreased Reconstruction wealth, decreased access to foodstuffs, and widespread postbullum disease. Consequently, late 19th century black and white height variations were the result of the complex relationships between diets and disease, but after 1880—and favoring the stature-nutrition hypothesis—stature gains pre-date large-scale Southern water treatment facilities, and disproportionately accrued to African-Americans in the Deep South.

References

Atack J, Bateman F (1987) To Their Own Soil: Agriculture in the Antebellum North. Iowa State University Press Ames, Iowa

Barondess DA, Nelson DA, Schlaen S (1997) Whole Body Bone, Fat and Lean Mass in Black and White Men. Journal of Bone and Mineral Research 12:967-971

Bishai, David and Ritu Nalubola, "The History of Food Fortification in the United States: Its Relevance for Current Fortification Efforts in Developing Countries," *Economic Deveolopment and Cultural Change,* 51(1), 2002: pp. 37-53.

Bleakley H (2003) Disease and Development: Evidence from the American South. Journal of the European Economic Association 1(2):376-386

Bodenhorn H (1999) A Troublesome Caste: Height and Nutrition of Antebellum Virginia's Rural Free Blacks. Journal of Economic History 59(4):972-996

Bodenhorn H (2002) Mulatto Advantage: The Biological Consequences of Complexion in Rural Antebellum Virginia. Journal of Interdisciplinary History 33(1):21-46

Bogin B (1988) Patterns of Human Growth. Cambridge University Press, Cambridge, UK

Bogin B (1991) Measurement of Growth Variability and Environmental Quality in Guatemalan Children. Annals of Human Biology 18(4):285-294.

Breeden J (1988) Disease and Southern Distinctiveness. In: Savitt TL, Young JA (eds) Disease and Distinctiveness in the American South. University of Tennessee Press, Knoxville, TN

Brinkley GL (1997) The Decline in Southern Agricultural Output, 1860-1880. Journal of Economic History 57(1):116-138

Carson SA (2005) The Biological Standard of Living in 19th Century Mexico and the American West. Economics and Human Biology 3(3):405-419

Carson, Scott A. "African-American and White Inequality in the American South: A Biological Comparison," Working Paper, no. 1696, University of Münich, Center for Economic Studies and Ifo Institute for Economic Research, March, 2006.

Coclanis PA, Komlos J (1995) Nutrition and Economic Development in Post Reconstruction South Carolina. Social Science History 19(1):91-115

Coelho P, McGuire R (2000) Diets versus Disease: the Anthropometrics of Slave Children. Journal of Economic History 60(1):232-46

Conrad, Alfred H. and John R. Meyer, *The Economics of Slavery and other Studies in Econometric History,* Aldine Publishing Company: Chicago, IL, 1964.

Costa, Dora, 1993, "Height, Wealth and Disease among the Native-Born in the Rural Antebellum North," *Social Science History Association,* 17(3), pp. 355-383.

Crimmens, E. and G. A. Condran. "Mortality Variation in U.S. Cities in 1900: A Two Level Explanation by Cause of Death and Underlying Factors." *Social Science History*. 7, no. 1 (1983): 31-59.

Crouch BA (1984) Sprit of Lawlessness: White Violence; Texas Blacks, 1865-1868. Journal of Social History 18(2):217-232

Cuff T (1992) A Weighty Issue Revisited: New Evidence on Commercial Swine Weights and Pork Production in Mid-Nineteenth Century America. Agricultural History 66(4): 55-74

Cuff T (2004) Historical Anthropometrics. EH.Net Encyclopedia, edited by Robert Whaples. URL http://eh.net/encyclopedia/article/cuff.anthropometric

David P, Temin P (1976) Capitalist Masters and Bourgeois Slaves. In: David P, Gutman H, Sutch R, Wright, G (eds) Reckoning With Slavery. Oxford University Press, New York, NY

Easterlin R (1971) Regional Income Trends, 1840-1950. In: Fogel RF, Engerman, SL (eds) The Reinterpretation of American Economic History. Harper & Row, New York, NY:38-53

Eveleth PB, Tanner JM (1976) Worldwide Variation in Human Growth 2nd edn. Cambridge University Press, Cambridge, UK

Ferrie JP (1997) The Entry into the U.S. Labor Market or Antebellum European Immigrants, 1840-1860. Explorations in Economic History 34(3):295-33

Ferrie JP (1999) Yankees Now: Immigrants in the Antebellum United States, 1840-1860. Oxford University Press and the National Bureau of Economic Research, New York. NY

Fite G (1986) The Agricultural Trap in the South. Agricultural History 60(4):38-50

Fogel RW, Engerman SL (1974) Time on the Cross: The Economics of American Negro Slavery. W. W. Norton, New York, NY.

Fogel, Robert W (1989) *Without Consent or Contract: The Rise and Fall of American Slavery,* W. W. Norton: New York.

Fogel, Robert W. "Economic Growth, Population Theory and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy," *American Economic Review 84(3)*, 1994, pp. 369-395.

Fogel RW, Engerman SL, Trussell J, Floud R, Pope C, Wimmer L (1978) Economics of Mortality in North America, 1650-1910: A Description of a Research Project. Historical Methods 11(2):75-108

Fogel RW, Engerman SL, Floud R, Friedman F, Margo R, Sakoloff K, Steckel R, Trussell J, Villaflor G, Wachter K (1983) Secular Changes in American and British Stature and Nutrition. Journal of Interdisciplinary History 14(2):445-481

Friedman LM (1993) Crime and Punishment in American History. Basic Books, New York, NY

Ginsburg, E, G. Livshits, K. Yakovenko and E. Kobyliansky, "Major Gene Control of Human Body Height, Weight and BMI in Five Ethnically Different Populations," *Annals of Human Genetics,* 62, 1998, pp. 307-322.

Godoy RE, Goodman R, Levins R, Leonard WR (2005) Anthropometric Variability in the USA. Annals of Human Biology 32(4):469-485

Goodman AH, Martin DL (2002) Reconstructing Health Profiles from Skeletal Remains. In: Steckel R, Rose JC (eds) The Backbone of History. Cambridge University Press, Cambridge, UK:11-60.

Haines M, Craig L, Weiss T (2003) The Short and the Dead: Nutrition, Mortality and the "Antebellum Puzzle" in the United States. Journal of Economic History 63(2):382-413

Haines M (2004) Growing Incomes, Shrinking People—Can Economic Development be Hazardous to Your Health? Social Science History 28(4):249-270

Harris JW (2006) The Making of the American South: a Short History, 1500-1877. Blackwell Publishing, Oxford, England

Higgs R (1977) Competition and Coercion. University of Chicago Press, Chicago, IL

Hilliard SB (1972) Hog, Meat and Hoecake: Food Supply in the Old South, 1840-1860. Southern Illinois University Press, Carbondale, IL

Holick, Michael F, "Environmental Factors that Influence the Cutaneous Production of Vitamin D." *American Journal of Clinical Nutrition 61,* 1995, pp. 638S-645S.

Holick, Michael F, "Vitamin D: Importance in the Prevention of Cancers, Type 1 Diabetes, Heart Disease and Osteroporosis." *American Journal of Clinical Nutrition 79.* 2004. pp. 362-371.

Holick, Michael F, 2007 "Vitamin D Deficiency." *New England Journal of Medicine 357(3).* pp. 266-281.

Islam, Talat, W. James Gauderman, Wendy Cozen, Thomas Mack, 2007, "Childhood Sun Exposure Influences Rick of Multiple Sclerosis in Monozygotic Twins," *Neurology* 69, pp. 381-388.

Johnston FE, Zimmer LO (1989) Assessment and Growth in the Immature Skeleton. In: Iscan M.Y, Kennedy KA (eds) Reconstruction of Life from the Skeleton.: Alan R. Liss, New York, NY: 11-22

Kiple, Kenneth F. and Virginia Kiple (1977a) "Black Tongue and Black Men: Pellagra and Slavery in the Antebellum South," *Journal of Southern History* 43, pp. 411-428.

Kiple, Kenneth F, and Virginia Kiple (1977b) "Slave Child Mortality: Some Nutritional Answers to a Perennial Puzzle," *Journal of Social History* 10, pp. 284-309.

Kiple, Kenneth F. and Virginia King (1981) *Another Dimension to the Black Diaspora: diet, disease and racism.* Cambridge University Press: Cambridge.

Komlos J (1985) Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development in the Eighteenth Century. American Historical Review 90(5):1149-61

Komlos J (1987) The Height and Weight of West Point Cadets: Dietary Change in Antebellum America. Journal of Economic History 47(4):897-927

Komlos J (1992) Toward an Anthropometric History of African-Americans: The Case of the Free Blacks in Antebellum Maryland. In: Goldin C, Rockoff H (eds) Strategic Factors in Nineteenth Century American Economic History: A Volume to Honor Robert W. Fogel, University of Chicago Press, Chicago, IL:297-329

Komlos J (1996) Anomalies in Economic History: Toward a Resolution on the Antebellum Puzzle. Journal of Economic History 56(1):202-214

Komlos J (1998) Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution. Journal of Economic History 58(3):779-802

Komlos J, Alecke B (Winter, 1996) The Economics of Antebellum Slave Heights Reconsidered. Journal of Interdisciplinary History 26(3):437-457

Komlos J, Coclanis P (1997) On the Puzzling Cycle in the Biological Standard of Living: The Case of Antebellum Georgia. Explorations in Economic History 34(4):433-59

Komlos J, Baur M (2004) From Tallest to (one of) the Fattest: the Enigmatic Fate of American Population in the 20th Century. Economics and Human Biology 2(1):57-74

Komlos, John and Jörg Baten (2004) "Anthropometric Research and the Development of Social Science History. Social Science History. 28: 191-210.

Komlos, John and Benjamin Lauderdale, 2005, "Spatial Correlates of US Heights and Body Mass Inexes, 2002," *Journal of Biosocial Science 39*, pp. 59-78.

Ladurie LE (1979) The Conscripts of 1968: A Study of the Correlation between Geographical Mobility, Delinquency and Physical Stature and Other Aspects of the Situation of the Young Frenchman Called to Do Military Service that Year. In: Reynolds B, Reynolds S (eds) The Territory of the Historian, University of Chicago Press, Chicago, IL:33-60.

Lynch J, Kaplan G (1997) Understanding How Inequality in the Distribution of Income Affects Human Health. Journal of Health Psychology 2(3): 297-314

Loomis, W. Farnsworth, 1967, "Skin-Pigment Regulation of Vitamin-D Biosynthesis in Man: Variation in Solar Ultraviolet at Different Latitudes may have Caused Racial Differentiation in May," *Science*, pp. 501-506.

Maloney TN (1992) Degrees of Inequality: the Advance of Black Workers in Northern Meatpacking and Steel Industries, 1910-1940. Social Science History 19(1):31-62

Marable M (1979) The Politics of Black Land Tenure, 1877-1915. Agricultural History 53: 142-152.

Margo, Robert, 2000, *Wages and Labor Markets in the United States, 1820-1860.* Chicago: University of Chicago Press.

Margo R, Steckel R (1982) Heights of American Slaves: New Evidence on Nutrition and Health. Social Science History 6(4):516-538.

Margo R, Steckel R (1983) Heights of Native Born Northern Whites during the Antebellum Era. Journal of Economic History 43(1):167-174

Margo R, Steckel R (1992) The Nutrition and Health of Slaves and antebellum Southern whites. In: Fogel RW, Engerman SL (eds) Without Consent or Contract: Conditions of Slave Life and the Transition to Freedom. W. W. Norton New York, NY:508-521

Metzer JM (1975) Rational Management, Modern Business Practices and Economies of Scale in Antebellum Southern Plantations. Explorations in Economic History 12(2):123-150

Mokkonen E (2002) Crime, Justice, History. The Ohio State University Press, Columbus, OH

Nelson, D., Kleerekoper, M., Peterson E. & A. M. Parfitt, (1993) "Skin Color and Body Size as Risk Factors for Osteoporosis," *Osteoporosis International,* 3, 18-23.

Norman, Anthony, "Sunlight, Season, Skin Pigmentation, Vitamin D and 25-hydroxyvatamin D: Integral Components of the Vitamin D Endocrine System," American Journal of Clinical Nutrition, 67. 1998, pp. 1108-1110.

Nyström-Peck, Maria and Olle Lundberg, 1995, "Short Stature as an Effect and Social Conditions in Childhood," *Social Science Medicine 41(5),* pp. 733-738.

Oaxaca RL (1973) Male Female Wage Differentials in Urban Labor Markets. International Economic Review 14(3):693-709

Postell, William Dusite, *The Health of Slaves on Southern Plantations.* Baton Rouge: Louisiana State University Press, 1951.

Pritchett JB, Freudenberger H (1992) A Peculiar Sample: the Selection of Slaves for the New Orleans Market. Journal of Economic History 52(1): 107-27

Ransom R, Sutch R (1977) One Kind of Freedom: the Economic Consequences of Emancipation. Cambridge University Press, Cambridge, UK

Rees R, Komlos J, Long N, Woitek U (2003) Optimal Food Allocation in a Slave Economy. Journal of Population Economics 16:21-36

Reid JD (1979) White Land, Black Labor and Agricultural Stagnation: The Causes and Effects of Sharecropping in the Postbellum South. Explorations in Economic History 16(1):31-55.

Riggs, Paul, 1994, "The Standard of Living in Scotland, 1800-1850," in Komlos, John (ed.), *Stature, Living Standards and Economic Development: Essays in Anthropometric History.* University of Chicago Press: Chicago.

Rose J (1989) Biological Consequences of Segregation and Economic Depravity: A Post-Slavery Population from Southwest Arkansas. Journal of Economic History 49(2): 351-360

Rosenbloom J (2002) Looking for Work, Searching for Workers: American Labor Markets during Industrialization. Cambridge University Press, Cambridge, UK

Sokoloff KL, Villaflor GC (1982) The Early Achievement of Modern Stature in America. Social Science History 6(4):453-481

Soltow L (1975) Men and Wealth in the United States, 1850-1870. Yale University Press, New Haven, CT

Steckel R (1979) Slave Height Profiles from Coastwise Manifests. Explorations in Economic History 16:363-380

Steckel R (1992) Work, Disease and Diet in the Health and Mortality of American

Slaves. In: Fogel RF, Engerman SL (eds) Without Consent or Contract: Conditions of Slave Life and the Transition to Freedom, Technical Papers, v. 2. W.W. Norton: New York, NY

Steckel R (1983) The Economic Foundations of East-West Migration during the 19th Century. Explorations in Economic History 20(1):14-36

Steckel R (1986) A Peculiar Population: The Nutrition, Health, and Mortality of American Slaves from Childhood to Mortality. Journal of Economic History 46(3):721-41

Steckel R (1989) Household Migration and Settlement in the United States, 1850-1860. Explorations in Economic History 26(2):190-218

Steckel R (1992) Work, Disease and Diet in the Health and Mortality of American Slaves. In: Fogel RW, Engerman SL (eds) Without Consent or Contract: The Rise and Fall of American Slavery, Conditions of Slave Life and the Transition to Freedom: Technical Papers. W. W. Norton, New York, NY:489-507

Steckel R (1994) Heights and Health in the United States. In: Komlos, J (ed) Stature, Living Standards and Economic Development. University of Chicago Press, Chicago, IL: 153-170

Steckel, R (1995) Stature and the Standard of Living. Journal of Economic Literature 33(4):1903-40

Steckel, R (2000) Diets versus Disease in the Anthropometrics of Slave Children: A Reply. Journal of Economic History, 60(1):247-259

Steckle, Richard H. (2005) "Health and Nutrition in the Pre-Industrial Era: Insights from a Millenium of Average Heights in Northern Europe." In Allen, Robert C.,

Tommy Bengstsson and Martin Dribe (eds.), *Living Standards in the Past: New Perspectives on Well Being in Asia and Europe.* Oxford: Oxford University Press. Pp. 227-253.

Steckel R, Haurin D (1994) Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsman. 1850-1910. In: Komlos J (ed) Stature, Living Standards and Economic Development. Chicago University Press, Chicago, IL:117-128

Sunder, Marco (2004) "The Height of Tennessee Convicts: Another Pieces of the "Antebellum Puzzle". *Economics and Human Biology.* pp. 75-86.

Sutch R (1975) The Treatment Received by American Slaves: A Critical Review of the Evidence Presented in Time on the Cross. Explorations in Economic History 12(4):335-438

Tanner JM (1962) Growth at Adolescence. Charles C. Thomas, Springfield, IL

Tanner JM (1977) Hormonal, Genetic and Environmental Factors Controlling Growth. In: Harrison GA, Weiner JS, Tanner JM, Barnicot NA (eds) Human Biology: an Introduction to Human Evolution, Variation, Growth and Ecology, 2nd Ed. Oxford University Press, Oxford, England:335-351

TEXAS STATE PENITENTIARY AT HUNTSVILLE. The Handbook of Texas Online. http://www.tsha.utexas.edu/handbook/online/articles/view/TT/jjt1.html

Tortolani, Justin, Edward McCarthy, Paul Sponseller, 2002, "Bone Mineral Density Deficiency in Children," *Journal of the American Academy of Orthopedic Surgeons,* 10(1) pp. 57-66.

Troesken W (2004) *Water, Race and Disease*. MIT Press, Cambridge, UK

Utterlinden, André, Yue Fang, Joyce B.J. van Meurs, Huibert A. P. Pols, Johannes P.T.M van Leeuwen, "Genetic and Biology of Vitamin D Receptor Polymorphisms," *Gene,* 338, 2004, pp. 143-156.

Wahl JB (1996) The Jurisprudence of American Slave Sales. Journal of Economic History 56(1):143-69

Wahl JB (1997) Legal Constraints on Slave Masters: The Problem of Social Cost. The American Journal of Legal History 41(1):1-24

Walker DR (1988) Penology for Profit: a History of the Texas Prison System, 1867-1912. Texas A & M University Press, College Station

Wannamethee, S. Goya, Peter Whincup, Gerald Shaper and Mary Walker, "Influence of Father's Social Class on Cardiovascular Disease in Middle-Aged Men," *The Lancet*, 348:9, 1996, pp.1259-63.

Woodward VC (1951) Origins of the new South, 1877-1913. Louisiana State University Press, Baton Rouge, LA

Wardlaw, G.M., J.S. Hampl, and R.A. Disilestro, 2004, *Perspectives in Nutrition, 6th ed.*, New York: McGraw-Hill, pp. 394-397.

Wright G (1978) The Political Economy of the Cotton South: Households, Markets, and Wealth in the Nineteenth Century. W. W. Norton, New York, NY

Xiong, E-H, F-H Xu, P-Y Liu, H Shen, J-R Long, L Elze, R R Recker and H-W Deng, "Vitamin D Receptor Gene Polymorphisms are Linked to and Associated with Adult Height," *Journal of Medical Genetics,* 42, 2004, pp. 228-234.

Y-Z Liu, F-H Shen, H Deng, Y-J Liu, L-J Zhao, V Dvornyk, T Conway, J-L Li, Q-Y Huang, K M Davies, R R Recker, and H-W Deng, "Confirmation Linkage Study

in Support of the X Chromosome Harboring a ATL Underlying Human Height Variation," *Journal of Medical Genetics,* 40, pp. 825-831.

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