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Abstract

Heights and body mass index values (BMIs) are now well accepted measures that reflect net nutrition during economic development and institutional change. This study uses 19th century weights instead of BMIs to measure factors associated with current net nutrition. Across the weight distribution and throughout the 19th century, white and black average weights decreased by 8.5 and 6.3 percent, respectively. Farmers and unskilled workers had positive weight returns associated with rural agricultural lifestyles. Weights in the Deep South were greater than other regions within the US, indicating that while Southern infectious disease rates were high, Southern current net nutrition was better than elsewhere within the US.

JEL-Code: I100, J110, J710, N310.

Keywords: weight, biological measurements, 19th century health, quantile estimation.

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I appreciate comments from John Komlos, Gary Taubes, Doug Henderson, Joe Beene, and Paul Hodges.

White and Black Weight by Socioeconomic Status and Residence: Revaluating Nineteenth Century Health during Institutional Change to Free Labor

I. Introduction

When traditional measures for economic welfare are scant or unreliable, height and body mass index (BMI) values are now well accepted measures that reflect net nutrition (Fogel et al., 1979; Komlos, 1987; Fogel, 1994). Increases in height represent improving cumulative net nutrition, and for non-obese populations, increases in BMI may represent improving current net nutrition.[1] Nevertheless, interpreting changes in BMI values is difficult because it is the ratio of current to cumulative net nutrition, and it increases when weight increases but is low for taller populations.[2] BMI variation also depends on when privation occurs. For example, individuals who receive sufficient nutrition during their youth are more likely to reach taller adult terminal statures, and their weight is subsequently distributed over a larger physical frame; their adult BMI is lower later in life. Alternatively, people who receive insufficient net nutrition during their youth are less likely to reach their genetically determined statures. If their net nutrition improves as they get older, they are more likely to be obese because more weight is distributed over smaller frames (Herbert et al. 1993, p. 1438; Carson, 2009; Carson, 2012; Sorkin et al.

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[1] $BMI = \frac{Weight(km)}{(Height(mt))^2}$. Fogel, 1994.

[2] Interpreting BMI variation is also more difficult than other biological measurements. If a young person is poorly nourished as a youth, their statures may be shorter, and their frames may not fully develop. Their adult calorie requirements would, therefore, be low. If a short adult's nutrition improves in later life, their BMI would be high because individuals with shorter statures have less weight to distribute weight (Herbert et al. 1993, p. 1438; Carson, 2009a; Carson, 2012a).

1999). Weight avoids this ambiguity with BMI because it is not the ratio of current to cumulative net nutrition but measures current net nutrition more directly. Weights are also more sensitive than height or BMI to changes in residence, demography, and socioeconomic status and lends insight into health during economic development.

Average weight varies when there is an imbalance between calories consumed and calories used during physical activity. Weight also varies when a population's diet or disease environment changes, and there were multiple transitions in the 19th century US that were related to nutrition, epidemiologic, and labor market transitions. The nutritional transition occurs when diets transition from rural diets high in complex carbohydrates and animal proteins to diets high in simple sugars and saturated fats (Popkin, 1993). Related to this dietary change is the epidemiological transition, where morbidities and mortalities transition from childhood infectious and epidemic diseases to old age diseases, such as heart disease, stroke, and obesity (Omran, 1971). Related to these historical nutritional and epidemiological transitions were changes in labor markets where agricultural occupations and household production to occupations in manufacturing (Rosenbloom, 2002, p. 88). These diet and physical activity transitions reflect US health, BMIs, and current net nutrition varied with economic development.

Against this backdrop this study considers three paths of inquiry into historical US weight variation. First, how did white and black weights vary over time and across their respective weight distributions? Like statures and BMIs, white and black weights decreased both over time and across their distributions, indicating that current net nutrition decreased with US economic development. Second, how did weight vary by residence? Diets and physical activity varied considerably by residence, and 19th century weights in the Deep South were greater than elsewhere within the US, while weights in the Northeast, Middle Atlantic, and Upper South were

lower. Third, across the weight distribution, what was the relationship between weight and socioeconomic status? Reflecting their rural agricultural lifestyles, farmers and unskilled workers had heavier weights compared to workers in white-collar and skilled occupations.

II. Nineteenth Century U.S. White and Black Nutrition: A Brief History

Before the 19th century nutritional, epidemiological, and labor market transitions took root, France and Great Britain were two economies that developed early and provide a comparison for early US current net nutrition. Fogel (1994, p. 373) demonstrates that 10 percent of working class French males were at the bottom of the calorie distribution and consumed about 2,400 calories per day during the 18th century, which did not give them enough calories to both maintain physical size and perform work. While nutrition was more abundant during the same period in Great Britain, English workers received only 2,700 calories, which was not sufficient for three percent of the English population to perform work (Fogel, 1994, p. 372; Fogel and Costa, 1997, p. 52; Floud et al., 2011, p. 56). Facing this nutritional squeeze, lower class 18th century French and English workers adapted to limited caloric intake by reaching shorter statures with lower BMIs.

Nineteenth century US natives and immigrants did not face the same dire conditions. For white Americans, Cummings (1940) finds that mid-19th century annual diets averaged about 205 pounds of wheat flour, 184 pounds of meat, 15 pounds of butter, 13 pounds of lard, and 30 pounds of sweeteners. Cummings estimates these diets provided 3,741 calories per day, which were sufficient to maintain body weight under moderate to heavy working conditions. Atack and Bateman (1987) consider 19th century Northern US diets and conclude that white annual diets averaged about 13.5 bushels of grain, 200 pounds of meat, 770 pounds of fluid milk, butter, and cheese, which provided over 5,000 calories per day (Atack and Bateman, 1987, p. 210).

Alternatively, Komlos (1987, p. 909), Putnam (2000), Floud et al. (2011, p. 314), and Carson (2014) estimate late 19th century calories to be around 3,100 per day. Nineteenth century diets also varied regionally, and Northeastern diets were high in grains, breads, and dairy products. Southern whites consumed more diverse and calorie abundant diets than Northern whites, which included pork, beef, corn, and Irish potatoes (Floud et al. 2011, p. 313; US Census, 1975, p. 1175; Comer, 2000, p. 1315; Hilliard, 1972, pp. 135 and 166, Shergold, 1982, pp. 185-195).

For African-Americans, with the end of slavery, access to calories decreased in the South. Part of the decrease was related to a lower quantity of food produced, and there was a general decline in late 19th century black current net nutrition. Part of the decrease in calories received by blacks was related to institutional change from a bound to free labor force (Carson, 2011b; Carson, 2014b). Under slavery, masters and owners had different incentives than free blacks to change slave dietary mixes in response to changes in market conditions and income variation (Komlos, 1998; Rees et al., 2003). Efficiency wages were related to slave nutrition, and because slave health was a slave owner's asset, slave masters had incentives to maintain slave diets at healthy levels while minimizing the cost of feeding them (Wahl, 1996; Rees et al., 2003; Komlos and Coclanis, 1997, pp. 453-454; Carson, 2008a). Emancipation also depreciated to zero a slave master's accumulated knowledge over slave feeding practices (Steckel, 1992, p. 502). After slavery, Southern food production decreased by around 50 percent (Ransom and Sutch, 1977, pp. 151-152), and black calories continued to decrease throughout the late 19th and early 20th centuries, indicating that blacks had greater access to calories under slavery (Fogel and Engerman, 1974; Fogel, 1989; Hilliard, 1972, p. 130; Carson, 2014).

Nineteenth century white and black calories varied with technological change, which reduced the physical activity required by agricultural workers in the north and the South

(Woodward, 1951, p. 134). Ransom and Sutch (1977, pp. 44-51) posit that an important explanation for post-bellum Southern agricultural decline is that after generations of life under bound labor, given the choice between work and leisure, free blacks chose leisure, which was associated with lower agricultural productivity and less physical activity. In sum, late 19th and early 20th century US nutrition and physical activity varied by ethnicity, proximity to agricultural production, residence and by socioeconomic status, and workers in agricultural occupations were more physically active and received greater net nutrition than workers in other occupations.

III. Nineteenth Century U.S. Prison Weight Data

The sample used here is part of a large data set that contains 19th century prison records from the Arizona, Colorado, Idaho, Kentucky, Missouri, New Mexico, Oregon, Pennsylvania, Philadelphia, Tennessee, and Texas prisons. Each inmate's physical characteristics were recorded by prison enumerators at the time of incarceration and, therefore, represents pre-incarceration conditions. Records are collected from 1840 through 1920, and because physical measurements were the primary means of identifying inmates in the event they escaped and were later recaptured, enumerators typically recorded inmates' age, pre-incarceration occupations, nativity, weight, height, complexion, and crimes. Because there are too few females in the sample, females and immigrants are excluded from this investigation (Carson, 2005; Carson, 2007; Carson, 2011a; Carson, 2013).

The two most frequently used historical weight and height sources are military and prison records. While plentiful, two concerns with military records may be that they represent conditions among higher socioeconomic groups (Sokoloff and Vilaflor, 1982) and a truncation bias imposed on height from military minimum stature requirements, which may be related to weight because only taller individuals have greater weight but lower BMIs (Herbert et al., 1993,

p. 1436; Carson, 2009a; Carson, 2012a).[3] On the other hand, prison records are less likely to suffer from this height truncation bias, therefore, reflect shorter statures and higher BMIs. Prison records are also analyzed with scrutiny because law enforcement may have imprisoned many of the poorest members of society, and it is not clear whether prison records represent physically fit individuals or individuals in poorer health. For example, law enforcement officials may have incarcerated the most physically fit individuals involved in assault crimes if they were presumed guilty because of a height and weight advantage relative to other participants in physical assault crimes. Alternatively, they may have incarcerated the materially poorest criminals who turned to crime to survive. Since the majority of prisoners were incarcerated for theft and assault crimes, prison records likely represent conditions among the working class.

Prison enumerators recorded a complexion variable from which ethnicity is inferred. Whites were recorded as light, fair, medium, and dark. African-Americans were recorded as light black, mulatto, medium black, copper, and dark black. While mulattos shared similar genetics with both European and African populations, they were treated as blacks in the 19th century US and are grouped here with blacks (Carson, 2009b). Occupations are important variables that represent socioeconomic status and are classified here into four categories. Miners, laborers, and cooks are classified as unskilled workers. Enumerators did not always distinguish between farm and common laborers, which may overstate the biological benefits experienced by common laborers and understate the benefits to farm laborers (Carson, 2013; Carson, 2014a; Carson, 2015). Agricultural workers are classified as farmers. Craft workers,

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[3] $\mathrm{BMI} = \frac{\mathrm{w(K)}}{\mathrm{h(M)}^2} = \mathrm{w\,h}^{-2}. \Rightarrow \ln \mathrm{BMI} = \ln \mathrm{w} - 2 \ln \mathrm{h}.$

$\varepsilon_{\mathrm{BMI,w}} = \frac{\%\Delta \mathrm{BMI}}{\%\Delta \mathrm{w}} = \frac{\mathrm{d} \ln \mathrm{BMI}}{\mathrm{d} \ln \mathrm{w}} = 1; \; \varepsilon_{\mathrm{BMI,h}} = \frac{\%\Delta \mathrm{BMI}}{\%\Delta \mathrm{h}} = \frac{\mathrm{d} \ln \mathrm{BMI}}{\mathrm{d} \ln \mathrm{h}} = -2.$

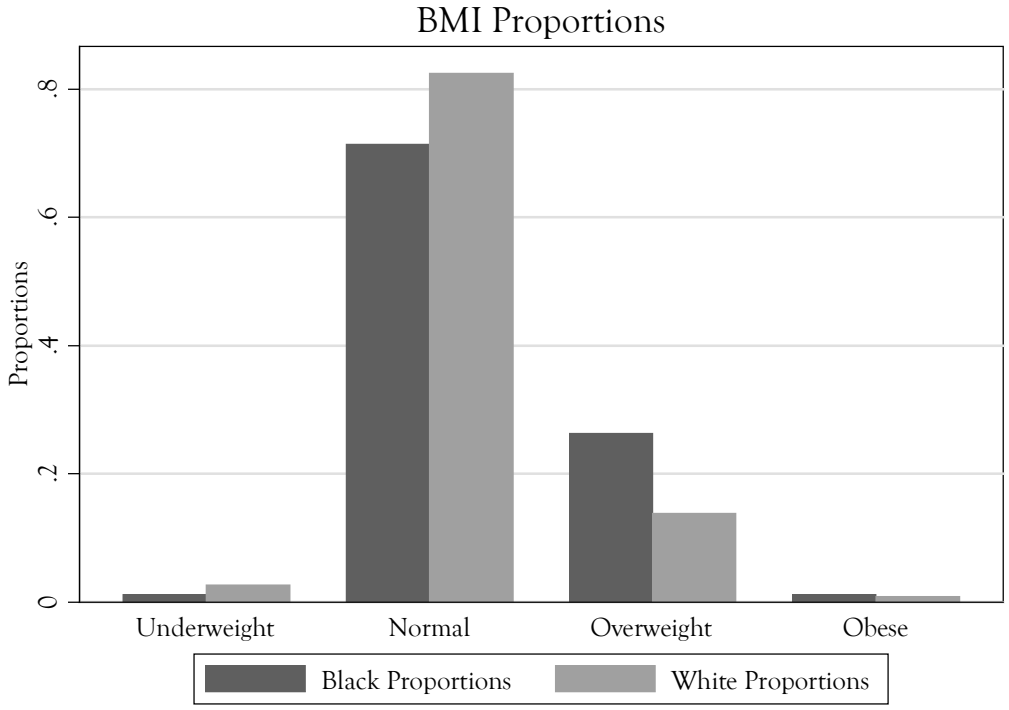
blacksmiths, and light manufacturers are classified as skilled workers. Highly skilled physicians and government administrators are classified as white collar workers.

Table 1. Nineteenth Century US State Prisons

	White		*Black*	
Age	N	Percent	N	Percent
Teens	10,035	13.64	14,044	20.71
Twenties	36,607	49.75	36,128	53.71
Thirties	16,191	22.00	11,074	16.33
Forties	6,841	9.30	4,216	6.22
Fifties	2,841	3.86	1,678	2.47
Sixties	896	1.22	557	.82
Seventies	175	.24	124	.18
Observation Period				
1840s	165	.22	20	.03
1850s	839	1.14	55	.08
1860s	1,307	1.78	980	1.44
1870s	8,748	11.89	7,615	11.23
1880s	10,888	14.80	12,508	18.44
1890s	14,114	19.18	14,285	21.06
1900s	17,782	24.16	16,319	24.06
1910s	18,533	25.19	15,090	22.25
1920s	1,210	1.64	949	1.40
Occupations				
White-Collar	7,024	9.55	1,747	2.58
Skilled	16,395	22.28	5,147	7.59
Farmer	7,307	9.93	6,411	9.45
Unskilled	32,289	43.88	38,551	56.84
No Occupation	10,571	14.37	15,965	23.54
Residence				
Arizona	2,156	2.93	194	.29
Colorado	3,502	4.76	483	.71
Idaho	575	.78	36	.05
Kentucky	6,602	8.97	6,167	9.09
Missouri	7,984	10.85	4,292	6.33
New Mexico	1,993	2.71	344	.51
Oregon	1,683	2.29	45	.07
Pennsylvania	11,214	15.24	2,685	3.96
Philadelphia	11,410	15.51	5,481	8.08
Tennessee	10,384	14.11	20,940	30.88
Texas	16,083	21.86	27,154	40.04
Total	73,586	100.00	67,821	100.00

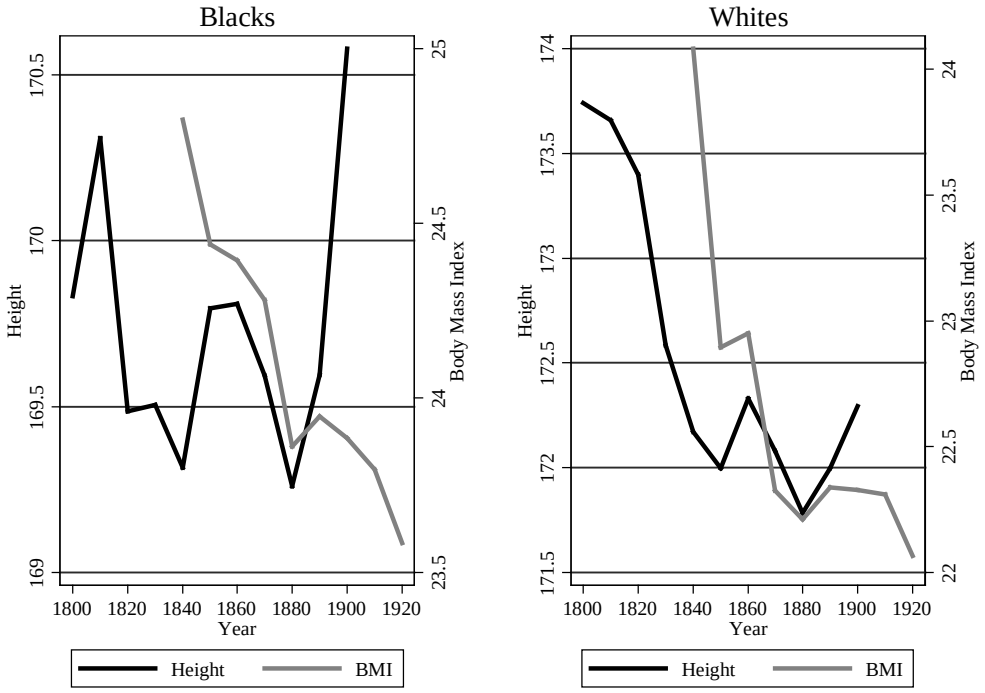
Source: Data used to study black and white anthropometrics is a subset of a much larger 19th century prison sample. All available records from American state repositories have been acquired and entered into a master file. These records include Arizona, California, Colorado, Idaho, Illinois, Kansas, Kentucky,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

Figure 1, Nineteenth Century White and Black BMI Distribution



Source: See Table 1.

Figure 2, Black and White BMIs and Height over Time



Source: See Carson (2012a) and Carson (2012b). Carson (2009) for height variation.

The majority of whites in the sample are from the Pennsylvania and Texas prisons; however, there are also whites from Missouri and the Far West (Table 1). Many blacks in the sample are from the Deep South and Border States. There are more whites in the prison sample than blacks, but blacks are over-represented in the prison sample relative to the general population. Under slavery, owners had claims on slave labor, and to prevent foregone earnings from lost labor while slaves were imprisoned, slaves who committed minor crimes were frequently remitted back to slave owners who punished slaves on their plantations (Wahl, 1996 and 1997; Friedman, 1993). However, once slavery ended, owners no longer had claims on

African-American labor,[4] and blacks who broke the law were turned over to law enforcement to pay the social costs of their crimes. After slavery, black incarceration may have also been more common than white incarceration because blacks had limited legal representation at trial (Walker, 1988). There were predictably more white skilled, white-collar workers, and farmers. Blacks were more likely to be unskilled and without identifiable occupations.

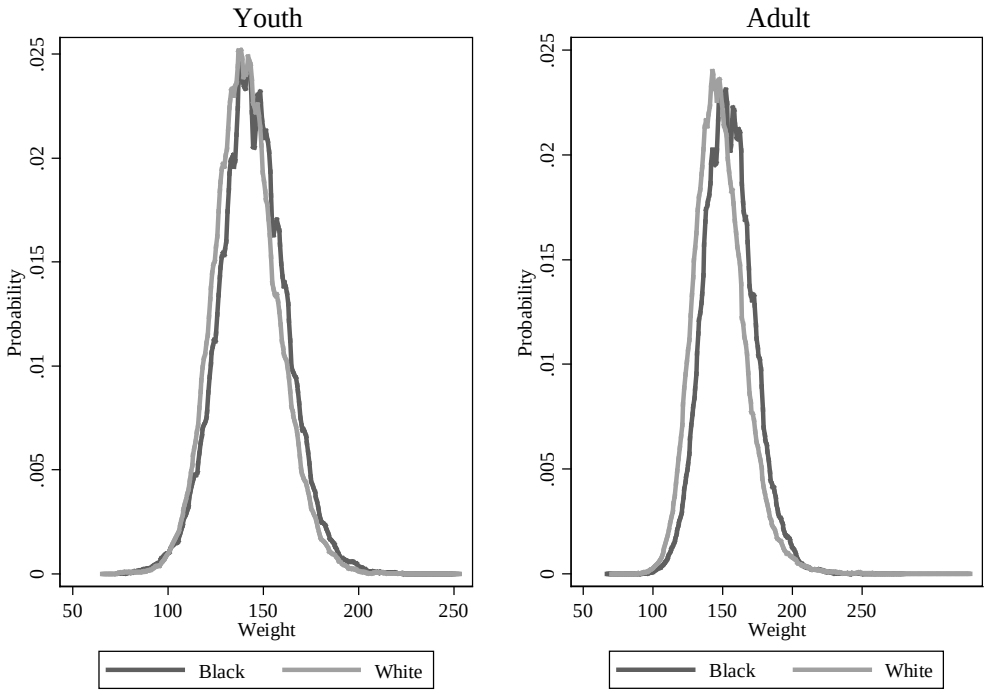
Modern obesity status offers important insight into health conditions during economic development, and BMIs are classified here into the four categories established by the World Health Organization (WHO). Individuals with BMIs less than 18.5 are classified as underweight; BMIs between 18.5 and 24.9 are normal; BMIs between 24.9 and 29.9 are overweight; BMIs greater than 29.9 are obese.

Figure 1 illustrates that the majority of 19th century white and black BMIs were in the normal category, and unlike 18th century France and Britain, neither starvation nor obesity were common. Figure 2 demonstrates that BMIs and height decreased throughout the late 19th and early 20th centuries, which coincides with deteriorating net nutrition and the separation of food consumption from food production (Komlos, 1987, p. 920; Carson, 2008, pp. 360-368; Comer, 2000, p. 1314; Floud et al., 2011; Carson, 2014).

How weight is distributed provides insight into a population's health, and if the means are the same and the weight distribution is positively skewed, a population is more likely to be underweight. If the weight distribution is negatively skewed, individuals are more likely to be overweight or obese. Figure 3 presents weight kernel density estimates and illustrates that black and white weights were approximately symmetric; late 19th and early 20th century men were neither starved nor did they live in caloric excess.

[4] Under Southern law, some states allowed the children of former slaves to be apprenticed.

Figure 3, Nineteenth Century Black and White Weight Distributions



Source: see Table 1.

Despite its importance relative to other physical measurements, weight variation has received little attention in historical health studies. Two existing studies that address 19th century US weight variation are Komlos (1987, p. 906) and Coclanis and Komlos (1995). Komlos (1987) uses 19th century West Point Cadet heights and weights to show a general decline in net nutritional status, which was geographically widespread, and farmer weights were greater than workers in other occupations. US net nutrition also decreased because meat and animal proteins were lower than population growth and urbanization, and industrialization increased the demand for food in urban areas. The weight of students at The Citadel decreased between the 1880s and 1900 (Coclanis and Komlos, 1995, p. 104). Nineteenth century weight studies have, otherwise,

gone without notice, and little is known about how weight varied across its distribution by height, demographics, nativity, and socioeconomic status.

The average weight of white males in US prisons was 146.26 pounds with an average height of 67.47 inches. The average weight of black males was 150.75 pounds with an average height of 66.96 inches, indicating that whites were half an inch taller than blacks; however, blacks were about five pounds heavier. Nevertheless, average weight and height masks how they responded to individual differences in characteristics.

IV. Socioeconomic Status, Residence, and Observation Period Across the White and Black Weight Distribution

To better understand the interaction between socioeconomic and demographic characteristics across the conditional weight distribution, a quantile weight regression is constructed. Weight quantile estimation is important in anthropometric studies because socioeconomic, demographic, and residential characteristics may have varied across the weight distribution and over time. When estimating weight regressions, quantile estimation offers several advantages over least squares estimation. Two advantages in weight studies are more robust estimation in the face of an unknown height truncation point and greater description of covariate effects across the weight distribution. Quantile also allows for a more accurate description when the dependent variable is not normally distributed. For example, Komlos and Brabec (2010) show that mid-20th century black and white BMIs by birth period increased earlier than previously believed, and Carson (2012b) shows that white BMIs at the 95th quantile increased at the same time that BMI values at the average and median decreased.

Let w_i represent the weight of the i^{th} inmate and x_i the vector of covariates representing birth cohort, socioeconomic status, and demographic characteristics. The conditional quantile function is

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

which is the p^{th}-quantile of w_i, given x. The coefficient vector θ is obtained using techniques presented in Koenker and Bassett (1978) and Hendricks and Koenker (1992). The interpretation of the coefficient θ_j is the influence of the j^{th} covariate on the weight distribution at the p^{th} quantile. For example, the age coefficient at the median (.5 quantile) is the weight increase that keeps an "average" inmate's weight on the median if age increases by one year.

To isolate how white and black characteristics were related across the weight distribution, white and black samples are partitioned by ethnic status, and quantile regressions are estimated separately. To start, the weight of the i^{th} individual is assumed to be related with height, age, date received, socioeconomic status, and residence.

$$Weight_i^p = \alpha^p + \theta_H^p Inches_i + \theta_c Complexion_i + \sum_{a=12}^{70} \theta_a^p Age_i + \sum_{t=1}^{10} \theta_t^p Decade\,\mathrm{Re}ceived_i$$

$$+ \sum_{l=1}^{3} \theta_l^p Occupation_i + \sum_{r=1}^{10} \theta_t^p\ \mathrm{Re}sidence_i + \varepsilon_i^p$$

Height in inches is included to account for the positive relationship between weight and height. In the African-American model, a dummy variable is included to account for how weight varied across the distribution by mulatto complexion. Dummy variables are included for youth ages 14 through 22; adult age dummies are included in ten year age intervals for the 40s through the 70s. To evaluate how weight varied over time, decade received dummy variables are

included in ten year intervals from 1840 through 1920. Occupation dummy variables are included for white-collar, skilled, farmer, and unskilled occupations. Residence dummy variables are included for net nutritional conditions in Arizona, Colorado, Idaho, Kentucky, Missouri, New Mexico, Oregon, Pennsylvania, Philadelphia, and Tennessee.

Model 1 in Tables 2 and 3 presents least squares estimates for the white and black samples. Model 2 presents results in log form to consider the percent change in weight with characteristics. Models 3 through 7 present .25, .50, .75, .90, and .95 weight quantile estimates to illustrate how white and black weights were related to demographic, occupation, and nativity across the weight distribution.

Table 2, Nineteenth Century White Male Weight Models

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	OLS	*ln(weight)*	*25th*	*50th*	*75th*	*90th*	*95th*
Intercept	-94.46***	3.33***	-94.42***	-99.05***	-100.15***	-94.22***	-82.61***
Height							
Inches	3.54***	.024***	3.40***	3.59***	3.76***	3.81***	3.73***
Ages							
14	-13.60***	-.119***	-12.92***	-13.55***	-14.42***	-16.08***	-13.88
15	-12.71***	-.106***	-15.10***	-14.44***	-12.69***	-10.37***	-9.82*
16	-10.77***	-.082***	-9.40***	-10.95***	-12.19***	-14.12***	-13.72***
17	-8.28***	-.060***	-7.61***	-8.36***	-9.39***	-9.94***	-10.46***
18	-5.94***	-.042***	-5.70***	-6.26***	-6.91***	-6.90***	-7.74***
19	-3.80***	-.026***	-3.32***	-3.85***	-4.69***	-4.81***	-5.49***
20	-2.49***	-.017***	-1.93***	-2.19***	-3.24***	-3.47***	-4.65***
21	-1.69***	-.011***	-.969***	-1.37***	-2.57***	-2.81***	-3.74***
22	-1.18***	-.008***	-.769***	-1.15***	-1.58***	-1.76***	-2.54***
23-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30s	1.46***	.009***	-.094	.863***	1.95***	3.85***	5.09***
40s	3.18***	.019***	.719***	1.91***	4.00***	7.52***	10.55***
50s	3.64***	.022***	.945**	2.32***	4.92***	8.26***	11.93***
60s	2.09***	.010**	-1.78*	-.042	3.34***	10.03***	13.41***
70s	3.83***	.095*	-3.19	1.41	8.36***	17.92***	22.27***
Received							
1840s	11.62***	.076***	11.57***	12.56***	12.72***	15.90***	14.57***
1850s	3.82***	.026***	4.45***	4.38***	3.20***	2.25*	1.74
1860s	4.13***	.028***	4.27***	5.00***	4.40***	4.21***	3.45**
1870s	-.008	-2.3^{-5}	.123	.208	-.224	-.013	-.776
1880s	-.749***	-.005***	-.053	-.249	-1.02***	-1.35***	-2.62***
1890s	.065	.001	.458***	.208	-.301	-.223	-.286
1900s	Reference	Reference	Reference	Reference	Reference	Reference	Reference
1910s	-.108	$-.8.8^{-4}$	-.203	.054	-.042	.261	.719
1920s	-1.71***	-.013***	-2.83***	-2.78***	-1.46**	-.091	1.36
Occupations							
White-Collar	1.08***	.007***	-.276	.299	1.50***	3.51***	4.80***
Skilled	1.70***	.013***	1.90***	1.65***	1.65***	1.92***	1.37**
Farmer	2.60***	.019***	2.75***	2.25***	2.71***	2.73***	2.79***
Unskilled	2.42***	.018***	2.60***	2.55***	2.47***	2.51***	2.05***

No Occupation	Reference	Reference	Reference	Reference	Reference	Reference	Reference
State							
Arizona	.940***	.007***	1.55***	1.53***	-.052	-.444	-.311
Colorado	3.46***	.024***	3.81***	3.79***	3.09***	1.84***	1.47
Idaho	1.48**	.011**	2.06**	1.98***	.963	-.962	-1.92
Kentucky	-2.39***	-.017***	-2.61***	-2.25***	-1.93***	-2.05***	-1.88***
Missouri	-3.84***	-.027***	-3.33***	-3.77***	-4.30***	-5.49***	-6.32***
New Mexico	2.39***	.016***	1.82***	3.01***	3.14***	2.59***	4.63***
Oregon	7.09***	.048***	7.24***	7.52***	6.92***	5.97***	5.43***
Pennsylvania	1.59***	.011***	1.43***	1.89***	1.88***	.884*	1.02*
Philadelphia	-1.31***	-.009***	-.523***	-.997***	-2.06***	-3.61***	-4.48***
Tennessee	3.13***	.022***	3.21***	3.62***	3.54***	3.26***	3.03***
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference
N	73,586	73,586	73,586	73,586	73,586	73,586	73,586
R^2	.3246	.3378	.1964	.1915	.1878	.1795	.1729

Source: See Table 1.

Table 3, Nineteenth Century Black Male Weight Models

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	OLS	*ln(weight)*	*25th*	*50th*	*75th*	*90th*	*95th*
Intercept	-75.69***	3.50***	-82.46***	-85.27***	-81.54***	-69.24***	-50.27***
Height							
Inches	3.41***	.023***	3.37***	3.54***	3.62***	3.57***	3.38***
Race							
Black	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Mulatto	-2.22***	-.015***	-2.33***	-2.28***	-2.31***	-2.06***	-1.97***
Ages							
14	-21.10***	-.170***	-21.37***	-21.05***	-21.63***	-21.19***	-20.23***
15	-18.76***	-.141***	-17.84***	-18.73***	-19.92***	-20.95***	-20.50***
16	-14.73***	-.105***	-13.58***	-14.76***	-14.93***	-16.23***	-17.33***
17	-10.87***	-.074***	-9.74***	-10.62***	-11.90***	-12.95***	-14.34***
18	-8.44***	-.057***	-7.58***	-8.13***	-8.77***	-10.02***	-11.22***
19	-5.65***	-.037***	-4.75***	-5.44***	-6.27***	-7.14***	-7.82***
20	-3.80***	-.025***	-3.63***	-3.77***	-3.98***	-4.41***	-5.14***
21	-2.23***	-.014***	-1.90***	-2.25***	-2.59***	-3.33***	-4.22***
22	-1.35***	-.008***	-.860***	-.886***	-1.55***	-2.29***	-2.87***
23-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30s	1.37***	.008***	.561**	1.49***	1.65***	2.57***	3.61***
40s	2.04***	.013***	.767**	1.46***	2.11***	4.00***	5.27***
50s	1.79***	.011***	1.05***	1.80***	3.01***	4.03***	4.16***
60s	.461	.003	-2.02***	-.342	1.75***	2.04	4.20**
70s	-3.74***	-.026***	-4.88***	-4.29***	-2.52	-2.12	-3.70
Received							
1840s	7.70**	.050***	15.74***	8.14***	8.26*	5.42	3.06
1850s	4.94*	.032*	1.95	2.98	5.33	9.99***	12.33
1860s	3.39***	.022***	2.86***	3.43***	3.94***	4.78***	6.18***
1870s	2.52***	.016***	2.05***	2.14***	2.97***	3.67***	3.68***
1880s	-.015	$-.3.5^{-4}$	-.035	-.228	-.199	-.113	.153
1890s	.537***	.004***	.684***	.342*	.144	6.41^{-8}	.289
1900s	Reference	Reference	Reference	Reference	Reference	Reference	Reference
1910s	-.765***	-.006***	-1.30***	-1.17***	-.293	.970***	1.59**
1920s	-1.82***	-.013***	-2.11**	-1.91***	-1.17*	-.476	.558
Occupations							
White-Collar	-.848**	-.005**	-1.05**	-1.32***	-.967**	-.786	-.156

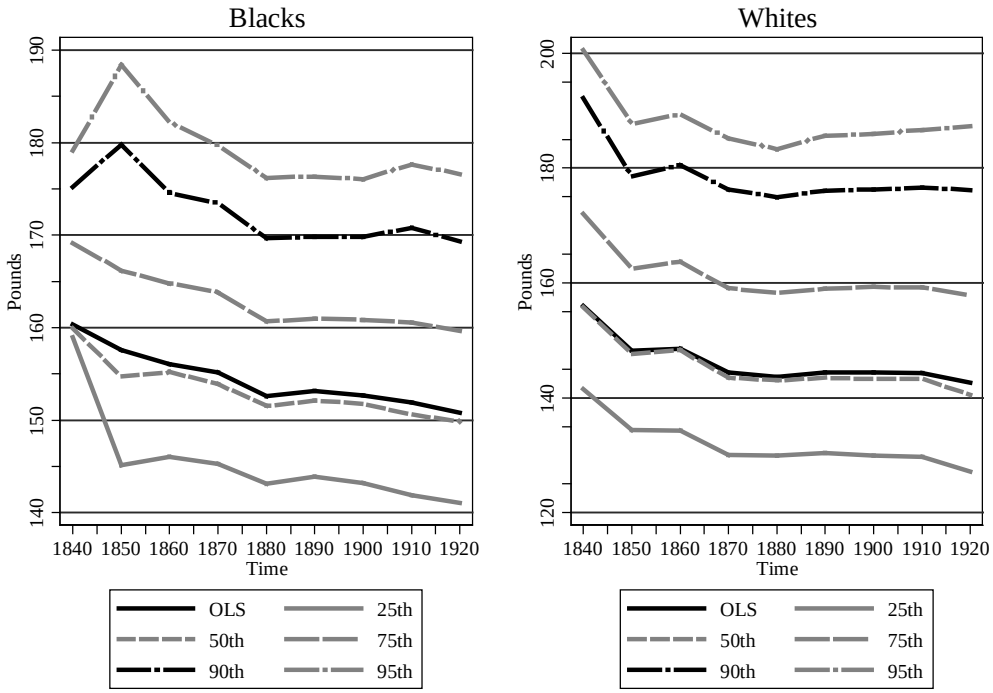
Skilled	.370	.002	-.298	-.329	.658*	1.31***	1.87**
Farmer	2.18***	.015***	2.11***	2.14***	2.25***	2.29***	2.27***
Unskilled	1.38***	.010***	1.35***	1.17***	1.46***	1.64***	1.97***
No Occupation	Reference	Reference	Reference	Reference	Reference	Reference	Reference
State							
Arizona	-2.35**	-.016**	-1.98	-2.33**	-2.44*	-2.55**	-5.70**
Colorado	1.45**	.010**	.790	1.18	.895	.637	1.39
Idaho	.142	.002	-2.84	.810	-3.48	6.76	5.39
Kentucky	-3.36***	-.024***	-3.75***	-3.41***	-3.00	-2.61***	-2.71***
Missouri	-4.66***	-.032***	-4.07***	-4.54***	-5.58***	-6.51***	-7.70***
New Mexico	-.296	-.002	.404	-1.05	-.061	.958	2.49
Oregon	3.92*	.027*	6.60**	3.71	3.25	3.42	.844
Pennsylvania	-2.45***	-.017***	-2.42***	-2.29***	-2.42***	-2.20***	-1.55**
Philadelphia	-3.43***	-.023***	-2.72***	-3.52***	-4.13***	-4.40***	-5.54***
Tennessee	1.80***	.012***	2.19***	1.94***	1.90***	1.85***	1.86***
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference
N	67,821	67,821	67,821	67,821	67,821	67,821	67,821
R^2	.3965	.4108	.2414	.2371	.2282	.2052	.1929

Source: See Table 1.

Three paths of inquiry are considered when analyzing weight variation across white and black weight distributions. First, a considerable amount of work highlights the modern obesity epidemic (Flegal et al., 2009; Flegal et al., 2010; Flegal et al., 2012; Flegal et al., 2013; Cawley, 2011; Gross and Macon, 2011); however, how weight was distributed across its distribution over the late 19th and early 20th centuries has received little attention, and white and black weights decreased over time and across their distributions. Between 1840 and 1920, white weights decreased by nearly nine percent, while black weight decreased by 6.3 percent. The greatest decrease in white weight occurred between 1840 and 1860 when white weight decreased by 4.8 percentage points; black weights decreased by 2.8 percentage points over the same period. White heights were constant between 1860 and 1920, and black heights increased by .1 percent, indicating that the late 19th century white and black BMI decreases were the result of weight decreasing and not height increasing (Figure 4). Much of the decrease was related to current net nutrition, which changed considerably in the late 19th and early 20th centuries (Floud et al., 2011, p. 314; Putnam, 2000; Fogel, 1974, p. 261; Comer, 2000, p. 1314; Komlos, 1987; Komlos, 212). Between 1860 and 1920, the percent of US calories from meat declined by 26 percent (Floud et al., 2011, p. 314). Part of the decline was also related to industrialization and the separation of food production from food consumption, which increased the relative price of nutrition (Komlos, 1985; Komlos, 1987; Carson, 2008, pp. 397-368; Comer, 2000, p. 1314). Greater white relative to black weight decreases also indicate that industrialization and urbanization affected whites more than blacks, and white working class current net nutrition was altered with emancipation when working class whites faced increased labor market competition from recently freed blacks (Woodword, 1951, p. 134; Bodenhorn, 1999, p. 994). In sum, throughout the late 19th and early

20th centuries, white and black weight decreases were widespread, occurred across the weight distribution, and were greater for whites than blacks.

Figure 4, Nineteenth Century Black and White Weights over Time



Source: See Tables 3 and 4. Imputed heights across the black weight distribution are 65 inches at the 25th quantile, 67 at the 50th quantile, 69 inches at the 75th quantile, 70.5 inches at the 90th quantile, and 71.5 inches at the 95th quantile. Across the white weight distribution are 66 inches at the 25th quantile, 67.5 at the 50th quantile, 69 inches at the 75th quantile, 71 inches at the 90th quantile, and 72 inches at the 95th quantile.

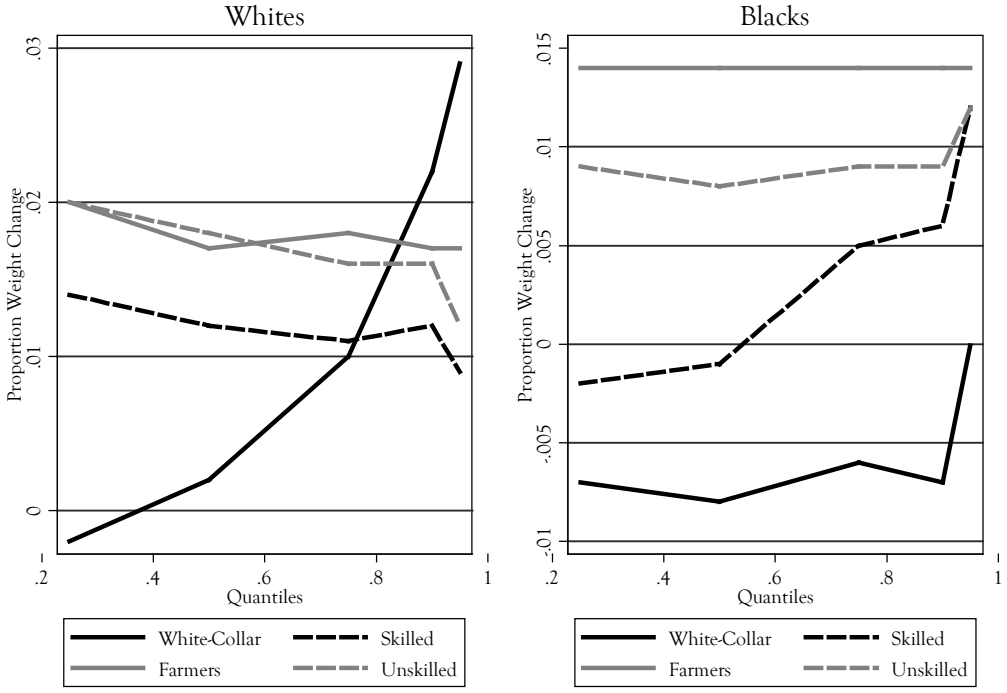
Second, across the distribution, 19th century weight varied by residence, and weights of individuals in the South and Far West were greater than elsewhere within the US. White weights

in Tennessee were about 2.2 percent greater than the omitted category, Texas, while white weights in Colorado and Oregon were 2.4 and 4.8 percent heavier. White weights in the upper South in Kentucky and Missouri were 1.7 and 2.7 percent lower than white weights. On the other hand, black weights in Tennessee were about 1.2 percent greater, and black weights in Colorado and Oregon were one and 2.7 percent heavier. Blacks in the upper South of Kentucky and Missouri also had about 2.4 and 3.2 percent lower weights, which indicates that after controlling for height, white weight variation by region was greater than blacks across the weight distribution; however, the black urban weight penalty was greater than whites. Much of the regional weight variation was related to diets, and diets in the Northeast, Middle Atlantic, and Upper South were less nutritious and provided fewer calories per day than the rural South (Carson, 2014). For example, Shergold (1982, pp. 185-195) finds that Northeastern diets were high in grains, breads, and dairy products (Floud et al. 2011, p. 313; Atack and Bateman, 1987, pp. 209-210). The Northeast and Middle Atlantic were also more urbanized, which increased the relative price of nutrition (Komlos, 1987), and Northeastern diets were also the first to experience the decline in nutrition's quality associated with early food processing (Comer, 2000, p. 1314).

Southern whites consumed more diverse and abundant diets than blacks, which included pork, beef, corn, and Irish potatoes (Hilliard, 1972, p. 175-179). Before the Civil War, the South was self-sufficient in food production and exported its surplus calories (Ransom and Sutch, 1977, p. 150). Slaves consumed diets that were heavily prescribed toward pork fat pork, corn, and rice (Fogel and Engerman, 1974, pp. 109-111; Kiple and King, 1981, p. 80; Hillard, 1972, pp. 62-69). Southern whites were also in close proximity to rural agriculture, which offset calorie claims placed on workers from physical activity and exposure to disease. Westerners had

heavier weights than in the Northeast and Middle Atlantic but were shorter, indicating that Western settlers' cumulative net health conditions before migration were lower than other US regions. However, after arrival, Western immigrant diets and net nutrition improved, and they gained weight in the West (Comer, 2000, p. 1312). Because it was not a settled area, early Far Western settlers may have also been more physically active than workers in other locations, and greater physical activity was associated with greater muscle mass and heavier weights (Poehlman, 1988; Poehlman, 1989; Byrne and Wilmore, 2003; Koshimishu e al., 2001; Speakman and Selman, 2012; Carson, 2014).

Figure 5, Nineteenth and 20th Century Weight Variation by Race and Occupations.



Source: See Tables 2 and 3.

Third, like statures and BMIs, farmer and unskilled workers had positive weight returns associated with rural agriculture, and across the weight distribution white and black farmers and unskilled laborers had about two percent greater weights than workers in other occupations (Green, 2012, p. 88; Atack and Bateman, 1987, pp. 209-210). Throughout the late 19th century, current net nutrition varied by occupation, and farmers in rural locations were physically more active than workers in other occupations and in close proximity to rural diets, which reduced food wastage that occurred when food was shipped from rural farms to urban markets (Carson, 2008b; Carson, 2014). Moreover, weight returns by occupations varied considerably by race and occupations (Figure 5), and across the weight distribution, white weight returns by occupation were greater than blacks. The largest occupational increase across the weight distribution was for white white-collar workers, which increased by 2.9 percent between the 25th and 95th quantiles. Skilled black workers' weight returns increased by 1.2 percent between the 25th to 95th quintiles during the same period.

Other patterns are consistent with expectations. Weight was sensitive to age by skin complexion, and at younger ages, blacks had greater catch-up weight gain than whites, indicating that while adult blacks had greater weight per unit of height, young black net nutrition was substandard to whites, and black youths experienced greater weight increases with age in current net nutrition than whites (Steckel, 1986). However, this weight age-relationship by ethnicity was not unique to young blacks, and black adult weight gain at older ages was less than for whites. In sum, white and black weights decreased both across their distributions and over time; Southern weights were greater than from elsewhere within the US, and rural farmers and unskilled workers had greater weight returns than workers in other occupations.

V. Conclusion

When traditional measures for economic well-being are scarce or unreliable, heights and BMIs are now well accepted measurements that reflect economic conditions. However, as the ratio of weight to height, BMI differences over time and across residence are difficult to interpret because BMIs increase with weight but are lower for taller heights, indicating that a more direct measure for current net nutrition is needed. Weight after controlling for height is a reasonable complement to BMI for current net nutrition. White and black weights decreased throughout the late 19th and early 20th centuries and across the weight distribution, and average white weight decreases were around two times the percent decrease as blacks, indicating that the decrease in current net nutrition was greater for white workers. There is also a long standing debate for how regional diets and disease were related to 19th century biological conditions. Southerners were taller and had heavier weights than individuals elsewhere within the US. That the South had higher disease rates but taller heights, heavier BMIs, and heavier weights indicates that Southern nutrition was sufficient to overcome higher disease rates in the South.

Across their distributions, white and black farmers and unskilled workers were taller and heavier than workers in other occupations, indicating that rural agriculture was associated with superior net nutrition. Therefore, like height and BMI variation, 19th century weight was related with a complex set of relationships between observation period, socioeconomic status, and residence, and weight studies reinforce the finding that white and black net nutrition deteriorated overtime, was better in the rural South, and better for agricultural workers.

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