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Demographic, Residential, and Socioeconomic Effects on the Distribution of 19th Century African-American Body Mass Index Values

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Abstract

Little research exists on the body mass index values of late 19th and early 20th century African-Americans. Using a new BMI data set and robust statistics, this paper demonstrates that late 19th and early 20th century black BMI variation by age increased in their mid-30s but declined at older ages when worker physical productivity declined. Throughout the late 19th and early 20th centuries, black BMIs decreased across the distribution, indicating that the 20th century increase in black BMIs did not have its origin in the 19th century. During industrialization, black BMIs were lower in Kentucky, Missouri, and urban Philadelphia.

JEL-Code: I000, I100, J150, N000.

Keywords: nineteenth century U.S. economic development, body mass index, 19th century race relations.

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I appreciate comments from Paul Hodges, John Komlos, and Tom Maloney.

I. Introduction

Throughout the 19th century, African-Americans experienced considerable degrees of political and economic instability. From its inception, US economic arrangements were based on inequality, and blacks were at an institionalized disadvantage to their white counterparts (Margo, 2007, pp. 232-254). During the antebellum period, many whites lived off the expropriated labor of enslaved blacks, and this inequality distorted black and white material and biological conditions. After emancipation, economic arrangements changed, but we are uncertain how black body mass index values (BMIs) varied with the transition from a bound to free labor force (Carson, 2010). Blacks continued to be at a material disadvantage to whites, and freedom from the lash did not translate into freedom of opportunity (Higgs, 1977). Therefore, this paper introduces a new 19th century black BMI data set and uses robust statistics to consider black BMI variation during US industrialization.

A population's average BMI (weight (km.)/ height (m^2)) reflects the net current balance between nutrition, disease climate, and the work environment, and heavier 19th century BMIs are evidence of more robust health (Fogel, 1994, p. 375; Strauss and Thomas, 1998). BMIs have also been linked to modern health outcomes (Waaler, 1984); however, the strength of this association across sub-populations remains debatable (Henderson, 2005, p. 340; Flegal et al., 2009, p. 240). Historical BMI studies provide important insight on the evolution of health during economic development. For BMIs less than 20, Waaler (1984) finds an inverse relationship between BMI and mortality risk. Costa (1993) applies Waaler's results to a historical population and finds the modern height and weight relationship with mortality applies to historical populations, and Jee et al., (2006, p. 780, 784-785) find the relationship is stable across racial groups. Costa (2004, pp. 8-10) demonstrates there were considerable differences between 19th century black and white BMIs, and blacks had greater BMI values than whites (Flegal, 2009 and 2010). Costa also finds that BMI values increased between 1860 and 1950. Cutler, Glaezer, and Shapiro (2003) find that the majority of increased 20th century BMI values occurred during the last 25 years because people consume more calories, not because they were physically inactive. However, little is known about when black BMIs began to increase.

It is against this backdrop that this paper introduces a large late 19th and early 20th century BMI data set to address three paths of inquiry into black BMI variation. First, how did BMIs vary with respect to age at the bottom, center, and top of the distribution? Across the distribution, average black BMIs increased until age 50, and declined at older ages, indicating black health deteriorated when worker productivity declined. Second, was there a 19th century mulatto BMI advantage, and how did it vary across the BMI distribution? A US mulatto stature advantage is reported in several stature studies, and if the mulatto advantage was due to sociological factors, mulatto BMIs may have been greater than darker black BMIs (Steckel, 1979; Bodenhorn, 1999; Carson, 2008 and 2009). After controlling for height, there was an inverse relationship between BMIs and mulatto complexions, indicating that a 19th century mulatto BMI advantage did not materialize. Third, how did black BMIs vary over time? Late 19th and early 20th century black BMIs decreased over time and across the distribution, indicating that the 20th century increase in black BMIs did not have its origin in the 19th century.

II. Nineteenth Century United States Black Prison Data

Prison Records

The data used here to study black BMIs is part of a large 19th century prison sample. All state prison repositories were contacted, and prisons included in this study are Arizona, California, Colorado, Idaho, Illinois, Kansas, Kentucky, Missouri, New Mexico, Ohio, Oregon, Pennsylvania, and Texas (Table 1). Most blacks in the sample were imprisoned in the Deep South or Border States—Kentucky, Tennessee, and Texas.

Table 1, Blacks in 19th Century US State Penitentiaries

Prison	*N*	*Percent*	*Prison*	*N*	*Percent*
Arizona	194	.29	Oregon	45	.07
Colorado	483	.71	Pennsylvania	2,685	3.96
Idaho	36	.05	Philadelphia	5,481	8.08
Kentucky	6,167	9.09	Tennessee	20,941	30.88
Missouri	4,292	6.33	Texas	27,154	40.04
New Mexico	344	.51	Total	67,822	100.00

Source: All state prison repositories were contacted and available records were acquired and entered into a master data set. These prison records include Arizona, California, Colorado, Idaho, Illinois, Kansas, Kentucky, Missouri, Montana, Nebraska, New Mexico, Ohio, Oregon, Pennsylvania, Texas, and Washington.

All historical data have various biases, and prison and military records are the most common source for historical BMI data. One common shortfall of military records is a truncation bias imposed by minimum stature requirements, and because shorter statures are associated with heavier BMIs, arbitrarily truncating shorter statures underestimates military BMIs (Herbert, 1993, pp. 1438). Fortunately, prison records do not implicitly suffer from such a truncation constraint. However, prison records are not above scrutiny, because they may have selected many of the materially poorest individuals from lower socioeconomic groups, that segment of society most vulnerable to economic change (Bogin, 1991, p. 288; Komlos and Baten, 2004, p. 199; Nicholas and Steckel, 1991, p. 944). However, if at the margins of subsistence, demographic and socioeconomic factors were more significant in BMI variation, prison records may illustrate these effects more clearly.

There is also concern over entry requirements, and physical descriptions were recorded by prison enumerators at the time of incarceration as a means of identification, therefore, reflect pre-incarceration conditions. Between 1840 and 1920, prison officials routinely recorded the dates inmates were received, age, complexion, nativity, height, weight, pre-incarceration occupation, and crime. All records with complete age, height, weight, occupation, and nativity were collected and are included in the sample used here. Because accurate measurement had legal implications for identification in the event that inmates escaped and were later recaptured, there was care recording inmate height and weight. Arrests and prosecutions across states may have resulted in various selection biases that may affect the results of this analysis. However, stature variations within US prisons are consistent with other stature studies (Steckel, 1979; Nicholas and Steckel, 1991, pp. 941-943; Komlos and Coclanis, 1997; Bodenhorn, 1999; Sunder, 2004; Carson, 2008, 2009).

Fortunately, inmate enumerators were quite thorough when recording inmate complexion and occupation. For example, enumerators recorded black complexions as black, negro, and various shades of mulatto. Enumerators recorded a broad continuum of occupations and defined them narrowly, recording over 200 different occupations, which are classified here into four categories: merchants and high skilled workers are classified as white-collar workers; light manufacturing, craft workers, and carpenters are classified as skilled workers; workers in the agricultural sector are classified as farmers; laborers and miners are classified as unskilled workers (Tanner, 1977, p. 346; Ladurie, 1979; Margo and Steckel, 1992; p. 520). Unfortunately, enumerators did not distinguish between farm and common laborers. Since common laborers encountered less favorable biological conditions during childhood and adolescence, this probably overestimates the biological benefits of being a common laborer and underestimates the advantages of being a farm laborer. Because the purpose of this study is to compare 19th century US black male BMIs, females, whites, and immigrants are excluded from the analysis.

Table 2, Nineteenth Century Black BMI Descriptive Statistics

Ages	*N*	*%*	*Mean*	*S.D.*	*Decade Received*	*N*	*%*	*Mean*	*S.D.*
Teens	14,044	20.71	22.30	2.30	1840s	20	.03	23.98	1.97
20s	36,129	53.27	23.78	2.30	1850s	55	.08	24.06	3.32
30s	11,074	16.33	24.04	2.47	1860s	980	1.44	23.94	2.71
40s	4,216	6.22	24.23	2.62	1870s	7,615	11.23	23.92	2.49
50s	1,678	2.47	24.78	2.63	1880s	12,509	18.44	23.61	2.40
60s	557	.82	24.15	2.54	1890s	14,285	21.06	23.68	2.34
70s	124	.18	23.56	2.51	1900s	16,319	24.06	23.57	2.38
Nativity					1910s	15,090	22.25	23.46	2.48
Northeast	2,727	4.02	23.21	2.23	1920s	949	1.40	23.62	2.47
Middle Atlantic	3,384	4.99	23.51	2.34	*Occupations*				
Great Lakes	1,223	1.80	23.47	2.50	White Collar	1,747	2.58	23.48	2.48
Plains	3,592	5.30	23.26	2.42	Skilled	5,147	7.59	23.67	2.57
Southeast	36,375	53.63	23.76	2.43	Farmer	6,411	9.45	23.80	2.37
Southwest	20,292	29.29	23.52	2.42	Unskilled	38,551	56.84	23.56	2.40
Far West	229	.34	23.57	2.57	No Occupation	15,966	23.54	23.71	2.43

Source: See Table 1.

Table 2 presents black inmates' age, birth decade, occupations, and nativity. Although average BMIs are included, they are not reliable because of possible compositional effects, which are accounted for in the regression models that follow. Age percentages demonstrate that black youths were more likely to commit and be incarcerated for criminal behavior; 74 percent of black inmates were in their teens and 20s. Blacks were primarily from the South and most were measured between 1880 and 1920. Because of overt racial prejudice that prevented human capital development and limited upward occupational mobility, a high percentage of black inmates were unskilled and with no listed occupation.

Using the World Health Organization (WHO) modern standards for BMI classification coding system, individuals with BMIs less than 18.5 are considered as underweight; BMIs between 18.5 and 24.9 are normal; BMIs between 24.9 and 29.9 are overweight; BMIs greater than 30 are obese. Because BMIs are sensitive to age, Figure 1 presents two age groupings: youths and adults.

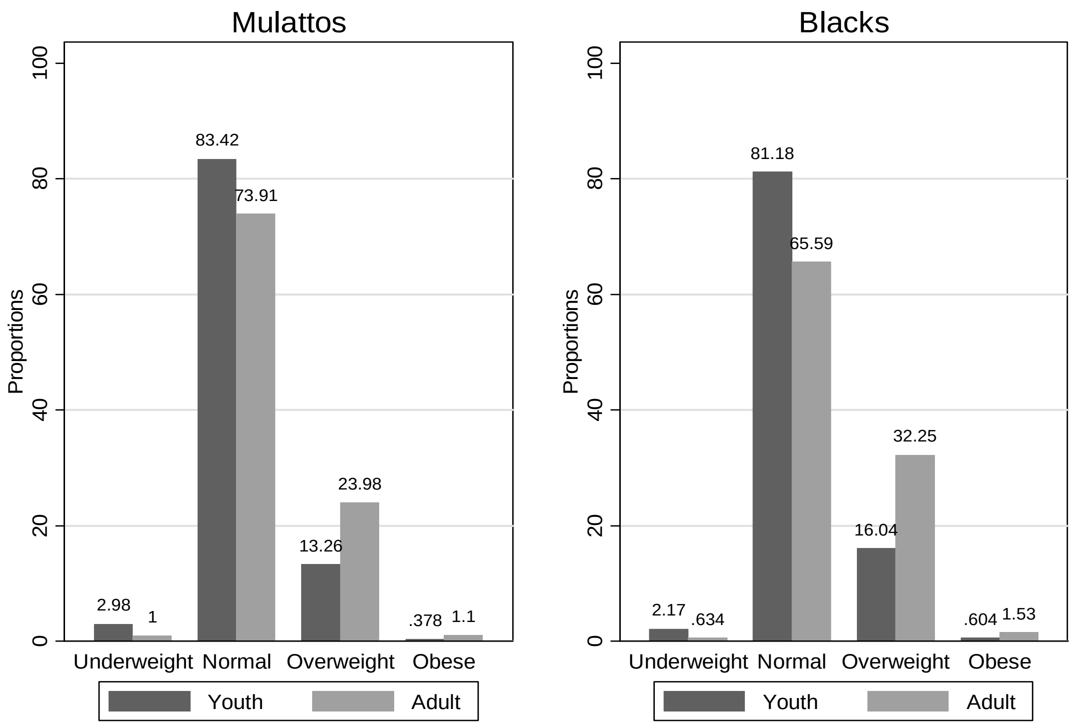

Figure 1, Nineteenth Century Mulatto and Black Underweight, Normal, Overweight, and BMI Percentages

Source: See Table 1.

The shape of the BMI distribution also tells us about a population's current biological conditions, and there are differing views about how 19th century BMIs were distributed. On the one hand, BMIs may have been low because 17th and 18th century diets were meager relative to work expenditures, which continued into the 19th century. On the other, as US agricultural settlement produced greater output and more nutritious diets relative to calories consumed for work and to fend off disease, this output growth created larger quantities of food and more nutritious diets. The overwhelming proportion of 19th century black BMIs were symmetrically distributed, fell within the normal BMI category, and neither starvation nor obesity were the historical problem facing 19th century US black populations (Figure 1). These historical BMIs are compared to modern US values, where approximately 36 percent of adult American men are overweight, and 23 percent are obese (Sturm and Wells, 2001, p. 231; Calle, et al, 1999, p. 1103; Flegal et al, 2010). BMIs less than 19 mark a threshold corresponding with increased mortality risk, and 40 percent of West Point Cadets between the ages of 20 and 21 had BMIs less than 19 (Cuff, 1994, p. 178). However, black 20 and 21 year old BMIs in 19th century US prisons were considerably greater than 19, and only 2.05 and 1.49 percent of mulattos and darker complexioned blacks had BMIs less than 19, indicating that black youths were not as likely as West Point Cadets to be in low BMI categories.

Morbid obesity is defined as a BMI>40, and has been linked to elevated risks of diabetes mellitus, cardiovascular disease, and cancer (Pi-Sunyer, 1991, p. 1599s; Kenchaiah, 2002, p. 306-312; Calle et al, 2003, pp. 1628-1630).[1] Cases of 19th century black morbid obesity in the US sample were nearly non-existent. Only .012 percent of US blacks in the prison sample was morbidly obese. This contrasts with 2.9 percent in

[1] There is also evidence suggesting that the health risks associated with higher BMIs are greater for whites than for blacks. (Flegal et al., 2009, p. 507; Stevens et al., 1998; Abel et al., 2007; Sanchez et al., 1998; Stevens et al., 1992; Weinpahl et al., 1990).

modern American samples (Steinbrook, 2004, p. 1077) and indicates that modern Americans are over 200 times more likely than blacks in 19th century US prisons to be morbidly obese. Therefore, compared with a modern developed economy, blacks in US prisons were in moderate weight ranges, and morbid obesity was nearly unheard of.

III. Socioeconomic Status, Geography, Birth Period, and Black BMIs

Across the 19th century BMI distribution, blacks experienced different relationships with BMIs, birth periods, demographics, and residential status. To better understand the interaction between socioeconomic and demographic characteristics, a quantile regression function is constructed. Let BMI_i represent the BMI of the ith inmate and x_i the vector of covariates representing birth cohort, socioeconomic status, and demographic characteristics. The conditional quantile function is

$$BMI_i = Q_y\left(p|x\right) = \theta x + \eta S\left(p\right),\ p \in \left(0,1\right)$$

which is the pth BMI quantile, given x. The coefficient vector θ is obtained using techniques presented in Koenker and Bassett (1982) and Hendricks and Koenker (1992). The interpretation of the coefficient θ_i is the influence of the ith covariate on the BMI distribution at the pth quantile. For example, the age coefficient at the median (.5 quantile) is the BMI increase that keeps an "average" inmate on the median if age increases by one year. When estimating BMI regressions, quantile estimation offers several advantages over least squares. Two advantages in anthropometric research are more robust estimation in the face of an unknown truncation point and greater description of covariate effects across the BMI distribution.

We test which of these variables were associated with 19th century African-American BMIs. To start, BMI for the ith individual is assumed to be related with stature, age, observation period, socioeconomic status, and residence.

$$BMI_i^p = \alpha + \beta_C^p Centimeters_i + \sum_{a=1}^{15} \beta_a^p Age_i + \sum_{t=1}^{10} \beta_t^p Decade\mathrm{Re}ceived_i + \sum_{l=1}^{3} \beta_l^p Occupation_i + \beta_R^p \mathrm{Re}sidence_i + \varepsilon_i^p$$

Dummy variables are included for individual youth ages 14 through 22; adult age dummies are included in ten year age intervals from the 30s through the 70s. Decade received dummies are in ten year intervals from 1840 through 1920. Occupation dummy variables are included for white-collar, skilled, farmers, and unskilled occupations. Residence dummy variables are included for location at time of measurement.

Table 3's model 1 presents least squares estimates for the black and mulatto pooled sample. Models 2 through 6 illustrate how BMIs were related with demographic, occupation, birth period, and nativity characteristics across the BMI distribution. Models 7 and 8 present black and mulatto BMI least squares regressions used in the BMI decomposition in the next section.

Table 3, National Quantile BMI Models Related to Demographic and Environmental Conditions

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
	OLS	*.25*	*.50*	*.75*	*.90*	*.95*	*Black*	*Mulatto*
Intercept	36.18***	31.64***	34.03***	37.50***	42.83***	47.47***	36.25***	35.86***
Height								
Centimeters	-.069***	-.052***	-.057***	-.068***	-.091***	-.112***	-.070***	-.066***
Race								
Black	Reference	Reference	Reference	Reference	Reference	Reference		
Mulatto	-.344***	-.365***	-.352***	-.354***	-.300***	-.318***		
Ages								
14	-3.74***	-3.87***	-3.59***	-3.83***	-3.47***	-3.52***	-3.78***	-3.53***
15	-3.18***	-3.01***	-3.11***	-3.42***	-3.55***	-3.48***	-3.22***	-3.00***
16	-2.41***	-2.21***	-2.38***	-2.46***	-2.65***	-2.82***	-2.45***	-2.20***
17	-1.74***	-1.54***	-1.71***	-1.91***	-2.08***	-2.28***	-1.77***	-1.58***
18	-1.33***	-1.18***	-1.28***	-1.40***	-1.58***	-1.78***	-1.36***	-1.21***
19	-.878***	-.726***	-.864***	-.972***	-1.12***	-1.25***	-.921***	-.708***
20	-.591***	-.567***	-.586***	-.630***	-.678***	-.810***	-.625***	-.461***
21	-.346***	-.280***	-.354***	-.419***	-.527***	-.627***	-.317***	-.471***
22	-.207***	-.135***	-.150***	-.248***	-.360***	-.449***	-.200***	-.239***
23-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30s	.213***	.094***	.231***	.261***	.402***	.587***	.203***	.250***
40s	.319***	.137***	.226***	.323***	.611***	.804***	.273***	.520***
50s	.292***	.136	.284***	.504***	.625***	.653***	.264***	.419***
60s	.083	-.308***	-.012	.311*	.307***	.628***	.109	-.053
70s	-.606**	-.749*	-.692***	-.399	-.270	-603	-.768***	1.18
Observation Period								
1840s	.592	1.80*	.650	.623	.159	-.475	.404	1.15
1850s	.259	-.134	-.065	.261	.767	1.06	.046	.256
1860s	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
1870s	-.162*	-.137*	-.201**	-.148*	-.177	-.353	-.114	-.989**
1880s	-.555***	-.460***	-.568***	-.637***	-.771***	-.920***	-.533***	-1.13***
1890s	-.471***	-.344***	-.489***	-.583***	-.755***	-.876***	-.446***	-1.07**
1900s	-.552***	-.442***	-.538***	-.614***	-.757***	-.922***	-.509***	-1.25***
1910s	-.673***	-.650***	-.714***	-.655***	-.594***	-.669*	-.600***	-1.45***
1920s	-.848***	-.787***	-.838***	-.807***	-.809***	-.749*	-.810***	-1.52***
Occupations								
White Collar	-.128**	-.172**	-.221***	-.137	-.090	-.058	-.108	.140
Skilled	.056	.044	-.055	.103*	.191***	.291***	.053	.079
Farmer	.347***	.324***	.320***	.353***	.368***	.393***	.308***	.501***
Unskilled	.219***	.204***	.186***	.226***	.250***	.305***	.203***	.270***

No Occupation	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Prisons								
West	.044	.010	.057	.201	-.086	.091	.008	.124
Kentucky	-.548***	-.587***	-.538***	-.471***	-.415***	-.410***	-.493***	-.802***
Missouri	-.758***	-.646***	-.717***	-.878***	-.1.03***	-1.21***	-.750***	-.726***
Pennsylvania	-.420***	-.283***	-.373***	-.394***	-.346***	-.232**	-.460***	-.322***
Philadelphia	-.580***	-.433***	-.558***	-.656***	-.701***	-.866***	-.596***	-.502***
Tennessee	.272***	.340***	.305***	.303***	.280***	.288***	.253***	.364***
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
N	67,822	67,822	67,822	67,822	67,822	67,822	54,483	13,339
R^2	.1242	.0673	.0654	.0646	.0693	.0776	.1211	.1150

Source: See Table 1.

Note: 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 WY. *** Significant at .01; **Significant at .05; *Significant at .10.

Three general patterns emerge when analyzing late 19th and early 20th century black BMIs. First, black BMIs varied with age, and between ages 14 and 23 years, black BMIs increased by 18 percent. Adult black BMIs increased at the middle of the BMI distribution until around age 50, after which, they declined. Nonetheless, it is in the tails of the distribution that BMI variation with age that is most telling. Between ages 40 and 70, adult black BMIs in the 25th quantile declined by 3.9 percent, while BMIs in the upper tail of the distribution decreased by over 4.8 percent, indicating that in later ages, black BMIs declined across the BMI distribution.

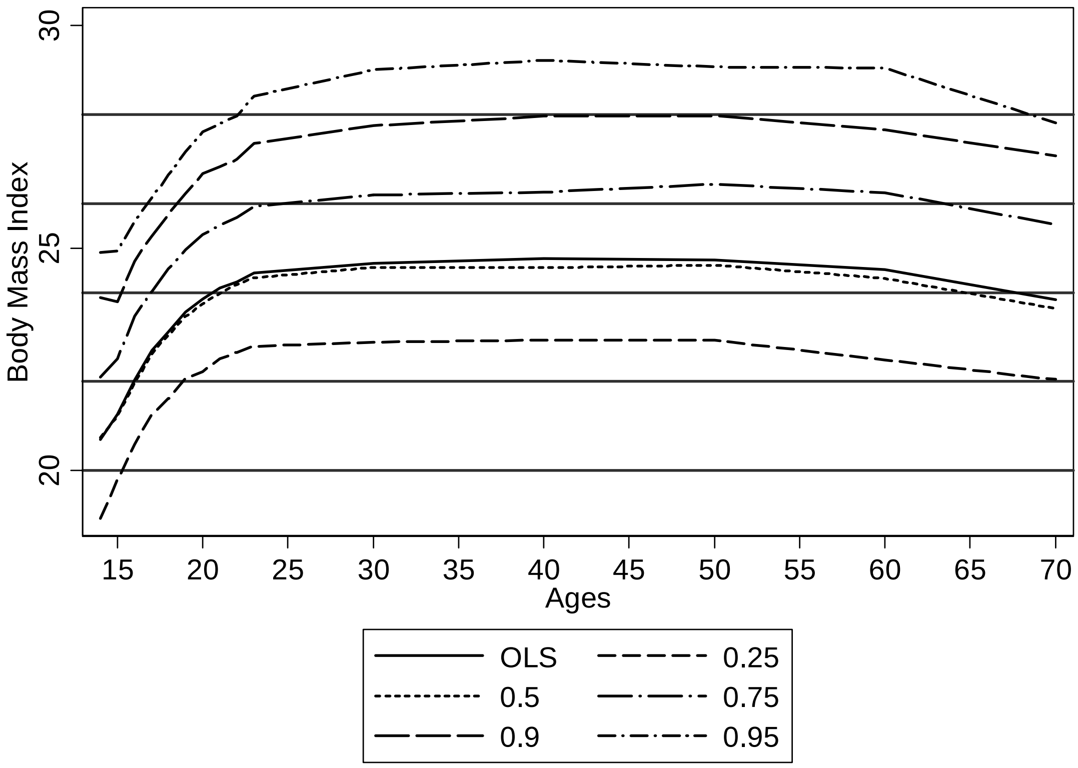

Figure 2, Nineteenth Century Black and White BMI Variation by Age

Source: See Table 3, Models 2 through 6. Black average BMI values imputed with an average stature of 170.767 centimeters.

Second, much has also been written about the 19th century male mulatto stature advantage, and 19th century US mulattos were taller than their darker complexioned counterparts (Steckel, 1979; Bodenhorn, 1999 and 2001; Carson, 2008 and 2009). However, the relationship between BMI and skin pigmentation is more complicated than height, because blacks have greater percent muscle mass, and muscle is heavier than fat (Flegal et al., 2010, p. 240; Flegal et al., 2009, p. 507; Fernandez et al., 2003; Aloia et al, 1999, p. 116; Evans et al., 2006). Moreover, darker complexioned blacks were also shorter than mulattos, and shorter statures are associated with greater BMI values (Herbert, 1993, p. 1438; Carson, 2009, p. 125). After controlling for height, darker complexioned blacks had greater BMI values than mulattos, indicating that the cumulative advantage of taller statures dominated black's greater percent muscle mass, and a mulatto BMI advantage did not materialize.

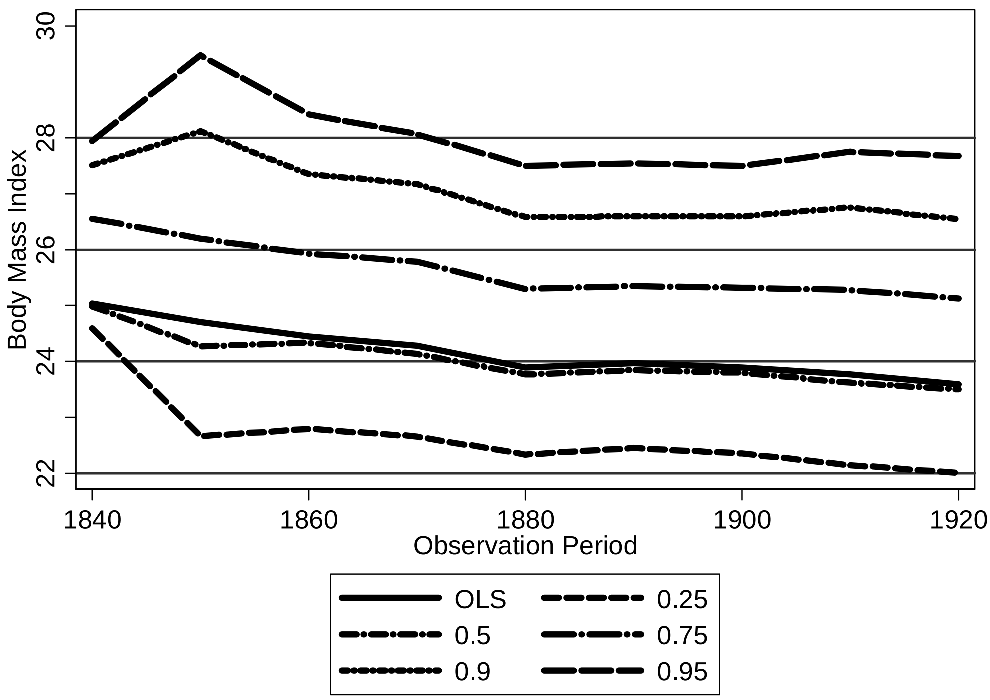

Figure 3, Nineteenth Century Black and White BMI Variation by Observation Period. Source: See Table 3, Models 2 through 6. Black average BMI values imputed with an average stature of 170.767 centimeters.

Third, throughout the 19th century, black BMIs declined across the distribution (Figure 3). Although 19th century blacks did not consume significant amounts of dairy products, the separation of agricultural consumption from production increased the relative cost of calories and nutrition (Kiple and King, 1981). In 1840, most Northern US agriculture was from single-family farms that primarily produced nutrition for distant markets. By 1900, US agriculture transformed into a highly organized commercial industry, which increased the relative price of dairy and meat products (Fletcher, 1955, p. 165; Cochrane, 1977, pp. 76 and 77). Therefore, the separation of agricultural consumption from production increased the price of food and decreased net nutrition.

Other patterns are consistent with expectations. There was an inverse relationship between BMIs and height across the distribution, and this inverse relationship was greater at higher BMI quantiles. All else equal, taller individuals have greater physical mass to distribute weight and have lower BMIs (Herbert, 1993, p. 1438). Regional biological differences also existed throughout the 19th century, and BMIs in Kentucky and the Upper South were consistently lower than BMIs reported elsewhere; black BMIs were greatest in the New South and lowest in the North. Compared to the North, 19th century Southern black diets had more fats (Hilliard, 1972), and the antebellum South had greater access to nutrition and animal proteins (Ransom and Sutch, 1977, p. 11-12, 151-152). Blacks from urban Philadelphia were less likely to be overweight or obese, but were also less likely to be underweight, suggesting that 19th century urban BMIs were more likely to be in normal weight ranges. After controlling for stature, blacks from the Far West had greater BMI values and were more likely to be overweight.

Across the BMI distribution, late 19th and early 20th century US black BMIs were related with occupations and farmers had heavier BMIs than workers in other occupations. Rural farmers were in close proximity to nutritious diets and were removed from disease environments. Part of farmer's heavier BMIs was also related with physical activity, and BMIs represent an individual's composition between muscle and fat, which are related to physical activity, therefore, occupations. Occupations requiring greater physical activity decreased fat and increased muscle, and for the same tissue volume, muscle is heavier than fat. Agricultural workers used between 2.5 and 6.8 energy multiples of sleeping basal metabolic rate (FAO/WHO, 1985; Fogel, 1994). On the other hand, skilled workers only used between 1.5 and 2.5 energy multiples of sleeping basal metabolic rate, and because of their physical inactivity relative to calories consumed, white-collar and skilled workers did not acquire as heavy of BMI values.

4. Explaining the Black-Mulatto BMI differential

To more fully account for the source of the black-mulatto BMI differential, a Blinder-Oaxaca BMI decomposition is constructed on the black-mulatto BMI gap (Oaxaca, 1973).[2] Let BMI_b and BMI_m represent the BMIs of blacks and mulattos, respectively; α_b and α_m are the autonomous BMI components that accrue to blacks and mulattos; β_b and β_m are the black and mulatto BMI returns associated with specific BMI enhancing

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[2] The null hypothesis for slope coefficients for male interactive effects in an ancillary regression, not reported here, illustrates that black coefficients are significantly different from mulatto coefficients (F-stat (29, 67,761)=2.46; p-value=.0000).

characteristics, such as age and occupation. X_b and X_m are mean black and mulatto characteristic matrices, and black BMIs are assumed to be the base structure.

$$\Delta BMI = BMI_b - BMI_m = (\alpha_b - \alpha_m) + (\beta_b - \beta_m)\overline{X}_b + \beta_m(\overline{X}_b - \overline{X}_m)$$

The second right hand-side element is the component of the BMI differential due to characteristics. The third right-hand side element is the part of the BMI differential due to differences in average characteristics and is undetermined because mulattos may have had characteristics associated with greater BMI values, but blacks were shorter.

Table 4, Nineteenth Century Black BMI Decomposition

	Youth BMIs	
Levels	$(\beta_B - \beta_M)\overline{X}_M$	$\beta_B(\overline{X}_B - \overline{X}_M)$
Total	.355	-.078
Sum		.277
Proportions		
Intercept	1.41	
Centimeters	-2.46	.027
Age	-.246	-.122
Occupations	-.228	-.038
Decade Received	2.89	-.453
Residence	-.078	.304
Proportions		
Total	1.28	-.281
Sum		1

Source: See Table 3.

Using coefficients from the BMI regressions (Tables 3, Models 7 and 8), a BMI decomposition indicates that the majority of heavier black BMIs was from non-identifiable characteristics, such as greater bone mineral density and lean muscle mass (Barondess et al., 1997; Flegal et al., 2010, p. 240). Measured in proportions, 19th century blacks had greater BMI returns associated with observation period, and darker complexioned blacks were more likely to be in the South; mulattoes had greater BMI returns associated with age and occupations. Moreover, the majority of the BMI differential due to observable characteristics was associated with stature, indicating that 19th century net current biological conditions were significantly related with net cumulative biological conditions. Therefore, at North American latitudes, the greatest share of the black-mulatto BMI differential was due to observation period and stature; however, the majority of the observable black-mulatto BMI differential is explained by non-identifiable characteristics, such as differences in access to nutrition, lean muscle mass, and higher bone mineral density (Barondess et al., 1997).

IV. Conclusions

There was considerable economic and social change that interacted with late 19th and early 20th century black health, and BMI variation reflects larger social forces shaping the US economy. Nineteenth century black BMIs were symmetrically distributed and were neither wasted nor obese by modern standards but in normal ranges. Across the distribution, black BMIs by age declined significantly after age 50, indicated that in older ages black BMIs declined as physical strength declined and productivity diminished. There was also no 19th century BMI mulatto advantage to fairer mulatto complexions, and the net cumulative advantage from taller mulatto statures dominated darker black complexions. Black BMIs decreased throughout the 19th and early 20th centuries, and unlike modern samples, there is little evidence of a black trend toward obesity, indicating that the 20th century trend toward obesity among the working class did not have its origin in the 19th century. Black BMIs varied geographically, and after controlling for stature, black BMIs in Tennessee and the West compared favorably with those in Texas, and the Northeast had the lowest BMIs. Therefore, except for the mulatto stature advantage, 19th century black BMI variation across the distribution was the result of a complex set of demographic and socioeconomic characteristics in ways consistent with 19th century stature and biological patterns that varied with the development of the US economy.

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