Racial Differences in Body-Mass Indices for Men Imprisoned in 19th Century US Prisons: A Multinomial Approach

Scott Alan Carson

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Abstract

Little research has been done on the body mass index values of 19th century US African-Americans and whites. This paper uses 19th century US prison records to demonstrate that although modern BMIs have increased in the 20th century, 19th century black and white BMIs were distributed symmetrically; neither underweight nor obese individuals were common. Throughout the 19th century, black and white BMI values declined. Farmers were consistently heavier than non-farmers, and blacks in Upper South had lower BMI values than their counterparts in other US regions.

JEL-Code: I10, I12, I30, J10, J15.

Keywords: body mass index, 19th century American health, racial disparity.

Scott Alan Carson
University of Texas, Permian Basin
4901 East University
USA - Odessa, TX 79762
Carson_S@utpb.edu

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1. Introduction

Industrialization and modernization frequently bring about rising incomes, wages and life expectancy, particularly in the long-run (Komlos, 1987; Floud, Wachter and Gregory, 1990, pp. 272-273). However, in the short-run, economic change also creates social turmoil, such as increasing inequality, crime, and a more virulent disease environment, which are associated with deteriorating biological conditions. Hence, the overall effect of industrialization on biological conditions depends on which effect dominates. In the case of the United States, economic growth was associated with greater factor mobility, and greater income accumulation, which enhanced biological conditions. However, economic growth was also associated with increased inequality, industrialization, and urbanization, which are negatively related with biological conditions. A considerable amount of research establishes the link between stature, economic development, and industrialization (Steckel, 1995 and 2009). However, less is known about BMI variation during industrialization, and BMIs are used here to address how US black and white biological conditions varied throughout the 19th century (Atack and Bateman, 1980, p. 125; Atack and Bateman, 1987, p. 87-92; Easterlin, 1971, p. 40-41; Soltow, 1975, p. 103; Steckel, 1983).

A population's average BMI (weight (km.)/ height (m^2)) reflects the net current balance between nutrition, disease climate, and the work environment (Fogel, 1994, p. 375), and heavier 19th century BMIs are evidence of more robust health. BMIs have also been linked to modern health outcomes (Waaler, 1984; Stevens et al, 1998, p. 1-7; Calle et al, 1999, p. 1097-1104; Kenchaiah et al, 2002, p. 305-313; Calle et al, 2003, pp. 1625-1638; Pi-Sunyer, 1991, pp. 1595s-1600s; Jee et al, 2006; Costa, 1993); however, the strength of this association across sub-populations remains debatable (Popkin, 2002, p. 1000; Henderson, 2005, p. 340). Without controlling for statures, historical and contemporary blacks have greater BMIs than whites (Flegal, 2010; Costa, 2004, pp. 11-12; Flegal, Carroll, Ogden, and Johnson, 2002).

Historical BMI studies provide important perspective 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. Costa also finds that BMI values increased between 1860 and 1950. Cutler, Glaezer, and Shapiro (2003) find that US BMIs increased since the beginning of the 20th century; however, they find the majority of increased BMI values occurred during the last 25 years because people consume more, not because they are physically inactive.

It is against this backdrop that this article considers three paths of inquiry into late 19th century US black and white BMI variation. First, how were black and white BMIs distributed, and how did they compare by race? Modern health studies demonstrate that 20th century BMIs have increased (Cutler, Glazier, and Shapiro, 2003; Sturm and Wells, 2001, p. 230; Calle et al, 1999, p. 1103), but we know little about how 19th century black and white BMIs were distributed as industrialization occurred. This study finds that 19th century black and white BMIs were distributed symmetrically, and neither wasting nor obesity were common. Second, was there a 19th century BMI mulatto advantage for lighter complexioned blacks compared to their darker complexioned counterparts? Nineteenth century mulattos had lower BMI values than darker complexioned blacks. Third, how did black and white BMIs vary throughout the 19th century? Consistent with biological change and industrialization, black and white BMIs declined throughout the 19th century.

2. Nineteenth Century US Prison Data

The two most common sources of historical BMI measurements are military and prison records. One common shortfall of military samples—which may have been related with BMI distributions—is a truncation bias imposed by minimum stature requirements (Fogel et al, 1978, p. 85; Sokoloff and Vilaflor, 1982, p. 457, Figure 1). Fortunately, prison records do not implicitly suffer from such a constraint and the subsequent truncation bias observed in military samples. However, prison records are not above scrutiny. Prison data may have selected many of the materially poorest individuals; nevertheless, this selectivity may have its own advantages in BMI studies because prisoners may have been drawn from lower socioeconomic groups, that segment

of society most vulnerable to economic change (Bogin, 1991, p. 288; Komlos and Baten, 2004, p. 199).

Table 1, Nineteenth Century US State Penitentiaries

Prison	*Black*		*White*	
	N	*Percent*	*N*	*Percent*
Arizona	194	.29	2,156	2.93
Colarado	483	.71	3,502	4.76
Idaho	36	.05	575	.78
Kentucky	6,167	9.09	6,602	8.97
Missouri	4,294	6.33	7,987	10.85
New Mexico	344	.51	1,993	2.71
Oregon	45	.07	1,683	2.29
Pennsylvania	2,685	3.96	11,214	15.24
Philadelphia	5,481	8.08	11,411	15.51
Tennessee	20,942	30.88	10,384	14.11
Texas	27,154	40.04	16,083	21.85
Total	67,825	100.00	73,590	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.

The data used here is part of a large 19th century prison sample.[1] Most blacks in the sample were imprisoned in the Deep South or Border States—Kentucky, Missouri, and Texas. Most whites in the sample were imprisoned in Missouri and Texas, but Northern whites were also from Pennsylvania and the Far West (Table 1). Physical descriptions were recorded by prison enumerators at the time of incarceration as a means

[1] 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 (Table 1).

of identification, therefore, reflect pre-incarceration conditions. Between 1840 and 1920, prison officials routinely recorded the dates inmates were received, age, complexion, nativity, stature, pre-incarceration occupation, and crime. All records with complete age, stature, weight, occupations, and nativity were collected. Because accurate recordings had legal implications in identification, there was a care recording inmate height and weight measurement in the event that inmates escaped and were later recaptured. Arrests and prosecutions across states may have resulted in various selection biases that may affect the results of this analysis. However, black and white stature variations across US prisons are consistent with other historical health studies (Costa, 2004; Cuff, 1994; Coclanis and Komlos, 1998). Because the purpose of this study is 19th century black and white male BMIs, females, and immigrants are excluded from the analysis.

Inmate enumerators were quite thorough when recording inmate complexion and pre-incarceration occupation. For example, enumerators recorded inmates' race in a complexion category, and African-Americans were recorded as black, light-black, dark-black, and various shades of mulatto (Komlos and Coclanis, 1997). Enumerators recorded white complexions as light, medium, dark, and fair. The white inmate complexion classification is further supported by European immigrant complexions, who were always of fair complexion and were also recorded as light, medium, and dark.[2] While mulatto inmates possessed genetic traits from both European and African ancestry,

[2] I am currently collecting 19th century Irish 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.

they were treated as blacks in the 19th century US and when comparing whites to blacks, are grouped here with blacks.

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, inmate enumerators did not distinguish between farm and common laborers. Since common laborers probably encountered less favorable biological conditions during childhood and adolescence, this potentially overestimates the biological benefits of being a common laborer and underestimates the advantages of being a farm laborer.

Table 2, National BMI Descriptive Statistics

Blacks					*Whites*				
Ages	N	%	BMI	S.D.	*Ages*	N	%	BMI	S.D.
Teens	14,045	20.74	22.60	2.33	Teens	10,037	13.64	21.72	2.80
20s	36,131	53.27	23.79	2.70	20s	36,609	49.75	22.54	2.34
30s	11,074	16.33	24.04	2.47	30s	16,191	22.00	22.86	2.54
40s	4,216	6.22	24.23	2.62	40s	6,841	9.30	23.14	2.78
50s	1,678	2.47	24.35	2.63	50s	2,841	3.86	23.24	2.94
60s	557	.82	24.15	2.54	60s	896	1.22	23.04	3.24
70s	124	.18	23.56	2.51	70s	175	.24	23.32	3.60
Decade Received					*Decade Received*				
1840s	20	.03	23.98	1.98	1840s	165	.22	23.43	2.60
1850s	55	.08	24.06	3.32	1850s	839	1.14	22.49	2.18
1860s	980	1.44	23.94	2.71	1860s	1,307	1.78	22.79	2.38
1870s	7,615	11.23	23.92	2.49	1870s	8,748	11.89	22.35	2.30
1880s	12,510	18.44	23.61	2.44	1880s	10,888	14.80	22.58	2.30
1890s	14,285	21.06	23.68	2.37	1890s	14,115	19.18	22.71	2.44
1900s	16,319	24.06	23.57	2.38	1900s	17,782	24.16	22.65	2.46
1910s	15,092	22.25	23.48	3.30	1910s	18,536	25.19	22.50	2.99
1920s	949	1.40	23.62	2.47	1920s	1,210	1.64	22.61	2.81
Occupations					*Occupations*				
White-Collar	1,747	2.58	23.48	2.48	White-Collar	7,024	9.54	22.60	2.79
Skilled	5,147	7.59	23.67	2.57	Skilled	16,396	22.28	22.67	2.76
Farmer	6,411	9.45	23.80	2.37	Farmer	7,307	9.93	22.68	2.45
Unskilled	38,553	56.84	23.57	2.76	Unskilled	32,292	43.88	22.57	2.49
No Occupation	15,967	23.54	23.71	2.45	No Occupation	10,571	14.36	22.39	2.38
Nativity					*Nativity*				
Northeast	2,727	4.02	23.21	2.23	Northeast	10,328	14.03	22.39	2.36
Middle Atlantic	3,384	4.99	23.51	2.34	Middle Atlantic	15,014	20.40	22.86	2.41
Great Lakes	1,223	1.80	23.47	2.50	Great Lakes	6,107	8.30	22.84	3.83
Plains	3,594	5.30	23.36	5.08	Plains	8,168	11.10	22.37	2.43
Southeast	36,376	53.63	23.76	2.45	Southeast	22,048	29.96	22.54	2.47
Southwest	20,292	29.82	23.52	2.42	Southwest	9,900	13.45	22.39	2.34
Far West	229	.34	23.57	2.39	Far West	2,025	2.75	22.82	2.32
Prison					*Prison*				
Arizona	194	.29	23.34	2.20	Arizona	2,156	2.93	22.78	2.39
Colorado	483	.71	24.08	2.52	Colorado	3,502	4.76	23.24	2.45
Idaho	36	.05	23.89	2.64	Idaho	575	.78	22.77	2.36

Kentucky	6,167	9.09	23.33	2.55	Kentucky	6,602	8.97	22.31	2.40
Missouri	4,294	6.33	23.08	4.72	Missouri	7,987	10.85	22.04	3.47
New Mexico	344	.51	23.82	2.68	New Mexico	1,993	2.71	22.93	2.65
Oregon	45	.07	24.65	2.56	Oregon	1,683	2.29	23.59	2.29
Pennsylvania	2,685	3.96	23.60	2.33	Pennsylvania	11,214	15.24	22.93	2.41
Philadelphia	5,481	8.08	23.45	2.26	Philadelphia	11,411	15.51	22.33	2.32
Tennessee	20,942	30.88	23.84	2.43	Tennessee	10,384	14.11	22.82	2.49
Texas	27,154	40.04	23.65	2.42	Texas	16,083	21.85	22.42	2.37

Source: See Table 1.

Table 2 presents black and white inmates' BMIs by age, birth decade, occupations, and nativity proportions. Although average BMIs are included, they are not reliable because of possible compositional effects, which are accounted for in the regression models that follow. Whites were a larger portion of the prison population than blacks; 52 percent of the US prison population was white. Age percentages demonstrate that black inmates were incarcerated at younger ages, while whites were incarcerated at older ages. During the early 19th century, blacks were less likely to be incarcerated; however, with passage of the 13th amendment, slave 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.[3] Whites within 19th century US prisons were more likely than blacks to be white-collar, skilled workers, and farmers. Blacks were more likely to be unskilled.

[3] Southern law evolved to favor plantation law, which generally allowed slave owners to recover slave labor on plantations while slaves were punished (Komlos and Coclanis, 1997, p. 436; Wahl, 1996, 1997; Friedman, 1993).

3. Nineteenth Century US BMI Distributions

The shape of the BMI distribution also tells us much 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 the 17th and 18th centuries had meager diets relative to work expenditures, which continued into the 19th century (Fogel, 1994, p. 373). On the other, 19th century BMIs may have increased as US agricultural settlement produced more nutritious diets relative to calories consumed for work and to fend off disease. Given similar means, if the BMI distribution is positively skewed, there are a disproportionate number of underweight individuals, and if the BMI distribution is negatively skewed, there is a disproportionate number of overweight individuals.

Average black youth and adult BMIs were 22.99 and 23.96, respectively; average white youth and adult BMIs were 21.98 and 22.77 respectively, indicating that average black BMIs were heavier than white BMIs, and young 19th century lower socioeconomic status males were not emaciated (Costa, 2004; Carson, 2009; Flegal, 2010).[4] However, heavier 19th century black BMIs are not necessarily a sign of better health because black statures were shorter than whites and shorter statures are associated with heavier BMIs (Herbert et al., 1993, p. 1438).

Using the World Health Organization BMI classification coding system for modern standards, BMIs less than 18.5 are classified as underweight; BMIs between 18.5 and 24.9 are normal; BMIs between 24.9 and 29.9 are overweight; BMIs greater than 30

[4] Modern black and white BMIs are comparable, but blacks have significantly higher bone mass than whites (Barondess, Nelson, and Schlaen, 1997, p. 968).

are obese. By considering the percentages of black and white males who fell into the underweight, normal, overweight and obese categories, we gain a better understanding for how 19th century weight-for-height ratios were distributed.

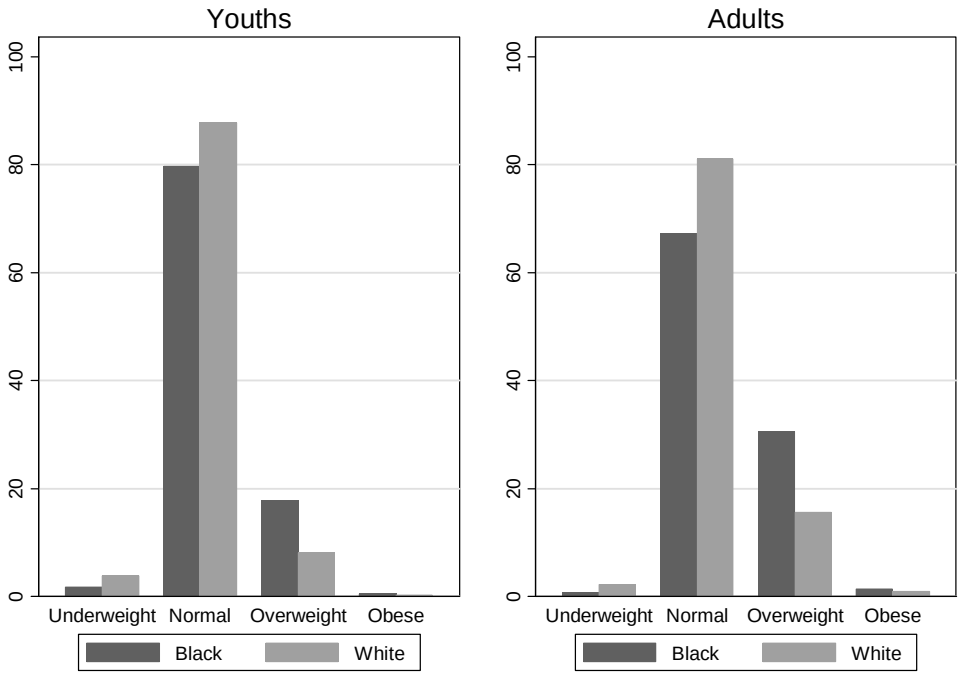

Figure 1, Nineteenth Century Black and White Underweight, Normal, Overweight, and BMI Percentages

Source: See Table 1.

Figure 1 illustrate that the percentages of 19th century black and white BMIs overwhelmingly fell within the normal BMI interval; therefore, wasting among the working class was not common. Moreover, it is striking that proportionally so many whites relative to blacks fell into the underweight category, indicating that although blacks came to shorter terminal statures, they were less likely to be underweight. Morbid

obesity is defined as a BMI>40, and has been linked to elevated risks of diabetes, cardiovascular disease and cancer (Pi-Sunyer, 1991, p. 1599s; Kenchaiah, 2002, pp. 306-312; Calle et al, 2003, pp.1628-1630). There were few 19th century cases of black or white morbid obesity in the US sample. BMIs less than 19 marks a threshold corresponding with increasing mortality risk, and 40 percent of West Point Cadets between ages 20 and 21 (Cuff, 1993, p. 178; Steckel, 2006, p. 582). However, 20 and 21 year old 19th century prison BMI values were considerably greater than these military samples. Only 1.6 percent of blacks and 4.1 percent of whites were less than 19, and working class youth were less likely than soldiers to have low BMI values. Therefore, rather than wide-spread wasting among the lower class, 19th century working class BMIs were in normal weight ranges and wasting was uncommon.

4. Black and White Demographics, Occupations and BMIs: a Multinomial Logit Approach

The underweight, normal, overweight, and obese BMI categories provide a natural range of binary classifications for 19th century biological conditions. Least squares results are calculated to contrast the comparative effect of race, stature, age, socioeconomic status, observation period, and residence on BMI, and multinomial logit models contrast BMI variation for underweight, overweight and obese classifications relative to the normal category by race. Coefficients are reported as odds ratios and are the relative probability of being in a given BMI classification relative to the normal category. For example, in Table 3's Model 2, an odds ratio for 60 year olds of 2.28 indicates six year old white adults were twice as likely as the 20 year old control group to be in the underweight BMI classification.

We test which of these variables were associated with 19th century black and white BMIs. To start, the BMI of the i^{th} individual is assumed to be related with race, height, age, occupations, decade received, and residence.

$$\log\left(\frac{p_j}{p_{Normal}}\right) = \beta_1 Race_i + \beta_2 Centimeters_i \sum_{a=1}^{14} \beta_a Age_i + \sum_{l=1}^{4} \beta_l Occupation_i \sum_{t=1840}^{1920} \beta_t \, Received_t$$

$$+ \sum_{r=1}^{10} \beta_r \, Residence_i + \varepsilon_i$$

for j=1, 2, and 3

Table 3, Black Multinomial BMI, Relative Risk Ratios

	Model 1	Model 2	Model 3	Model 4
	OLS	*Underweight*	*Overweight*	*Obese*
Intercept	35.11***			
Complexion				
Mulatto	-.359***	1.34***	.767***	.768***
Black	Reference	Reference	Reference	Reference
Height				
Centimeters	-.069***	1.06***	.960***	.870***
Ages				
14	-3.74***	37.19***	.082***	.120***
15	-3.18***	13.86***	.089***	.117***
16	-2.41***	9.85***	.149***	.087***
17	-1.74***	3.54***	.224***	.195***
18	-1.33***	2.68***	.339***	.229***
19	-.880***	1.93***	.500***	.353***
20	-.590***	1.51**	.613***	.445***
21	-.344***	1.48**	.768***	.651**
22	-.132**	.916	.858***	.739*
23-29	Reference	Reference	Reference	Reference
30s	.210***	1.28*	1.18***	1.61***
40s	.317***	1.20	1.20***	2.44***
50s	.292***	1.63*	1.33***	1.97***
60s	.083	1.05	1.17*	1.63
70s	-.611***	4.95***	.678*	.902
Occupations				
White-collar	-.143**	.775	.896*	1.25
Skilled	.047	.888	1.03	1.57***
Farmers	.340***	.592***	1.24***	1.33*
Unskilled	.215***	.763*	1.16***	1.22
No-Occupation	Reference	Reference	Reference	Reference
Received				
1840s	1.15***	0	2.34*	0
1850s	.816*	1.03	1.69*	2.70
1860s	.547***	.939	1.46***	1.99**
1870s	.392***	.989	1.36***	1.80***
1880s	.003	.990	1.03	1.04
1890s	.085***	.706***	1.01	1.10
1900s	Reference	Reference	Reference	Reference
1910s	-.121***	1.25**	.885***	1.19
1920s	-.309***	2.24***	.779***	1.37
Prisons				
Arizona	.221	1.36	1.43**	1.75
Colorado	.838***	0	1.78***	4.29***

Idaho	.651	0	1.80	3.9^{-14}***
Kentucky	.069	1.68***	1.22***	1.58***
New Mexico	.588***	1.46	1.61***	2.44**
Oregon	1.25***	0	1.91**	7.59***
Tennessee	.887***	.682**	2.04***	2.48***
Texas	.617***	.796*	1.64***	2.81***
Pennsylvania	-.013	1.10	1.05	1.27
Philadelphia	Reference	Reference	Reference	Reference
N	67,825	67,825	67,825	67,825
R^2	.1046	.0618	.0618	.0472

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 WA.

Table 4, White Multinomial BMI, Relative Risk Ratios

	Model 1	Model 2	Model 3	Model 4
	OLS	*Underweight*	*Overweight*	*Obese*
Intercept	30.78***			
Height				
Centimeters	-.051***	1.04***	.964***	.908***
Ages				
14	-2.52***	9.46***	.242***	1.1^{-13}***
15	-2.18***	10.75***	.186***	2.21**
16	-1.77***	4.52***	.187***	.758
17	-1.33***	3.07***	.292***	.470*
18	-.904***	2.05***	.436***	.502**
19	-.599***	1.30***	.590***	.440**
20	-.396***	1.05	.621***	.452**
21	-.257***	.860	.740***	.561*
22	-.181***	.936	.792***	.796
23-29	Reference	Reference	Reference	Reference
30s	.219***	1.06	1.29***	2.66***
40s	.485***	1.09	1.58***	4.65***
50s	.559***	1.26*	1.73***	5.49***
60s	.319***	2.32***	1.63***	5.33***
70s	.576**	3.26***	1.75***	9.95***
Occupations				
White-collar	.143***	1.07	1.27***	2.37***
Skilled	.254***	.634***	1.21***	1.31
Farmers	.371***	.521***	1.31***	1.49**
Unskilled	.353***	.588***	1.34***	1.26
No-Occupation	Reference	Reference	Reference	Reference
Received				
1840s	1.72***	.404*	3.29***	4.16**
1850s	.550***	.442***	1.37***	.228
1860s	.618***	.623**	1.48***	1.03
1870s	.036	1.03	1.00	.988
1880s	-.098***	1.16*	.915	.521***
1890s	.0244	1.02	.985	963
1900s	Reference	Reference	Reference	Reference
1910s	-.093***	1.41***	.931**	1.17
1920s	-.301***	1.88***	.801**	1.55*
Prisons				
Arizona	.525***	.511***	1.30***	2.29*
Colorado	.925***	.303***	1.99***	2.42***
Idaho	.648***	.392***	1.66***	2.02*
Kentucky	-.016***	1.47***	1.27***	1.75***
New Mexico	.757***	.839	1.91***	3.55***

Oregon	1.42***	.307***	2.99***	3.03***
Tennessee	.843***	.523***	2.05***	2.82***
Texas	.370***	.829***	1.42***	2.34***
Pennsylvania	.563***	.667***	1.65***	2.10***
Philadelphia	Reference	Reference	Reference	Reference
N	73,590	73,590	73,590	73,590
R^2	.0653	.0472	.0472	.0472

Source: See Table 1.

Notes: See Table 3

Race indicator variables are classified as white, black, and mulatto. Stature in centimeters is included to account for the inverse relationship between BMI and stature.[5] Youth age dummies are included for ages 14 through 22, and adult ages are accounted for with 10 year-age dummy variables. Occupation dummy variables are included for white-collar, skilled, farmers, and unskilled occupations. Decade received dummy variables are in 10 year intervals from 1840 through 1929. Residence dummy variables are included for state residence at time of arrest.

Three general patterns emerge when comparing 19th century black and white BMIs. First, blacks had the highest BMI values, followed by mulattos and whites. Throughout the 19th century black BMIs remained about 10 percent greater than white BMIs (Figure 2; Costa, 2004; Flegal 2010). In the late 19th century, African and European

[5] Because stature is potentially an endogenous regressor. its inclusion as an explanatory variable creates the possibility of biased and inconsistent estimates. However, a Hausman test demonstrates that stature is not an endogenous regressor. Testing the least squares against the two-stage least squares estimate produces a black Hausman test statistic of 16.64. The χ^2 critical value with 37 degrees of freedom is 52.19. The white Hausman test statistic is 15.19. The χ^2 critical value with 36 degrees of freedom is 51.00. It is, therefore, reasonable to reject that stature is an endogenous regressor.

Americans faced considerable economic and social change, and black BMIs were ironically greater than white BMIs (Figure 1; Costa, 2004, p. 8). During the late 19th and early 20th centuries, US black incomes probably increased, and blacks devoted a higher share of their incomes than whites to food acquisition, which may have been associated with heavier black BMIs (Higgs, 1977, p. 107; Bodenhorn, 1999, pp. 985-993; Flegal, et al., 2002). Within the black cohort, mulatto BMIs were lower than their darker black counterparts (Table 3). Moreover, because of 19th century cultural practices that favored fairer to darker complexions, there is a 19th century mulatto stature advantage over their darker complexioned counterparts (Steckel, 1979; Bodenhorn, 1999, 2002). However, mulattos were consistently taller than darker complexioned blacks, and after controlling for stature, darker black BMIs were consistently greater than mulatto BMIs. Therefore, there is little evidence of a 19th century mulatto BMI advantage.

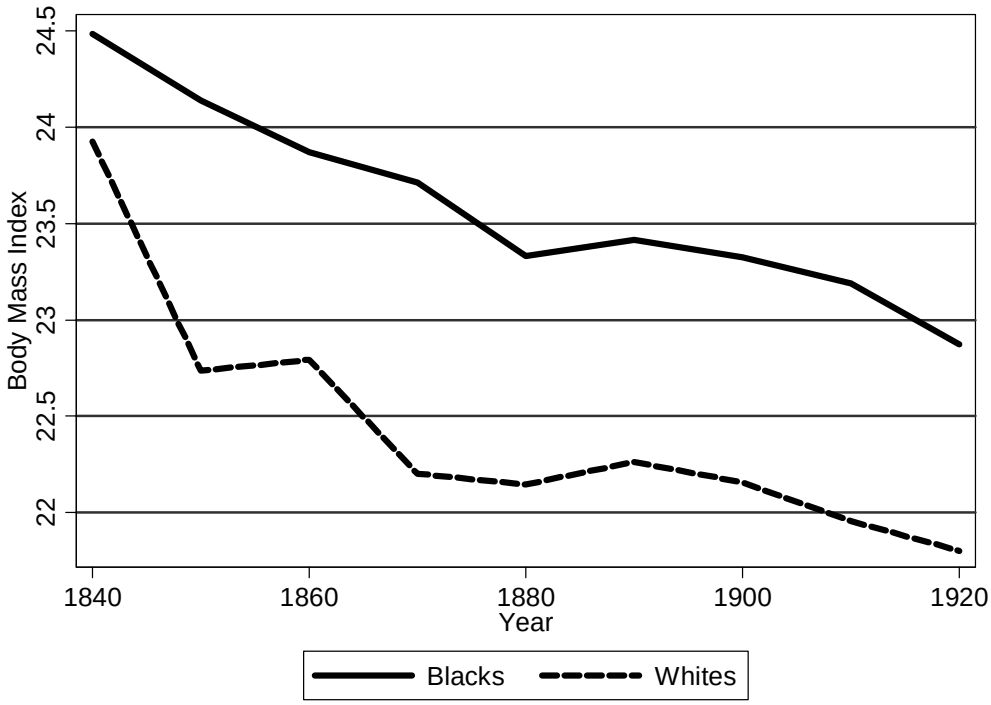

Figure 2, Nineteenth Century Black and White BMI Variation

Source: Tables 3 and 4.

Second, to the degree that BMI represents net current access to calories relative to energy expended for work and to fend off disease, US BMIs during the late 19th century suggests a period of increasing dietary stress. This study finds that US black and white BMI values decreased throughout the 19th century, with the largest BMI declines experienced during the first half of the 19th century (Figure 2). Between 1830 and the eve of the Civil War, black and white BMIs decreased by 2 and 7 percent, respectively, indicating that 19th century black and white BMIs decreased with industrialization (Rees,

et al., 2003; Komlos, 1998; Komlos and Cocalinis, 1997; Carson, 2009, p. 154).[6] Moreover, unlike modern samples, there is little evidence of a white trend toward the obese category, indicating that 19th century white obesity did not have its origin in the 19th century (Komlos, AJHB, forthcoming).

Third, US BMIs were related to occupation, and farmers had heavier BMIs than non-farmers. Part of farmer's heavier BMIs may be related to physical activity. Agricultural workers used between 2.5 and 6.8 energy requirement multiples of sleeping basal metabolic rate (FAO/WHO, 1985; Fogel, 1994), indicating that US farmers had sufficient calories to maintain weight because they were closer to nutritious diets than workers in other occupations. On the other hand, only white white-collar workers were more likely to be obese than white workers in other occupations. Sedentary white collar workers only used between 1.5 and 2.5 energy requirement multiples of sleeping basal metabolic rate, and because of their physical inactivity relative to calories consumed, experienced excess weight gain.

Other patterns are consistent with expectations. Only BMIs in the Kentucky prison and Upper South were consistently lower than BMIs of inmates incarcerated in other prisons. After controlling for stature, blacks from the Far West had greater BMI values and were more likely to be overweight, although not obese. BMIs may have also been related with urbanization. Blacks and whites from Philadelphia were less likely to be overweight or obese, but were also less likely to be underweight, indicating that urban BMIs were more likely to be in normal weight ranges.

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[6] The black and white BMI decrease during the early 19th century may also be inconsistent with low BMIs during the 18th century.

4. Explaining the Black-White BMI differential

To more fully account for the source of the black-white BMI differential, a Blinder-Oaxaca BMI decomposition is calculated (Oaxaca, 1973). Let S_w and S_b represent the BMIs of whites and blacks, respectively; α_b and α_w are the autonomous BMI components that accrue to blacks and whites; β_b and β_w are the black and white BMI returns associated with specific stature enhancing characteristics, such as age and occupation. X_b and X_w are black and white characteristic matrices, and black BMIs are assumed to be the base structure.

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

The second right hand-side element is that component of the BMI differential due to characteristics and was likely positive. The third right-hand side element is the part of the BMI differential due to differences in characteristics and is undetermined because whites probably had characteristics associated with greater BMI values, but blacks were shorter.

Table 5, Nineteenth Century National BMI Decomposition

Levels	$(\beta_B - \beta_W)\overline{X}_W$	$\beta_B(\overline{X}_B - \overline{X}_W)$	$(\beta_B - \beta_W)\overline{X}_B$	$\beta_W(\overline{X}_B - \overline{X}_W)$
Total	1.003	.0998	1.171	-.068
Sum		1.103		1.103
Proportions				
Intercept	3.926		3.926	
Centimeters	-2.797	.081	-2.775	.060
Age	-.115	-.169	-.139	-.145
Occupations	-.123	.026	-.094	-.003
Decade	.051	-.008	.058	-.010
Received				
Residence	.056	.161	.086	.037
Proportions				
Total	.910	.091	1.061	-.061
Sum		1		1

Source: See Tables 3 and 4.

Using coefficients from the BMI regressions (Tables 3 and 4, Model 1), the BMI decomposition indicates that the majority of heavier black BMIs was from non-identifiable characteristics, such as higher bone mineral density and diets heavy with saturated fats; however, the majority of the BMI differential due to observable characteristics was associated with stature, indicating 19th century current biological conditions were significantly related with cumulative biological conditions. Measured in proportions, 19th century blacks had greater BMI returns and characteristics associated with residence; whites had greater BMI returns associated with age and occupations. Other observable characteristics did not contribute to the black-white BMI differential. Therefore, at North American latitudes, the greatest share of the BMI black-white differential was due to taller white statures; however, the majority of the black-white BMI differential is explained by non-identifiable characteristics, such as differences in access to nutrition and higher bone mineral density (Barondess, Nelson, and Schlaen, 1997).

4. Discussion

United States prison data indicate that working class black and white BMIs were normally distributed, and 18th and 19th century BMIs were not wasted but in normal ranges. Unlike stature studies, there was no BMI mulatto advantage. Rather, mulatto BMI values were unexpectedly lighter than darker black BMIs and are contrary to the 19th century mulatto stature advantage. The link between BMI and socioeconomic status indicates that, although blacks had heavier BMIs, both black and white farmers consistently had heavier BMIs than workers in other occupations. Throughout the 19th century, rural US farmers had greater access to nutritious diets than workers in other

occupations and lived in rural environments where disease was less easily propagated, and allowed for heavier farmer BMIs. Although the effect was not large, white BMI returns and characteristics associated with BMIs were predictably greater than black returns and characteristics. The black-white BMI gap was due mostly to unobservable characteristics; however, of those measurable, the majority of the BMI differential was attributable to stature differences, and white BMI returns associated with stature were greater than blacks. Therefore, excluding a mulatto stature advantage, 19th century black and white BMI variation was the result of a complex set of demographic and socioeconomic characteristics in ways consistent with 19th stature variation.

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