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Abstract

When traditional measures for material and economic welfare are scarce or unreliable, height and the body mass index (BMI) are now widely accepted measures that represent cumulative and current net nutrition in development studies. However, as the ratio of weight to height, BMI does not fully isolate the effects of current net nutrition. After controlling for height as a measure for current net nutrition, this study uses the weight of a sample of international men in US prisons. Throughout the late 19th and early 20th centuries, individuals with darker complexions had greater weights than individuals with fairer complexions. Mexican and Asian populations in the US had lower weights and reached shorter statures. Black and white weights stagnated throughout the late 19th and early 20th centuries. Agricultural workers' had greater weights than workers in other occupations.

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

Keywords: weight, 19^{th} century current net nutrition, US race relations.

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Weight and US Economic Development: Current Net Nutrition in the Late 19th and Early 20th Centuries

I. Introduction

When traditional measures for economic welfare are scarce or unreliable, stature and the body mass index (BMI) are now well accepted measures that reflect net nutrition during economic development (Fogel, 1994; Deaton, 2008; Case and Paxson, 2008; Deaton, 2013). Stature reflects the cumulative net difference between calories consumed and calories required for work and to withstand the physical environment. BMI is weight in kilograms divided by height in meters squared and reflects the current net difference between the same variables.[1] However, as the ratio of weight to height, BMI variation depends on when privation occurs. For example, if an individual is poorly nourished in their youth, they reach shorter terminal statures, their frames may not fully develop, resulting in shorter adult-terminal statures (Mifflin et al., 1990; Nyström-Peck, 1994; Nyström-Peck and Lufgren, 1995; Schneider, 2017, pp. 4-7). If a short person's nutrition improves as an adult, they have higher BMIs because greater weight is distributed over smaller physical dimensions (Herbert et al., 1993, pp. 1438; Carson, 2009a; Carson, 2012; Komlos and Carson, 2017). On the other hand, if a person receives adequate nutrition during their youth, they reach taller statures, have higher metabolic rates, and have

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[1] $BMI = \frac{w(kg)}{h(mt)^2} \Rightarrow \ln BMI = \ln w - 2\ln h. \Rightarrow d\ln BMI = d\ln w - 2d\ln h$. $E_{BMI,w} = \frac{\%\Delta BMI}{\%\Delta w} = 1$ $E_{BMI,h} = \frac{\%\Delta BMI}{\%\Delta h} = -2$.

lower BMIs in later life. Subsequently, as the ratio of weight to height, BMI reflects the timing lag or mismatched effect of privation, and after controlling for height, BMI may not be as good of measure as weight for current net nutrition (Gluckman and Hanson, 2006, p. 10; Carson, 2015b; Schnieder, 2017, p. 7; Carson, 2017a).

Because weight is more plastic than BMI and height, weight provides important insight into how current net nutrition varies over time and across ethnic status (Dawes, 2014, p. 30; Carson, 2015b).[2] On its surface, holding current net nutrition constant, there is a positive relationship between stature and weight because taller statures are required for weight to be distributed, indicating that weight alone is not the only measure to isolate changes in current net nutrition. Weight variation over time can be measured by either observation or birth period. Measured by observation period, weight summarizes the current net nutrition experienced by different cohorts at a point in time, while weight measured by birth period summarizes the cumulative net nutrition as the same cohort ages over time (Guillot, 2011, p. 533; Carson, 2019). Moreover, weight after controlling for height is important in resolving the conundrum between complexion and BMI because individuals with darker complexions historically had greater BMIs, however, reached shorter average statures (Fogel, 1989, p. 143; Carson, 2009a; Carson, 2012; Carson, 2009b). The distinction is important because if darker complexioned individuals have greater weight after controlling for height, it demonstrates their BMIs were higher because of heavier weights and not shorter statures.

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[2] Body mass is also related to health, and mortality risk is high for individuals with BMIs less than 19, remains low for BMIs between 19and 27. And increases for values over 27 (Waaler, 1984; Koch, 2011; Fogel, 1994, pp. 375-377). Costa (1993) applies Waaler's results to a historic population and shows that this modern relationship between BMI and mortality risk holds historically, and Jee et al. (2006, pp. 780, 784-785) show this relationship is similar across ethnic groups.

Because migrants may have received sub-standard net nutrition prior to migration that improved upon arrival, accounting for the lagged relationship between weight and height by complexion and nativity is useful to isolate factors related to race and nativity (Dirks, 2016, pp. 128-130). Weight as a complement to BMI is also useful in late 19th and early 20th century net nutrition because few individuals were overweight or obese, yet each had the more granular measure for weight.

Table 1, Research in 19th and Early 20th Century Weights

Study	*Sample*	*Observation Period*	*Weight Δ by Height*	*W Δ Over Time*	*Mixed-race Δ Compared to Blacks*	*Δ Farmer*
Komlos, 1987	White, West Point Cadets	1860-1885		2.3(lbs.) by birth	na	.40
Coclanis and Komlos. 1995	White 19 year olds, The Citadel	1870-1930		15.6(lb.)		
Carson, 2015	US Prison Sample	1840-1920	3.47(in.)	-13.00(lb.)	-2.36(lb.)	2.14(lb.)
Carson, 2017	US Prison Sample	1840-1920	3.53(in.)	-13.01(lb.)	-2.21(lb.)	2.51(lb.)
Komlos and Carson, 2017	US and McNeil Prison Samples	1882-1937	.62(cm.)	-2.49(kg.)	na	.86(kg.)
Carson, 2018b	Mexican, US Prisons	1970-1920	3.27(in.)	-2.31(lb.)	na	3.02(lb.)

Sources: Carson 2015b; Carson , 2017a; Komlos and Carson, 2017; Carson, 2018b.

Weight after controlling for height provides insight into how current net nutrition varied with economic development, ethnic status, and socioeconomic conditions (Table 1). After controlling for height, individuals with darker complexions had greater weight compared to fairer complexioned individuals, and individuals in rural locations had greater average weight compared to individuals in urban locations. Rural residents were in close proximity to traditional diets and faced mild disease environments, while urban residents were separated from food production and were in more virulent disease environments (Komlos, 1987; Carson, 2015b; Carson, 2015c). However, little is known about historical weight variation by ethnic status and how immigrants' weight varied after their arrival in the US.

It is against this backdrop that this study considers three paths of inquiry into late 19th and early 20th century US weight variation. First, how did African-American, mixed-race, and white weights compare by complexion and international nativity? Individuals with darker complexions had greater weight than mixed-race individuals and whites. Compared to US natives, Mexican and Asian populations had lower weights and reached shorter statures. Second, how did black and white weights vary over time by complexion? Like BMIs and stature, black and white weights stagnated and decreased during the early 20th century, and native and immigrant weights followed a similar path. Third, how was weight related to socioeconomic status? Agricultural workers' weights were heavier than workers in other occupations, which is robust across ethnic status and nativity.

II. US Prisoners' Weights in the late 19th and early 20th Centuries

Because the institutions that collected randomized samples were yet to develop, all historical data sets reflect the purposes for which they were collected. To assess how net nutrition varied during economic development, military and prison records are the most common sources for historical weight and height records (Fogel et al. 1982; Fogel et al. 1982). Military records may represent conditions among the upper class, while prison records likely represent conditions among the working class (Sokoloff and Vilaflour, 1982, pp. 456-458; Ellis, 2004, p. 27). One common issue inherent in military records is a minimum stature requirement for service, and military records disproportionately include taller individuals with lower BMIs. Fortunately, prison records do not suffer from this minimum stature requirement. Moreover, because individuals may have turned to crime to survive, prison records are more likely to represent conditions in lower socioeconomic status. Law enforcement may have been trained to target taller individuals with higher BMIs who were perceived as having an advantage in assault crimes. Because individuals incarcerated for white-collar crime and embezzlement are included in the sample, prison records also represent a more diverse cross-section of the general population than military records. Subsequently, prison weight and height records likely represent conditions among the working class, but there is diverse representation across socio-economic groups in prison records.

There is a recent challenge to the well-established pattern that US statures decreased during the late 19th century that posits the observed stature decrease—known as the antebellum paradox—was the result of selection rather than a genuine decrease in cumulative net nutrition (Komlos, 2019). However, selection processes were considered early in the anthropometric literature, and this recent view overlooks widespread acknowledgement of selection concerns (Sokoloff and Vilaflor, 1982, pp. 456-458; Komlos and A'Hearn, 2016; Zimran, 2015; Komlos and A'Hearn, forthcoming; Komlos, 2019). Recent selection concerns also do not account for the established result that stature decreases with economic development and urbanization across multiple disciplines (Zehetmyer, 2011; Haines, Craig, and Weiss, 2003, pp. 398-407; Davidson et al. p. 268; Steckel and Rose, 2002, p. 275; Carson, 2008, p. 368). Statures were shorter and BMIs lower in geographic regions with higher disease rates, and disease and nutrition are essential explanations for the antebellum paradox (Haines, Lee, and Weiss, 2003, p. 402; Coelho and McGuire, 2000, pp. 240-243). Subsequently, recent critiques of the antebellum paradox are not well supported in the literature, and when examining 19th century weight, prison records remain a valuable source for net nutritional studies that reflects working class conditions.

Each state prison was contacted multiple times, and available records were acquired and entered into a comprehensive data set. The data used in this study is part of large prison extraction project to organize and report the weights and heights of individuals in US prisons during the late 19th and early 20th centuries.[3] Prisons used in this study include Arizona, Colorado, Idaho, Illinois, Kentucky, Missouri, Mississippi, Montana, Nebraska, New Mexico, Oregon, the East and West Pennsylvania state prisons, Philadelphia, Tennessee, and Texas. Characteristics were recorded at the time an individual was admitted into prison, therefore, reflect pre-incarceration conditions. Women were recorded in state prisons; however, because each prison incarcerated only a few females, they are excluded from this investigation but examined elsewhere (Carson, 2011; Carson, 2013b; Carson, 2016; Carson, 2018a).

Race and ethnic status were important in 19th century social class, and race is inferred from a complexion variable recorded by prison enumerators. Enumerators were thorough when recording an individual's complexion, and individuals of African descent were recorded as Negro, dark-black, light-black, and various shades of 'mulatto.' Individuals of European descent were recorded as white, light, and medium. The white complexion category is supported further because individuals claiming birth in traditionally fair complexioned European countries incarcerated in the US were also classified with the same white, light, and medium complexions. Until the 1930s, US census and state prisons routinely used the term 'mulatto' to describe a person of mixed African and European ancestry; however, in results presented here, they are referred to as 'mixed-race.' While mixed-race individuals shared genetic characteristics common to both blacks and whites, they were treated as blacks in the late 19th and early 20th century United States. As a result, in the results that follow, when classifying mixed-race

[3]The total prison sample includes Arizona, California, Colorado, Idaho, Illinois, Kentucky, Maryland, Mississippi, Missouri, Montana, Nebraska, New Mexico, Ohio, Oregon, Pennsylvania, Philadelphia, Tennessee, Texas, Utah, and Washington.

individuals, both black and mixed-race are included as African-Americans. Other complexions used in this study are Asian, Native-American, and Mexican.

To account for how weight varied with regional characteristics, individuals born in the US are partitioned into seven broad categories: Northeast, Middle Atlantic, Great Lakes, Plains, Southeast, Southwest, and Far West.[4] International nativities are partitioned as from Africa, Asia, Australia, Great Britain, Canada, Europe, Latin America, and Mexico. Enumerators were thorough when recording pre-incarceration occupations, and there are workers from across the occupational distribution. Five broad categories are used to classify occupations. Bankers, government administrators, and ministers are recorded as white-collar workers. Butchers, tailors, and craftsmen are recorded as skilled workers. General farmers, dairymen, ranchers, farm laborers, and stockmen are classified as farmers. Laborers, miners, and cooks are classified as unskilled workers. A final category is included for individuals who reported no occupation at the time of measurement.

[4] The occupation classification scheme is consistent with Ferrie (1997); The following nativity 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.

Table 2, Late 19th and Early 20th Century US Demographics, Observation Period, Residence, Occupations, and Nativity

	N	*Percent*	*Mean Weight*	*Mean Height*
Ages				
Teens	27,758	14.06	139.17	66.36
20s	98,828	50.05	149.23	67.42
30s	42,153	21.35	150.64	67.43
40s	18,207	9.22	151.38	67.21
50s	7,568	3.83	151.05	67.00
60s	2,457	1.24	149.41	66.77
70s	445	.23	147.65	66.57
80s	53	.03	142.68	66.11
Decade Received				
1840s	233	.12	157.58	68.66
1850s	1,201	.61	148.85	67.79
1860s	2,619	1.33	149.24	67.07
1870s	14,876	7.53	149.81	67.18
1880s	28,700	14.53	148.65	67.20
1890s	37,333	18.91	148.44	67.08
1900s	51,134	25.89	147.45	67.11
1910s	48,785	24.71	148.32	67.33
1920s	7,902	4.00	149.18	67.44
1930s	3,621	1.83	149.71	68.31
1940s	1,065	.54	151.06	69.08
Residence				
Arizona	4,326	2.19	144.66	66.68
Colorado	6,769	3.43	150.56	67.08
Idaho	767	.39	149.77	67.74
Illinois	12,022	6.09	147.90	67.04
Kentucky	13,696	6.94	146.53	67.15
Missouri	21,129	10.70	143.80	67.20
Mississippi	2,295	1.16	150.32	67.72
Montana	10,924	5.53	156.51	68.33
Nebraska	10,521	5.33	147.62	68.01
New Mexico	3,682	1.86	146.69	66.79
Oregon	2,527	1.28	150.26	66.74
PA, East	9,149	4.63	142.05	66.15
PA, West	8,113	4.11	149.32	66.71
Philadelphia	8,747	4.43	142.15	66.48
Tennessee	32,065	16.24	149.50	66.88
Texas	50,169	25.41	150.67	67.64
Washington	568	.29	145.32	66.76

Occupations				
White-Collar	16,876	8.55	147.10	67.24
Skilled	35,329	17.89	147.55	67.20
Farmer	20,758	10.51	152.20	67.90
Unskilled	97,928	49.59	148.30	67.22
No Occupation	26,578	13.46	147.59	66.77
Nativity				
US, Northeast	2,111	1.07	148.23	67.17
US, Middle Atlantic	25,142	12.73	144.93	66.72
US, Great Lakes	17,167	8.69	148.59	67.53
US, Plains	24,626	12.47	147.60	67.69
US, Southeast	64,499	32.66	149.65	67.27
US, Southwest	34,090	17.26	150.74	67.71
US, Far West	4,666	2.36	149.78	67.79
Africa	75	.04	146.29	66.38
Asia	393	.20	129.77	64.34
Australia	126	.06	146.28	66.94
Canada	1,777	.90	149.80	67.33
Europe	10,203	5.17	148.66	66.23
Great Britain	5,490	2.78	146.33	66.67
Latin America	279	.14	146.97	66.86
Mexico	6,825	3.46	140.72	65.67
Ethnicity				
American Indian	435	.22	152.17	67.62
Asian	117	.06	132.36	64.14
Black	44,181	22.37	150.79	66.95
Mexican	7,364	3.73	141.60	65.88
Mixed Race	29,374	14.88	150.06	67.04
White	115,998	58.74	147.47	67.47
Total	197,469	100.00	148.38	67.22

Source: : Arizona State Library, Archives and Public Records, 1700 W. Washington, Phoenix, AZ 85007; Colorado State Archives, 1313 Sherman Street, Room 120, Denver, CO 80203; Idaho State Archives, 2205 Old Penitentiary Road, Boise, Idaho 83712; Illinois State Archives, Margaret Cross Norton Building, Capital Complex, Springfield, IL 62756; Kentucky Department for Libraries and Archives, 300 Coffee Tree Road, Frankfort, KY 40602; Missouri State Archives, 600 West Main Street, Jefferson City, MO 65102; William F. Winter Archives and History Building, 200 North St., Jackson, MS 39201; Montana State Archives, 225 North Roberts, Helena, MT, 59620; Nebraska State Historical Society, 1500 R Street, Lincoln, Nebraska, 68501; New Mexico State Records and Archives, 1205 Camino Carlos Rey, Santa Fe, NM 87507Oregon State Archives, 800 Summer Street, Salem, OR 97310; Pennsylvania Historical and Museum Commission, 350 North Street, Harrisburg, PA 17120; Philadelphia City Archives, 3101 Market Street, Philadelphia, PA 19104; Tennessee State Library and Archives, 403 7th Avenue North, Nashville, TN 37243; Texas State Library and Archives Commission, 1201 Brazos St., Austin TX 78701; Utah State Archives, 346 South Rio Grande Street, Salt Lake City, UT 84101; Washington State Archives, 1129 Washington Street Southeast, Olympia, WA 98504.

In modern and historical studies, crimes are committed by younger individuals (Hirshchi and Gottredson, 1983; Gottfredson and Hirshchi, 1990, pp. 126-144; Carson, 2009b). Table 2 illustrates that most individuals in the sample were in their 20s and 30s. Compared to military samples, there were large inmate proportions in their teens, 40s, and 50s. Individuals were received as early as the 1840s and as late as the 1940s. There were numerous individuals who resided in the Plains, Middle Atlantic, and Far West but geographic residence is widespread. Unskilled laborers were predictably the most common occupation (Rosenbloom, 2002, p. 88);[5]

[5] There is some concern regarding how prison unskilled workers compared to the general population. As expected, the percent of unskilled workers in the prison sample is greater than the percent in the general population, indicating the prison population represents conditions among the working class.

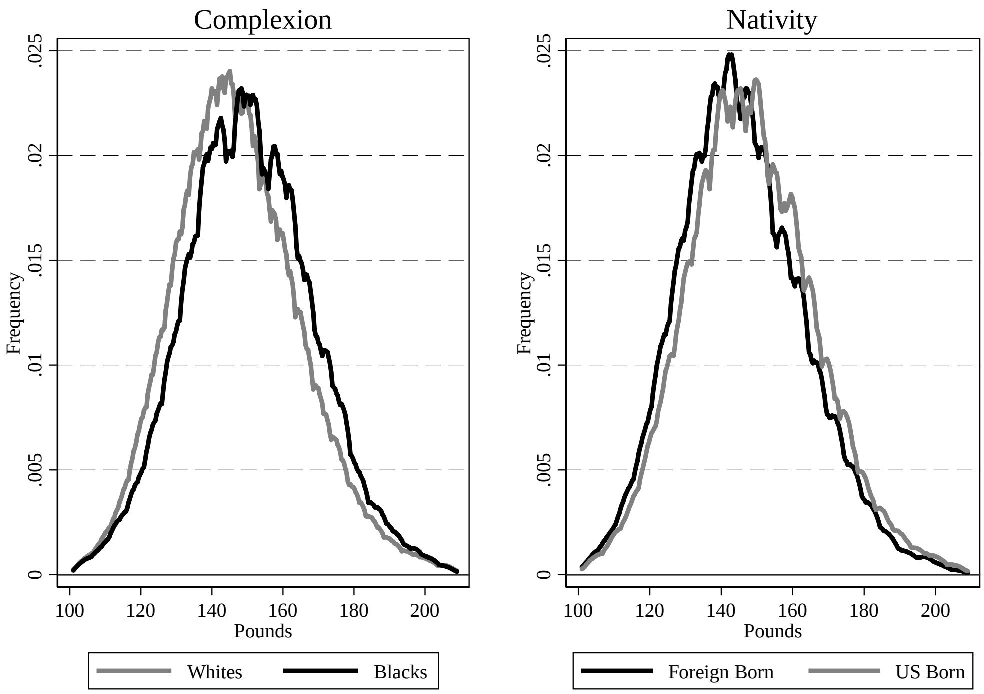
Year	*Prisoners*	*US Population*
1850s	32.9	
1860s	58.2	
1870s	52.6	31.9
1880s	47.5	30.4
1890s	52.0	
1900s	52.3	33.1
1910s	46.9	29.5

however, there are skilled, agricultural, and white-collar workers in the sample. Nearly one quarter of inmates were residents of Texas, and about 16 percent were in Tennessee, indicating that Southern residence is well represented in the sample. The Middle Atlantic, Great Lakes, Plains, and Far West are also represented. The most common international nativities were from Continental Europe, Mexico, and Great Britain (Cohen, 2009). There were smaller proportions from Australia, Asia, and Latin America. In sum, prison records represent lower socioeconomic status, residence, and nativity, and most individuals were young, unskilled, and received during the early 1900s.

1920s	37.8	23.6

Source: US general population estimates are from Rosenbloom, 2002, p. 88.

Figure 1, Weight Distributions by Complexions and Nativity



Source: See Table 2.

Weight kernel density estimates by complexion and nativity demonstrate that late 19th and early 20th century weights were approximately symmetric. Average black weight was 150.50 pounds, with an average height of 66.98 inches. Average white weight was 147.47 pounds, with an average height of 67.47 inches, indicating blacks were short and heavy, while whites were tall and thin (Carson, 2013b; Carson, 2015b; Carson, 2017b). Weight and height by nativity illustrates that average US weight was 148.76 pounds with an average height of 67.38 inches. Average immigrant weight was 145.75 pounds with an average height of 66.23 inches, indicating that immigrants to the US were short and thin, while US natives were tall and heavy.

III. Residence on Late 19th and Early 20th Century US Weight: The Effects of Ethnic Status, Nativity, Age, and Socioeconomic Status

Late 19th and early 20th century US weight variation reflects the relationships between diets, disease, and socioeconomic status. To test these relationships, the weight of the ith individual is regressed in pounds on height, age, observation decade, socioeconomic status, residence, and nativity.

$$w_t = \theta_0 + \theta_h Inches_i + \sum_{c=1}^{5} \theta_c Complexion_i + \sum_{a=1}^{16} \theta_a Age_i + \sum_{t=1840}^{1940} \theta_t Observation\ Decade_i$$

$$+ \sum_{j=1}^{5} \theta_j Occupations_i + \sum_{r=1}^{17} \theta_r Residence_i + \sum_{n=1}^{17} \theta_n Nativity_i + \varepsilon_i \qquad (1)$$

Height in inches is included to account for the positive relationship between weight and height. Complexion dummy variables are included to account for weight variation by race. Youth age dummy variables are included for ages 13 through 22; adult age decade dummy variables are included for ages 30 through 70. Observation decade dummy variables are included to assess how net nutrition varied over time, and occupation dummy variables are included to evaluate how weights varied by socioeconomic status. State prison is included to account for the effect of residence at the time of measurement.

Table 3's models 1 and 2 present male weight and height estimates for the late 19th and early 20th centuries and includes immigrants to assess how foreign-born weight compared to US natives. To assess proportional weight variation Model 3 presents the natural log of weight regressed on the same variables. Models 4 and 5 present weight and height estimates for black males born in the US, while models 6 and 7 do the same for US born whites.

Table 3, Late 19th and Early 20th Century Black and White Weight and Height Regressions

	Total			*Blacks*		*Whites*	
	Model 1 Weight	Model 2 Height	Model 3 Ln Weight	Model 4 Weight	Model 5 Height	Model 6 Weight	Model 7 Height
Intercept	-88.24***	68.90***	3.39***	-72.61***	67.46***	-95.72***	69.30***
Height							
Inches	3.48***		.024***	3.38***		3.58***	
Complexion							
White	Reference	Reference	Reference				
Black	7.27***	-.905***	.049***	Reference	Reference		
Mixed Race	5.66***	-.672***	.038***	-2.01***	.285***		
Indian	3.08***	-.643***	.020***				
Asian	-.472	-1.21***	-.002				
Mexican	.520***	-1.65***	.003**				
Ages							
13	-22.71***	-6.08***	-.204***	-25.92***	-6.22***	-12.32***	-5.38***
14	-19.08***	-4.57***	.157***	-21.16***	-4.58***	-13.38***	-4.98***
15	-16.37***	-3.20***	-.126***	-18.69***	-3.23***	-12.07***	-3.31***
16	-12.56***	-2.07***	-.091***	-14.62***	-2.12***	-10.07***	-2.03***
17	-9.20***	-1.26***	-.064***	-10.77***	-1.32***	-7.57***	-1.20***
18	-6.89***	-.782***	-.047***	-8.40***	-.887***	-5.48***	-.676***
19	-4.57***	-.480***	-.031***	-5.55***	-.539***	-3.67***	-.448***
20	-2.71***	-.200***	-.018***	-3.66***	-.233***	-2.07***	-.158***
21	-1.73***	-.091***	-.011***	-2.12***	-.115***	-1.48***	-.053***
22	-1.15***	-.076***	-.007***	-1.29***	-.100***	-1.06***	-.044***
23-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30s	1.43***	-.028***	.009***	1.22***	.037***	1.60***	-.018**
40s	3.02***	-.279***	.018***	1.95***	-.288***	3.71***	-.190***
50s	3.45***	-.566***	.021***	2.19***	-.605***	4.33***	-.498***
60s	2.57***	-.932***	.014***	.485***	-.829***	3.40***	-.928***
70s	1.37***	-1.23***	.005***	-1.08***	-1.27***	2.84***	-1.24***
80s	-3.03***	-1.90***	-.026***	-9.20***	-1.76***	-4.32***	-1.61***
Observation Decade							
1840s	9.22***		.060***	7.47***		10.61***	
1850s	3.66***		.025***	4.20		3.84***	
1860s	4.47***		.030***	3.99***		4.74***	
1870s	2.36***		.016***	3.61***		1.29***	
1880s	.578***		.004**	.755**		.276	
1890s	.754***		.005***	.986***		.628**	
1900s	Reference		Reference	Reference		Reference	
1910s	-.302***		-.002***	-.973***		.092	

1920s	.393***		.002**	-1.05**		1.05***	
1930s	1.01*		.006*	-1.87		1.46**	
1940s	-.155		-.002	-1.41		-.409	
Birth Decade							
1700s	Reference	Reference	Reference	Reference	Reference	Reference	Reference
1800s		.238			.057		.141
1810s		-.019			.344		-.151
1820s		-.403			-.139		-.400
1830s		-.756**			-.422		-.962*
1840s		-.840**			-.328		-1.16**
1850s		-.891**			-.205		-.132**
1860s		-.919**			-.292		-1.32**
1870s		-1.02***			-.491*		-1.38**
1880s		-1.13***			-.564**		-1.51***
1890s		-1.03***			-.404		-1.42**
1900s		-.767**			-.114		-1.17**
1910s		-1.33			.571*		-.501
1920s		.613			1.10		.285
Occupations							
White-Collar	-.008	-.033	-.001	-1.45***	-.108***	.687	-.085
Skilled	.200	-.077**	.002	-.021	-.034	.813***	-.143**
Farmer	2.15***	.355***	.015***	1.89***	.436***	2.59***	.288***
Unskilled	.897***	.036	.007***	.575***	.154***	1.29***	-.033
No Occupations	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Residence							
Arizona	.326**	-.904***	.002**	-2.40***	.160	1.10***	-.858***
Colorado	3.20***	-.722***	.022***	1.85***	-.182	3.41***	-.793***
Idaho	1.17**	-.108*	.009**	.199	-.095	1.34**	-.101
Illinois	-.503	-.650***	-.004	-2.82***	-.317***	-.037	-.712***
Kentucky	-2.83***	-.804***	-.020***	-3.53***	-.704***	-2.84***	-.824***
Missouri	-4.68***	-.681***	.-.032***	-5.24***	-.511***	-4.17***	-.709***
Mississippi	-1.62***	.095	-.010***	-2.15***	.207***	-1.95*	.344***
Montana	5.00***	.494***	.033***	1.65***	.740***	5.34***	.450***
Nebraska	-3.67***	-.206***	-.025***	-5.97***	.068	-3.03***	-.253***
New Mexico	1.34***	-.348***	.009***	-.075	.159	2.26***	-.359***
Oregon	5.10***	-.913***	.035***	3.58*	-.624***	6.11***	-.909***
PA East	-2.64***	-1.32***	-.019***	-4.84***	-.967***	-1.75***	-1.32***
PA West	2.89***	-.928***	.020***	2.37***	-.552***	3.33***	-.888***
Philadelphia	-3.56***	-.948***	-.025***	-4.35***	-.766***	-3.45***	-1.04***
Tennessee	2.30***	-.876***	.016***	1.76***	-.694***	2.69***	-.874***
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Utah							
Washington	-.333	-.884***	-.002	-1.52	-1.57***	-.680	-1.00***
Nativity							
National							

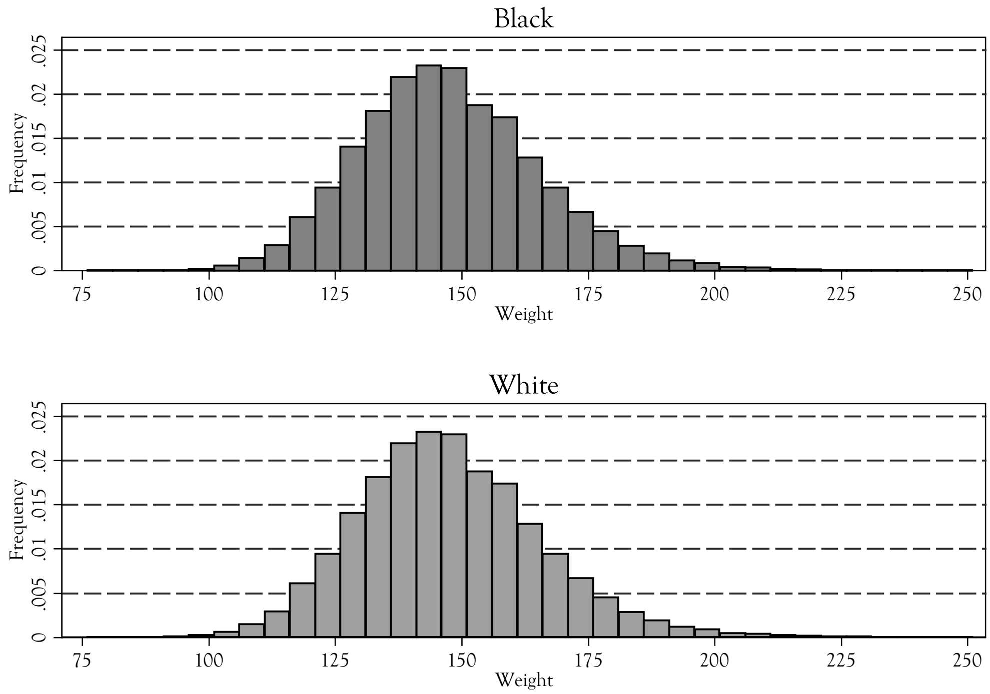
Northwest	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Middle Atlantic	-.549	-.054	.004	-2.04	-.198	-.125	-.074
Great Lakes	.090	.341***	3.90^{-4}	-1.45	.055	.167	.383***
Plains	.282	.535***	.002	-.127	.110	.142	.612***
Southeast	-.879**	.728***	-.006**	-.712	.396***	-1.37***	.810***
Southwest	-.764**	.760***	-.005**	-.930	.634***	-1.20***	.773***
Far West	-.996***	.463***	-.006***	-1.39	.249*	-1.20***	.520***
International							
Africa	1.51	-.568**	.012				
Asia	-13.80***	-2.24***	-.101***				
Australia	-1.90***	.273*	-.012				
Canada	.049	-.088	9.03^{-5}				
Europe	4.38***	-.977***	.030***				
British	.009	-.507***	8.83^{-4}				
Latin America	-2.98***	.208	-.017***				
Mexico	-1.69***	-.715***	-.012***				
N	197,469	197,469	197,469	72,519	72,519	99,262	96,262
R^2	.3571	.1258	.3722	.3994	.1100	.3198	.0923

Source: See Table 2.

Notes: *** is significant at .01. ** is significant at .05. * is significant .10.

Three general patterns emerge when evaluating late 19th and early 20th century US weight variation. First, although they have the ability to reach comparable statures when brought to maturity under ideal biological conditions, Steckel (1979, p. 374) finds that whites were taller than African-Americans. Bodenhorn (2002, pp. 23, 30, and 43) indicates much of the stature difference was due to social preferences that disproportionately favored individuals with fairer complexions, a pattern known as the 'mulatto advantage.' However, if social preferences were the primary explanation for better white net nutrition, individuals with fairer complexions should have had heavier weights than individuals with darker complexions. However, individuals with fairer complexions had lower weights than darker complexioned individuals, and mixed-race individuals had lower weights that darker complexioned individuals, indicating that a net nutrition-complexion explanation goes beyond social preferences favoring fairer complexioned individuals. Various explanations account for why individuals with darker complexions had greater weights than individuals with fairer complexions. Individuals with darker complexions have more protein for each unit of tissue mass than mixed-race individuals and whites, and muscle is heavier than fat (Schutte et al, 1984; Aloi et al. 1997; Barrondess et al 1997; Wagner and Hayward, 2000). That individuals with darker complexions had heavier weights than individuals with fairer complexions was also common in areas where free and bound labor were the primary labor forces, indicating that net nutrition differences were not explained by labor market environments and economic systems (Table 2). In sum, individuals with darker complexions had greater weights than individuals with lighter complexions, and a 19th century weight 'mulatto advantage' did not exist (Bodenhorn, 2002).

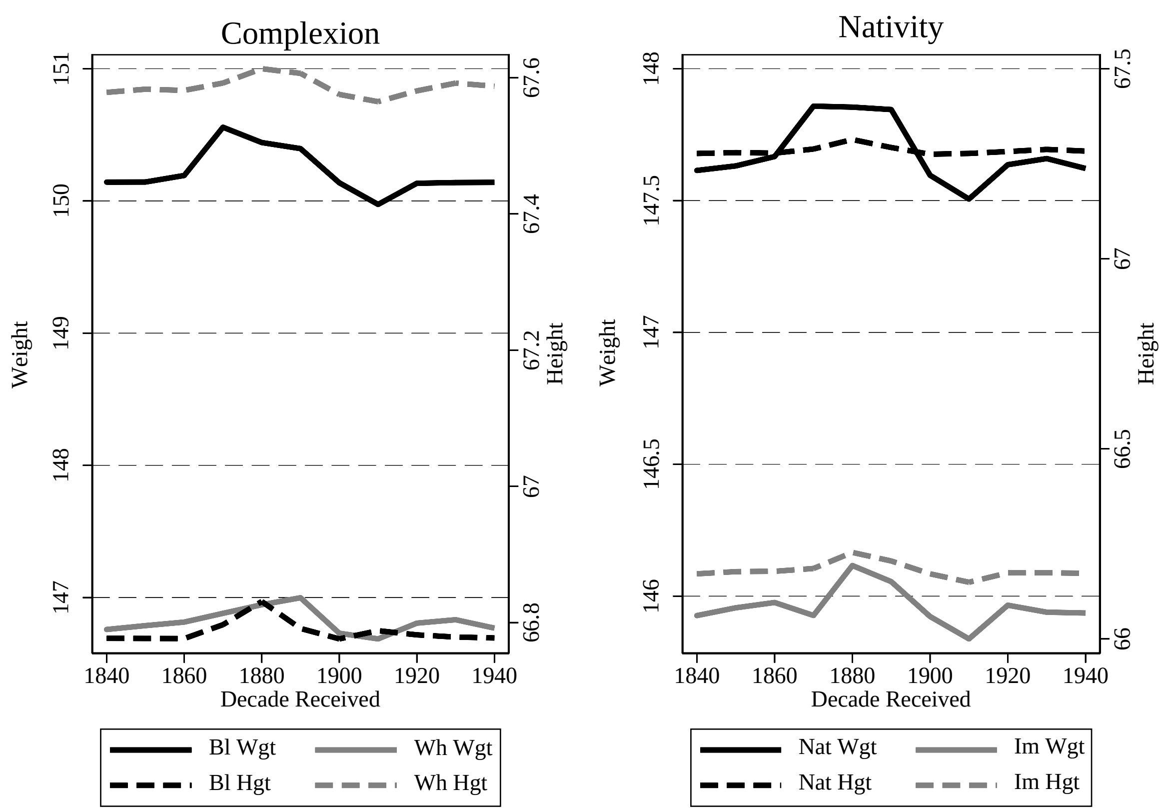
Figure 2, Late 19th and Early 20th Century Black and White Status



Source: See Table 1.

Second, C. Vann Woodward (1951, pp. 131-134), Arnold Plant (1947, pp. 3-16), and Keith Tribe (2009, pp. 80 and 92) propose that under free-labor, lower socioeconomic status whites were unable to compete with recently freed slaves and were made worse-off with the transition to free-labor (Donald, 1995, pp. 24, 417). Alternatively, Becker (1957, pp. 75-80), Becker (1966, pp, 188-190), and Higgs (1977, pp. 8-10) indicate that white net nutrition would have increased relative to blacks if free-labor workers and employers discriminated against blacks. Black and white weights stagnated throughout the 19th and early 20th centuries (Figure 3), and after controlling for height, black weight was greater than fairer complexioned mixed-race individuals and whites. In 1840, average black weight was 149.88 pounds with an average height of 66.78 inches, and white average weight was 147.10 pounds with an average height of 67.72 inches. By the 1910s, average black weight had increased to 150.12 pounds, and their average heights decreased to 67.29 inches. By the 1910s, average white weight was 147.04 pounds, and their average height was constant at 68.97, indicating that like BMIs, black and white weight and height remained constant between 1840 and 1910 (Carson 2019). While weights and statures stagnated during the mid-19th century, there was a slight weight increase in the 1880s, followed by a second decrease in the early 1900s (Figure 3).

Figure 3, Late 19th and Early 20th Century Black and White Weight and Height over Time



Source: See Table 2. Estimates over time are from Table 2.

Much of weight and height stagnation was related to changes in the relative price of nutrition and industrialization (Fogel et al. 1982, p. 28; Fogel et al. 1983, pp.473-476; Fogel and Engermann, 1982, p. 395; Komlos, 2012). For example, in 1840, most agricultural production was on small family farms devoted to household needs; little production was left over for market transactions. However, by 1900, US agriculture commercialized, and proximity to net nutrition increased as workers urbanized and moved from farms into factories (Cochrane, 1979; Rosenbloom, 2002, p. 88). Net nutrition was also related to disease, and disease episodes varied throughout the United States and between urban and rural areas (McGuire and Coelho, 2011, pp. 122-125). After slavery, recently freed slaves devoted a higher proportion of their income to food acquisition (Higgs, 1977, p. 105). BMIs also stagnated throughout the late 19th and early 20th centuries, indicating that current and cumulative net nutrition were sufficient throughout the period but not excessive (Komlos and Carson, 2017).

Third, weights varied by socioeconomic status, and workers in agricultural occupations had access to better nutrition and were physically more active than workers in other occupations (Figure 4; Komlos, 1987; Carson, 2009a; Carson, 2012). Agricultural workers' weights were 1.65 pounds heavier and their heights .350 inches taller than workers in other occupations (Table 6). During the late 19th and early 20th centuries, farmers, ranchers, and farm laborers were in close proximity to diets yet were in more physically demanding occupations (Dimitri et al 2005).[6] Carson (2015b, p. 959) demonstrates that farmer's weight at the national level were two

[6] Margo and Steckel (1992, p. 518) and Steckel and Haurin, (1994, p. 122) propose that agricultural workers had greater weight and height because of comparative advantage from size associated with occupational choice.

pounds heavier and their heights half an inch taller than workers in other occupations, indicating agricultural occupations were associated with higher current net nutrition. On the other hand, reflecting the separation of food consumption from production, white-collar and skilled workers had shorter statures and weighed less than workers in other occupations, (Komlos, 1987; Dirks, 2016, pp. 61-63).

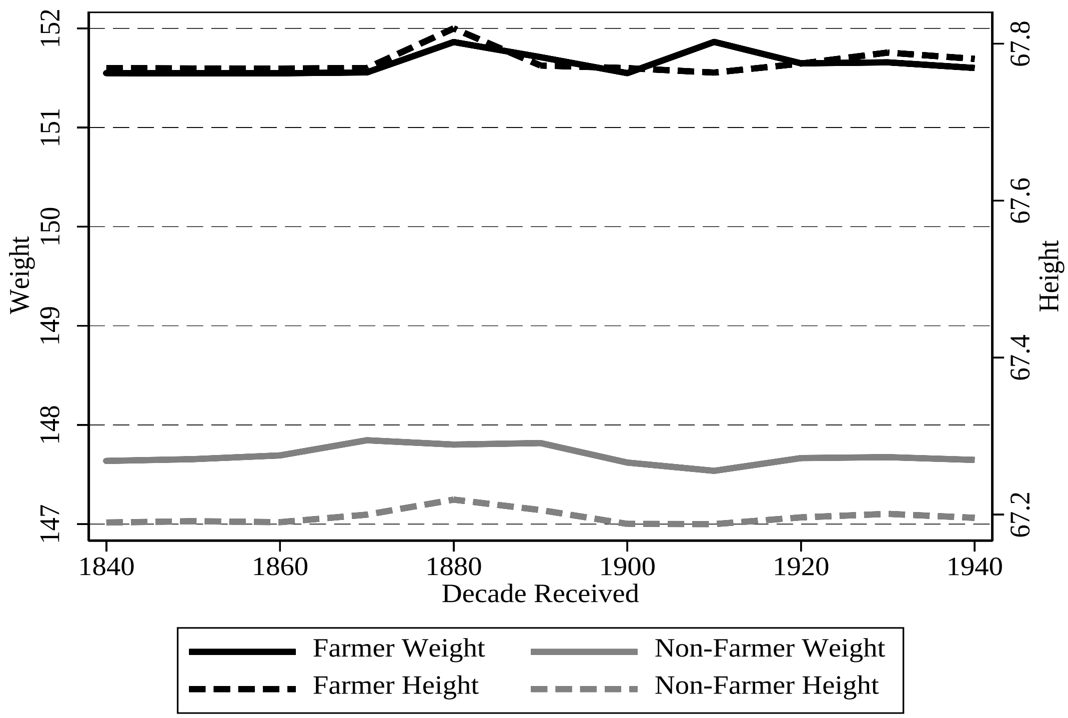


Figure 4, Late 19th and Early 20th Century Weight and Height by Socioeconomic Status

Source: See Table 2.

Alternatively, agricultural workers may have head greater weight associated with rural agricultural net nutrition because the relative price of rural nutrition was low.

Other patterns are consistent with expectations. Nativity within the US had an independent relationship with weight and height, and individuals from the Northeast, Middle Atlantic, and Plains had shorter statures, and greater weights compared to the South and Far West. International nativity patterns are also noteworthy (Figure 3). If, prior to migration, an individual received poor childhood net nutrition and reached shorter statures, and their nutrition improved upon their US arrival, they were more likely to have higher adult BMIs because they were short and had less physical dimensions to distribute weight (Komlos and Carson, 2017). Independent of compositional effects, European immigrants had heavier weights than US natives (Table 4; Koepke and Baten, 2005; Koepke and Baten, 2008). Greater weight among European immigrants also reflects better net nutrition among those who migrated (Carson, 2009b). However, Mexicans and Asians were shorter and had lower weights, indicating they had poor net nutrition prior to migration and did not fully assimilate into the US economy (Table 3; Carson, 2005; Carson, 2007; Dirks, 2016. p. 7).

Table 4, Late 19th and Early 20th Century Immigrant and Native-Born Weight and Height Models

	Native		*Immigrant*	
	Model 1 Weight	Model 2 Height	Model 3 Weight	Model 4 Height
Intercept	-88.94***	69.18***	-90.12***	67.76***
Height				
Inches	3.48***		2.53***	
Complexion				
White	Reference	Reference	Reference	Reference
Black	7.27***	-.822***	-.192	-.099
Mixed Race	5.64***	-.594***	-3.77***	-.925***
Indian	2.82***	-.720***	1.01	1.11***
Asian	-3.35**	-1.24***	-14.73***	-2.70***
Mexican	.022	-1.88***	-2.71***	-1.28***
Ages				
13	-22.95***	-6.15***	-16.04***	-1.40***
14	-19.11***	-4.67***	-23.65***	-2.06***
15	-16.48***	-3.25***	-17.14***	-2.20***
16	-12.74***	-2.08***	-9.53***	-1.73***
17	-9.28***	-1.27***	-8.92***	-1.12***
18	-6.92***	-.783***	-6.64***	-.776***
19	-4.52***	-.495***	-5.33***	-.296***
20	-2.77***	-.201***	-2.34***	-.194***
21	-1.74***	-.083***	-2.04***	-.218***
22	-1.10***	-.073***	-1.60***	-.065***
23-29	Reference	Reference	Reference	Reference
30s	1.42***	-.005	1.57***	-.197***
40s	3.10***	-.243***	2.74***	-.504***
50s	3.78***	-.544***	3.10***	-.755***
60s	2.62***	-.943***	3.47***	-1.00***
70s	1.49***	-1.31***	1.36***	-1.24***
80s	-6.41***	-1.80***	5.78***	-2.01***
Observation Decade				
1840s	10.10***		2.96	
1850s	3.95***		1.21	
1860s	4.65***		2.50***	
1870s	2.79***		-.808**	
1880s	.837***		-.027	
1890s	.989***		.066	
1900s	Reference		Reference	

1910s	-.404***		-.023	
1920s	.366*		1.05	
1930s	.969*		.856	
1940s	-.432		5.18	
Birth Decade				
1800s		.445		.569*
1810s		.378**		-.010
1820s		Reference		Reference
1830s		-.455**		-.063
1840s		-.546***		-.151
1850s		-.591***		-.297*
1860s		-.601***		-.737***
1870s		-.688***		-.462***
1880s		-.798***		-.577***
1890s		-1.15***		-1.23***
1900s		-.390*		-.420
1910s		.274*		-.296
1920s		1.01***		-.551
Occupations				
White-Collar	.020	-.061*	1.28*	-.143**
Skilled	.295**	-.100***	.779**	-.210***
Farmer	2.17***	.435***	3.82***	.074
Unskilled	.767***	.082**	2.17***	-.237***
No Occupations	Reference	Reference	Reference	Reference
Residence				
Arizona	.614***	-.864***	-2.82***	-.905***
Colorado	3.48***	-.943***	3.15***	-.554***
Idaho	1.70**	-.320***	.064	.009
Illinois	-.194	-.943***	1.64	-.596***
Kentucky	-3.04***	-.813***	-.324	-.913***
Missouri	-3.96***	-.858***	-4.10***	-.495***
Mississippi	-1.71***	.075	-2.55	.980
Montana	5.45***	.212***	4.96***	.748***
Nebraska	-2.78***	-.399***	-4.92***	-.128
New Mexico	1.46***	-.406***	1.81***	.071
Oregon	5.39***	-1.20***	3.50***	-1.19***
PA East	-2.63***	-1.89***	-1.32**	-1.48***
PA West	2.85***	-1.45***	4.23***	-1.06***
Philadelphia	-4.05***	-1.59***	-.571	-.727***
Tennessee	2.05***	-.856***	2.37***	-.643***
Texas	Reference	Reference	Reference	Reference
Utah	1.42**	-.494***	1.84**	.079

Washington	-.961*	-1.38***	.908	-.588**
N	175,333	175,333	26,715	26,715
R^2	.3553	.1088	.3507	.0717

Source: See Table 2.

Notes: *** is significant at .01. ** is significant at .05. * is significant .10.

Much of the regional weight variation was related to diets, nutrition, and environmental conditions (Atack and Baten, 1987; Dirks, 2016). For 19th century white Americans, Cummings (1940) finds that average annual diets had about pounds of meat, 13 pounds of lard, 15 pounds of butter, 205 pounds of flour, and 30 pounds of sweeteners, from which he infers that whites received about 3,741 calories per day, which was sufficient to maintain work under moderate to heavy workloads. Atack and Bateman (1987) estimate that northern white diets averaged around 200 pounds of meat, 770 pounds of fluid milk, cheese, and butter, and 13.5 bushels of grain, which provided around 5,000 calories per day. Northeastern diets were high in cereals, grains, and dairy products, while Southern diets were more abundant in calories from beef, pork, Irish potatoes, and corn (Floud et al. 2011, p. 313; Hilliard, p. 1972, pp. 135 and 166; Margo and Steckel, 1992, pp. 516-517). On the other hand, Komlos (1987, p. 909), Putnam (2000), Floud et al. (2011, p. 314) and Carson (2014, pp. 772-773) find that late 19th century calories to be around 3,100 calories per day. African-American diets also varied regionally, and blacks in the South received higher average calories per day than blacks elsewhere within the US (Fogel and Engerman, 1974; Dirks, 2016, pp. 61-66). Subsequently, there was an independent relationship between 19th century current net nutrition and regional variation that reflects local diets, the relative price of current net nutrition, and agricultural productivity (Condran and Crimmens, 1978; Costa, 1993).

V. Decomposing the Late 19th and Early 20th Black and White Weight and Height

To further account for black and white weight variation over time, a Blinder-Oaxaca decomposition is constructed for late 19th and early 20th century weight. Two decompositions are considered: blacks to whites and native to foreign-born. Let w_h and w_l, respectively, be heavy and light weights associated with characteristics. θ_{0h} and θ_{0l} are the autonomous heavy and light weight components, which include genetic differences and different access to nutrition. θ_{1h} and θ_{1l} are the heavy and light weight returns associated with characteristics, such as residence and occupations. $\overline{X}_h$ and $\overline{X}_l$ are the heavy and light average weight characteristics. If weight differences are due to returns to characteristics, it reflects different processes associated with weight variation and access to nutrition. However, if differences are associated with average characteristics, it reflects sample differences.

Heavy Weight Function $w_h = \theta_{0h} + \theta_{1h}\overline{X}_h$

Light Weight Function $w_l = \theta_{0l} + \theta_{1l}\overline{X}_l$

The gap between heavy and light weights is

$$\Delta w = w_h - w_l = \theta_{0h} + \theta_{1h}\overline{X}_h - \theta_{0l} - \theta_{1l}\overline{X}_l$$

Adding and subtracting $\theta_{1l}\overline{X}_h$ to the right-hand side and collecting like terms

$$\Delta w = w_h - w_l = (\theta_{0h} - \theta_{0l}) + (\theta_{1h} - \theta_{1l})\overline{X}_h + (\overline{X}_h - \overline{X}_l)\theta_{1l}$$

The first right-hand side element, $(\theta_{0h} - \theta_{0l})$, is that part of the weight gap due to non-identifiable characteristics, such as genetics and access to nutrition by ethnic and migration status. The second right-hand side element, $(\theta_{1h} - \theta_{1w})\overline{X}_h$, is the structural component due to returns to characteristics. The third right-hand side element, $(\overline{X}_h - \overline{X}_l)\theta_l$, is the is the part of the weight gap associated with differences in average characteristics.[7]

[7] There is some concern over the value of decomposing dependent variable differences into returns to characteristics and average characteristics because coefficient estimates vary with respect to the choice of the omitted category (Oaxaca, 1973; Oaxaca and Ransom, 1999). There is little concern about explaining the dependent variable gap $(\overline{X}_b - \overline{X}_w)\theta_w$. However, because the intercept is sensitive to the omitted category, identification of black and white weight decompositions are considered first, followed by foreign-native weight decompositions. $(\theta_{0b} - \theta_{0w}) + (\theta_{1b} - \theta_{1w})\overline{X}_b$ is less clear, and there is some degree of arbitrariness that is unavoidable (Yun, 2008; Fortin, Lemieux, and Firpo, 2011, pp. 40 and 45).

Table 5, Weight Decomposition between US Blacks and Whites

Levels	$(\theta_b - \theta_w)\bar{X}_b$	$(\bar{X}_b - \bar{X}_w)\theta_w$	$(\theta_b - \theta_w)\bar{X}_w$	$(\bar{X}_b - \bar{X}_w)\theta_b$
Sum	8.20	-4.38	6.09	-2.27
Total		3.82		3.82
Proportions				
Intercept	6.25		6.25	
Height	-3.51	-.676	-3.54	-.639
Ages	-.290	-.310	-.224	-.375
Observation Decade	-.013	.001	-.087	.075
Occupations	-.163	-.026	-.233	.044
Residence	-.208	.015	-.433	.240
Nativity	.073	-.148	-.014	.062
Sum	2.15	-1.14	1.59	-.594
Total		1		1

Source: See Tables 1 and 2, Models 3 and 5.

Using coefficients from weight regressions in Tables 2 and 3, weight decompositions show that the majority of black weight advantage was associated with non-identifiable characteristics in the intercepts, such as greater bone mineral density and lean muscle mass that favored individuals with darker complexions (Table 5; Waaler, 1984; Wagner and Heyward, 2000; Barondess et al. 1997). However, whites had greater weight returns with observable characteristics. Much of the white weight advantage was attributable to older ages, and there was a greater share of whites in the prison sample that was older and attained their adult weight. The greatest share of the weight gap that favored whites was associated with height and indicates that taller white heights that favored whites had lasting effects. White stature advantages also extended to nativity, and the white stature return advantage was nearly twice that of blacks.

Table 6, Weight Decomposition between Native and Foreign-Born

	$\left(\theta_N - \theta_F\right)\bar{X}_N$	$\left(\bar{X}_N - \bar{X}_F\right)\beta_F$	$\left(\theta_N - \theta_F\right)\bar{X}_F$	$\left(\bar{X}_N - \bar{X}_F\right)\beta_N$
Levels				
Sum	67.73	.742	64.09	4.38
Total		68.47		68.47
Proportions				
Intercept	.017		.017	
Height	.935	.041	.920	.056
Complexion	.051	-.003	.012	.037
Ages	2.55^{-4}	-.020	8.79^{-4}	-.021
Observation	.007	3.01^{-4}	.007	5.54^{-4}
Decade				
Occupations	-.016	1.11^{-4}	-.016	8.76^{-4}
Residence	-.005	-.008	-.004	-.010
Sum	.989	.011	.936	.064
Total		1		1

Source: See Tables 1 and 2. Table 4's Models 1 and 6.

Using coefficients from weight regressions in Table 2 and 4, native and foreign-born weight decompositions illustrate that the majority of the native weight advantage was associated with height (Table 6). Moreover, little of the native weight advantage was due to non-identifiable characteristics in the intercept, indicating that native weight was primarily due to native cumulative net nutrition. The greatest share of the foreign-born proportional weight advantage was associated with occupations, indicating that the greatest share of the foreign-born working class was associated with socioeconomic status. Beyond height, complexion had the greatest affect explaining the native, foreign-born weight difference. The largest part of the native weight advantage was associated with returns to characteristics rather than average characteristic differences.

IV. Conclusion

Because weight is more plastic and responsive to the immediate effects of nutrition and the physical environment, weight provides important insight into how net nutrition varies over time, by ethnicity, and socioeconomic status. Weight is also a driving factor in BMI variation, and because adult height is more calcified and less responsive to changes to net nutrition, weights' responsiveness accounts for much of BMI variation over time. Individuals with darker complexions had greater weights than individuals with fairer complexions and mixed-race individuals. Black and white weights stagnated throughout the 19th and early 20th centuries, and workers in agricultural occupations had greater weights than workers in other occupations. Differences in weight due to unidentifiable sources by complexion illustrates that blacks were heavier than whites after controlling for characteristics, such as greater muscle mass and protein in black muscle mass than whites. However, white weight stature returns were greater than blacks, indicating that white compared to blacks cumulative net nutrition hand lasting effects. After controlling for characteristics, agricultural workers had heavier weights, and taller statures compared to workers in other occupations, indicating the late 19th and early 20th century net benefits to rural agricultural lifestyles extended to weight.

References

Aloia, John, Vaswani, Ashok, Ma, Reimei, Flaster Edith. 1997. Comparison of body composition in black and white premenopausal women. Journal of Laboratory Clinical Medicine 129(3), 294-299.

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

Barondess, D. A., D. A. Nelson, and S. E. Schlaen, 1997. Whole body bone, fat and lean mass in black and white men. *Journal of Bone and Mineral Research* 12: 967-971.

Becker, Gary. (1957). *The Economics of Discrimination.* Chicago: University of Chicago.

Becker, Gary. (1966). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education.* Chicago: University of Chicago Press.

Bodenhorn, Howard. 2002. The mulatto advantage: The biological consequences of complexion in rural antebellum Virginia. Journal of Interdisciplinary History 33(1), 21-46.

Carson, Scott Alan. (2005) "The Biological Standard of Living in 19th-Century Mexico and in the American West," *Economics and Human Biology,* Volume 3(3), pp. 405-419.

Carson, Scott Alan. (2007) "Mexican Body Mass Index Values in the 19th Century American West," *Economics and Human Biology,* Volume, 5(1), pp. 37-47.

Carson, Scott Alan. (2008) "Health during Industrialization: Evidence from the 19th Century Pennsylvania State Prison System," *Social Science History*. Volume 32(3). pp. 347-372.

Carson, Scott Alan. (2009a) "Racial Differences in Body-Mass Indices of Men Imprisoned in 19th Century Texas" *Economics & Human Biology* 7, pp. 121-127.

Carson, Scott Alan, (2009b) "Geography, Insolation and Vitamin D in 19th Century US African-American and White Statures," 46(1), *Explorations in Economic History.* pp. 149-159.

Carson, Scott Alan. (2011), "Height of Female Americans in the 19th century and the Antebellum Puzzle," *Economics and Human Biology* 9, pp. 157-164.

Carson, Scott Alan. (2012), "The Body Mass Index of Blacks and Whites in the United States during the Nineteenth Century," *Journal of Interdisciplinary History* 42. pp. 371-391.

Carson, Scott Alan. (2013a). "Biological Conditions and Economic Development: Westward Expansion and Health in Late 19th and Early 20th Century Montana." *Journal of Historical Society,* 13(1), pp. 51-68.

Carson, Scott Alan. (2013b). "Socioeconomic Effects on the Stature of Nineteenth Century US Women." *Feminist Economics* 19, pp. 122-143.

Carson, Scott Alan. (2014). "Nineteenth Century US Black and White Working Class Physical Activity and Nutritional Trends during Economic Development." *Journal of Economic Issues,* 48(3), pp. 765-786.

Carson, Scott Alan. (2015a). "Biological Conditions and Economic Development: 19th Century US Statures on the Great Plains." *Human Nature,* 26(2), pp. 123-142.

Carson, Scott Alan. (2015b). "A Weighty Issue: Diminished 19th Century Net Nutrition among the US Working Class." *Demography,* 52. pp. 945-966.

Carson, Scott Alan. (2015c). "Biology, Complexion, and Socioeconomic Status: Accounting for 19th Century US BMIs by Race." *Australian Economic History Review*. 55(3), pp. 238-255.

Carson, Scott Alan (2016). "Body Mass Index through Time: Explanations, Evidence, and

Future Directions." In: Komlos, John and Inas Kelly (Eds.). *Handbook of Economics and Human Biology*. Oxford: Oxford University Press, pp. 133-151.

Carson, Scott Alan. (2017a). "Health on the 19th Century US Great Plains: Opportunity or Displacement?" 48(1), *Journal of Interdisciplinary History*. 48(1), pp. 21-41

Carson, Scott Alan. (2017b). "White and Black Weight by Socioeconomic Status and Residence: Revaluating Nineteenth Century Health during Institutional Change to Free Labor." *Journal of Institutional and Theoretical Economics*. 173(4), pp. 643-661.

Carson, Scott Alan. (2018a). "Black and White Female Body Mass Index Values in the Developing Late 19th and Early 20th Century United States." *Journal of Bioeconomics*.

Carson, Scott Alan. (2018b). "The Weight of 19th Century Mexicans in the Western United States." *Historical Methods: A Journal of Quantitative and Interdisciplinary History*. 51(1), pp. 1-12.

Carson, Scott Alan (2019). "Late 19th and Early 20th Century Native and Immigrant Body Mass Index Values in the United States." *Economics and Human Biology*

Case, Anne and Christina Paxson. (2008a). "Height, Health, and Cognitive Development at Older Ages." *American Economic Review* 98, pp. 463-467.

Case, Anne and Christina Paxson (2008b). "Stature and Status: Height, Ability, and Labor Market Outcomes." *Journal of Political Economy* 116, pp. 499-532.

Cochrane, Willard (1979). *The Development of American Agriculture: A Historical Analysis*. University of Minnesota Press: Minneapolis.

Coelho, Philip R. P. & McGuire, R. (2000). "Diets Versus Diseases: The Anthropometrics of Slave Children." *The Journal of Economic History, 60*(1), pp. 232-246.

Cohn, Raymond (2009). *Mass Migration Under Sail: European Immigration to the Antebellum United States.* Cambridge: Cambridge University Press.

Condran, Gretchen A, and Eileen Crimmins. "Public Health Measures and Mortality in U.S. Cities in the Late Nineteenth Century." *Human Ecology.* 6, no. 1 (1978): .

Costa, D. (1993). " Height, Wealth, and Disease among the Native –Born in the Rural, Antebellum North." *Social Science History* 17: 355-383.

Cummings, Richard O. 1940. *The American and his Food.* Chicago: University of Chicago Press.

Davidson, James, Jerome Rose, Myron Gutman, Michael Haines, Keith Condron, and Cindy Condran. (2002). "The Quality of African-American Life in the Old Southwest near the Turn of the 20th Century." In: Richard Steckel and Jerome Rose. (Eds.). *The Backbone of History: Health and Nutrition in the Western Hemisphere.* Cambridge: Cambridge University Press. pp. 226-280.

Dawes, Laura (2014). *Childhood Obesity in America.* Cambridge: Harvard University Press.

Deaton, A. (2008). Height, health, and inequality: The distribution of adult heights in India. *American Economic Review*, 98, pp. 468-474.

Deaton, Angus (2013). *The Great Escape: Health, Wealth, and the Origins of Inequality.* Princeton University Press. Princeton.

Dimitri, Carolyn, Anne Effland, and Neilson Conklin. (2005). "The 20th Century Transformation of US Agriculture and Farm Policy." United States Department of Agriculture Electronic Information Bulletin no. 3 http://ageconsearch.umn.edu/bitstream/59390/2/eib3.pdf. Accessed August 7th, 2016.

Dirks, Robert (2016). *Food in the Gilded Age:What Ordinary Americans Ate.* Rowman and

Littlefield: Lanham, MD.

Donald, David Herbert (1995). *Lincoln.* New York: Simon & Schuster.

Ellis, Joseph. 2004. His Excellency George Washington. New York: Knopf.

Floud, Roderick, Robert W. Fogel, Bernard Harris, and Sok Chul Hong. (2011). *The Changing Body: Health, Nutrition, and Human Development in the Western World since 1700.* Cambridge: Cambridge University Press.

Fogel, Robert and Stanley Engermann. (1982). "Editors' Forward," Social Science History Association, 6(4), pp. 395-400.

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

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

Fogel, Robert, Stanley Engerman, and James Tressell. (1982). "Exploring the Uses of Height: The Analysis of Long-Term Trends in Nutrition, Labor Welfare, and Labor Productivity." *Social Science History*, 6(4),pp. 401-421.

Fogel, Robert, Stanley Engerman, Rodrick Floud, Gerald Friedman, Robert Margo, Kenneth Sokoloff, Richard Steckel, James Trussell, Georgia Villaflor, Kenneth Watcher (1983). "Secular Changes in American and British Stature and Nutrition." *Journal of Interdisciplinary History* 14, pp. 445-481.

Fortin N, Lemieax T, Firgo S. Decomposition methods in economics. In: Card D Ashenfelter O editors. Handbook of labor economics, Volume 4, Part A. 2011. pp. 1-102.

Gluckman, P. D. Hanson, M. A. 2006. The consequences of being born small—An adaptive perspective. Hormone Research. 65, 5-14.

Gottfredson, Michael and Travis Hirschi (1990). *A General Theory of Crime.* Stanford University Press: California.

Guillot, Michel. (2011). "Period vs. Cohort Life Expectancy." In: Richard Rogers and Eileen Crimmins (Eds.). *International Handbook of Adult Mortality.* Springer, New York. pp. 533-549.

Haines, Michael, Lee Craig, and Thomas Weiss (2003). "The Short and the Dead: Nutrition, Mortality, and the "Antebellum Puzzle" in the United States. *The Journal of Economic History*, *63*(2), pp. 382-413.

Herbert, P., Richards-Edwards, J., Manson, J.A., Ridker, P., Cook, N., O'Conner, G., Buring, J., and Hennekens, C. (1993) Height and incidence of cardiovascular disease in male physicians. *Circulation* 88, p. 1437-1443.

Higgs, Robert (1977). *Competition and Coercion: Blacks in the American Economy, 1865-1914.* Chicago: University of Chicago Press.

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

Hirschi, Travis and Michaeal Gottfredson. (1983). "Age and Explanation of Crime." *American Journal of Sociology* 89(3), pp. 552-584.

Jee, H., Jee, J. W., Sull, Park, J., Lee, S. Y, Ohrr, H., Guallar, E., and Samet, J. (2006). "Body-Mass Index and Mortality in Korean Men and Women." *New England Journal of Medicine*, 355:779-787.

Koch, D. (2011). "Waaler Revisited: The Anthropometrics of Mortality." *Economics Human Biology* 9(1): 106-117.

Koepke, Nikola, Baten, Joerg. 2005. The biological standard of living in Europe during the last two millennia. European Review of Economic History 9(1), 61-95.

Koepke, Nikola, Baten, Joerg. 2016. Global perspective on economics and biology. In: John Komlos and Inas Kelly. Oxford Handbook of Economics and Human Biology. Oxford: Oxford University Press.

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

Komlos, John. (2012). "A Three-Decade History of the Antebellum Paradox: Explaining the Shrinking of the U. S. Population at the Outset of Modern Growth." *Journal of Historical Society*,12(4), pp. 395-445.

Komlos, John and Brian A'Hearn (2016). "The Decline in the Nutritional Status of the US Antebellum Population at the Onset of Modern Economic Growth." (No. 21845). National Bureau of Economic Research.

Komlos, John, Carson Scott Alan. 2017. The BMI values of the lower classes likely declined during the Great Depression. Economics and Human Biology 26, 137-143.

Komlos, J. (Forthcoming) Clarifications of a puzzle: The decline in nutritional status at the onset of modern economic growth in the U.S.A. *Journal of Economic History.*

Komlos, J. & A'Hearn, B. (Forthcoming). Shrinking in a growing economy is not so puzzling after all. *Economics and Human Biology.*

Margo, Robert and Richard Steckel (1992). "The Nutrition and Helath of Slaves and Antebellum Southern Whites." In Robert Fogel and Stanley Engerman. *Without Consent of Contract: Conditions of Slave Life and the Transition to Freedom, Technical Papers*. New York: Norton Publishers, pp. 508-521.

McGuire R, Coelho P. Parasites, pathogens, and progress: disease and economic development. Cambridge: MIT Press; 2011.

Mifflin, M.D., St Jeor, ST, Hill, LA, Scott, BJ, Daugherty, SA and YO Koh (1990). "**A** new predictive equation for resting energy expenditure in healthy individuals." *American Journal of Clinical Nutrition*, Vol 51, pp. 241-247.

Nyström-Peck, Maria. (1994) "The Importance of Childhood Socio-Economic Group for Adult Health." *Social Science & Medicine* 39, pp. 553-562.

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

Oaxaca R. L. (1973) Male female wage differentials in urban labor markets. *International Economic Review* 14, 3: 693-709.

Oaxaca, Ronald and Michael Ransom (1999). "Identification in Detailed Wage Decompositions." *Review of Economics and Statistics*, 81 (1), pp. 154-157.

Plant, Arnold (1947). *Selected Economic Assays and Addresses.* Boston: Routledge Press.

Putnam, Judy 2000. "Major Trends in U.S. Food Supply, 1909-1999." *Food Review*. 23(1), pp. 8-15).

Rosenbloom, Joshua, *Looking for Work, Searching for Workers: American Labor Markets during Industrialization.* Cambridge: Cambridge University Press, 2002.

Schneider, Eric (2017). "Children's Growth in an Adaptive Framework: Explaining the Growth Patterns of American Slaves and Other Historical Populations." *Economic History Review.* 70(1), pp. 3-29.

Schutte, J. E., E. J. Townsent, J. Hugg, and R. M. Malina, and C.G. Blomquist. (1984). "Density of Lean Body Mass is Greater in Black than in Whites." *Journal of Applied*

Physiology 56(6), pp. 1647-1649.

Sokoloff, K. & Villaflor G. (1982). Early achievement of modern stature in America. *Social Science History*, 6, 453-481.

Steckel R. Slave height profiles from coastwise manifests. Explorations in Economic History. 1979;16(4): 363-380.

Steckel, Richard, Rose, Jerome. 2002. Patterns of health in the western hemisphere. In: Richard Steckel and Jerome Rose. (Eds.). The Backbone of History: Health and Nutrition In the Western Hemisphere. Cambridge University Press: Cambridge. pp. 563-582.

Tribe, Keith (2009). "Liberalism and Neo Liberalism." In: Philip Mirowski and Dieter and Plehwa. *The Road from Mont Perlerin: The Making of Neoliberal Thought Collective.* Cambridge: Harvard University Press.

Waaler, Hans. (1984). "Height, Weight, and Mortality: The Norwegian Experience." *Acta Medica Scandinavica, Suppliment 679.*

Wagner, D. R. and V. H. Heyward, 2000. Measures of composition in blacks and whites: a comparative review. *American Journal of Clinical Nutrition* 71: 1392-1402.

Woodward, C. Vann (1951). *Origins of the New South, 1877-1913.* Baton Rouge: Louisiana State University Press.

Xiang, Xiaoling and Ruopong An. (2015). "Body Weight Status and Onset of Cognitive Impairment among US Middle Aged Older Adult." *Archives of Gerontology and Geriatrics* 60, pp. 334-400.

Yun MS. Identification problem and detailed Oaxaca decomposition: a general solution and inference. Journal of Economic and Social Measurement. 2008;33(1):27-38.

Zehetmayer, M. (2011). "The continuation of the antebellum puzzle: stature in the US, 1847–

1894." *European Review of Economic History*, *15*(2), 313-327.

Zimran, Ariell (2015). "Does Sample-Selection Bias Explain the Industrialization Puzzle? Evidence from Military Enlistment in the Nineteenth-Century United States" http://aez.econ.northwestern.edu/zimran_height_selection.pdf