CESifo Working Papers

www.cesifo.org/wp

Nineteenth Century Black and Mulatto Physical Activity, Calories, and Life Expectancy

Scott Alan Carson

CESifo Working Paper No. 4899

Category 4: Labour Markets

July 2014

CESifo *Working Paper No. 4899*

Nineteenth Century Black and Mulatto Physical Activity, Calories, and Life Expectancy

Abstract

Using data from late 19th and early 20th century US prisons, this study considers how black and mulatto basal metabolic rates and calories varied with economic development. During the 19th century, black physical activity and net nutrition declined during the late 19th and early 20th centuries across their BMR and calorie distributions, and increasing black life expectancy was not likely due to improved nutrition. Physically active farmers had greater BMRs and received more calories per day than workers in other occupations. Black diets, nutrition, and calories varied by residence, and rural blacks in the Deep South consumed the most calories per day, while their Northeastern urban counterparts consumed the least. Policy implications are that public sanitation facilities are of greater import than nutrition during economic development.

JEL-Code: I100, I150, I320, N310.

Keywords: nineteenth century US race relations, nutrition, physical activity, life expectancy.

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

I appreciate comments from John Komlos, Tom Maloney, Kelley Manning, Harry Taute, Gwendolyn Pennywell, James Swofford, Larry Wimmer, Martin Conlavi Konou, Paul Hodges, and Hugh Davis.

Eating Less, Longer Lives: 19th Century Black and Mulatto Physical Activity, Calories, and Life Expectancy

1. Introduction

Nineteenth century African-Americans experienced considerable degrees of political and economic exclusion. From its founding, US economic arrangements were based on inequality, and blacks were at an institutionalized disadvantage to whites. This inequality extended not only to black material conditions but also to their physical activity, nutrition, and life expectancy. While inferior to whites under slavery, the variety and quality of black diets were sufficient to maintain slave health (Fogel and Engerman, 1974; Sutch, 1976), and as slave owner property, slave masters had incentives to maintain slave health and extend their life expectancies. After emancipation, economic arrangements changed, and Southern agricultural productivity declined; however, we are uncertain how black and mulatto physical activity and nutrition varied with the transition. After generations under slavery, when given a choice, black workers may have chosen to work less, and their physical activity levels may have decreased (Ransom and Sutch, 1977, pp. 41-47). It is also unclear how free black life expectancy changed with the transition from bound to free labor and the change in nutrition associated with slavery's demise. As a result, this study considers how 19th century US institutional change altered the nutrition, physical activity, and life expectancy facing African-Americans.

It is against this backdrop that this study considers three paths of inquiry into 19th century black physical activity, nutrition, and life expectancy. First, how did late 19th and early 20th century black physical activity and calories vary over time and across their respective distributions? The question is important because there is considerable debate about how black physical activity, calorie consumption, and life expectancy varied during and after slavery (Ransom and Sutch. 1977; Komlos, 1987; Bodenhorn, 1999). Throughout the late 19th and early 20th centuries, black and mulatto BMRs and calories declined while their life expectancies increased, indicating that black life expectancy increased despite diminishing calories associated with their transition to a free labor force. Second, how did black physical activity and calories vary by occupations and socioeconomic status? Physically active farmers had greater BMRs and consumed more calories per day than workers in other occupations. Third, how did black BMRs and calories vary by residence within the US? Rural Southern blacks had greater BMRs and consumed more calories per day than blacks in the Upper South, and Northeastern blacks had both the lowest BMRs and received the fewest calories per day, indicating that urban workers were physically less active and received fewer calories per day than workers in rural locations.

2. Basal Metabolic Rate and Energy Accounting

2.1 Basal Metabolic Rate and Energy Accounting

The basal metabolic rate is the daily amount of calories required by the body to maintain vital organ function while at rest, awake, and in a warm climate, and BMR is equivalent to one kilocalorie per minute or about 1,400 kilocalories per day. Average BMRs range between 1,350 and 2,000 calories per day, and BMRs are greater for lean muscle mass and low temperatures. As muscle mass declines with age, an individual's ideal BMR decreases (Williams and Woods, 2006); however, factors beyond age slow BMRs. For example, receiving too few calories during one period slows BMRs in future periods because the body comes to anticipate fewer calories and slows calorie consumption when it is deprived of them in the present (Neel, 1962; Prentice et al., 2005; Prentice et al. 2008; Speakman, 2008).

A second novel approach with the basal metabolic rate is its use in estimating calories required to maintain physical dimensions. There is a long history of deriving calories from physical measurements, and BMR and calorie equations are used in the biomedical literature to estimate calories required to maintain a given height and weight (Harris and Benedict, 1919; Mifflin et al. 1990, p. 247; Weijs et al., 2007).[1] Because males and females differ by percent muscle mass, they have different relationships with age, height, and weight.

$$BMR_{Male}=5+10\times\text{Weight (kgs)}+6.25\times\text{Height (cms)}-5\times\text{Age}$$

$$BMR_{Female}=-161+10\times\text{Weight (kgs)}+6.25\times\text{Height (cms)}-5\times\text{Age}$$

These Mifflin et al. equations predict resting energy requirements for men and women in healthy, normal to moderately overweight categories, and the normal weight range assumption is important because the majority of 19th century black males were in normal weight ranges (Mifflin et al. 1990, p. 247; Carson, 2009a and 2012a). Since calories are estimated from height and weight, some degree of error is expected (Weijs et al, 2007, pp. 153-156); nonetheless, Mifflin et al. equations provide reasonable approximations for BMRs (Frankenfield et al. 2005;

---

[1]Mifflin et al. 1990, p. 246. Calorie equations from height and weight were first proposed in 1919 with the Harris-Benedict equations. Harris-Benedict equations for males are BMR_{Males}=66.5+13.75weight(kg)+5.003height(cms)-6.775Age. Harris-Benedict equations for women are $BMR_{Females}$=655.1+9.563weight(kg)+1.85height(cms)-4.676Age.

Floud, et al., 2011, p. 314).[2] There is a positive relationship between physical activity, fat-free mass, and metabolic rates (Poehlman et al., 1988; Poehlman et al., 1989; Byrne and Wilmore, 2001; Speakman and Selman, 2003; Koshimishu, et al., 2012), and BMRs increase with age through the early 20s and decrease at older ages. Approximations for average daily calorie requirements are then calculated by multiplying BMRs by a reasonable activity ratio.[3]

Because modern activity levels are lower than historical levels, modern activity levels are inappropriate to estimate historical calories. The majority of 19th century US workers were in agricultural occupations (Rosenbloom, 2000, p. 88; Federico, 2013, pp. 157-158), and farmers were more physically active than workers in other occupations. To estimate 19th century calories per day, each individual's imputed basal metabolic rate is calculated and sorted by occupations. These imputed occupation values are standardized by dividing each occupation average by the imputed average farmer BMR values. Relative to imputed farmer's BMRs, the white-collar worker imputed BMR value is .9713; average skilled worker imputed values are .9750; average unskilled imputed values are .9900; workers with no occupations are .9885 of imputed farmer values. To calculate calories, these farmer weighted imputed ratios are then multiplied by farmers' extra physical active BMRs of 1.90.[4]

---

[2] For example, Floud et al. (2011, p. 314) estimate that 19th century calories per day were 2,974. Mifflin et al. equations are also robust across race, and to date, no studies demonstrate that significant errors exist for the Mifflin et al. equations across US ethnic groups (Frankenfield et al. 2005, p. 786).

[3] Resting survival calories are about 127 percent of BMRs (Floud et al., 2011, p. 43); however, because such a diet measures calories only a survival diet, it does not account for physical activity, such as work, leisure, and household production.

[4] The white collar BMR is multiplied by 1.8455; skilled worker BMRs are multiplied by 1.8525; unskilled worker BMRs are multiplied by 1.8811; workers with no occupation BMRs are multiplied by 1.8781. For sedentary

While Mifflin et al. equations represent one means to estimate historical calories, some degree of error is expected, and they are not above reproach. For example, diets have changed between the late 19th and early 20th centuries (Popkin, 1993; Comer, 2000), and calories estimated from modern equations may underestimate historic calories because of the effects of infectious disease (Floud et al., 2011, pp. 289-362). Nevertheless, despite the passage of time, differences in populations, and technological changes, Mifflin et al. equations provide practical calorie estimates for 19th century nutrition (Frankenfield et al., 2003, p. 1157).

3. Nineteenth Century US Working Class Blacks

3.1 Prison Records

The data used to study black physical activity and calories is part of a large 19th century prison sample. All state prison repositories were contacted and available records were acquired and entered into a master data set. These prison records include Arizona, California, Colorado, Idaho, Kansas, Kentucky, Missouri, New Mexico, Ohio, Oregon, Pennsylvania, Texas, and

---

individuals, calories are attained by multiplying BMR by 1.200; for lightly active individuals, BMR is multiplied by 1.375; for moderately active individuals, BMR is multiplied by 1.550; for very active individuals, BMR is multiplied by 1.725; for extra active individuals, BMR is multiplied by 1.900 (Mifflin et al. 1993). Together, BMI, BMR, and energy accounting provide new insights into 19th century biological conditions, and instead of relying on only height and BMIs—two measures that provide little information about the physical activity required to maintain physical dimensions—BMRs provide reliable approximations for physical activity levels, and energy accounting provides the calories necessary to maintain health. Recent evidence also suggests it is difficult to judge the adequacy of historical diets using modern standards because infectious diseases are significant and may underestimate nutrients consumed by 10 percent (Floud et al. 2011, p. 162).

Table 1, Nineteenth Century US Blacks and Mulattos

	Black		*Mulatto*	
	N	Percent	N	Percent
Arizona	158	84.44	36	18.56
Colorado	408	84.47	75	15.53
Idaho	31	86.11	5	13.89
Kentucky	5,084	82.44	1,083	17.56
Missouri	2,530	58.95	1,762	41.05
New Mexico	344	100.00	0	0.00
Oregon	41	91.11	4	8.89
Pennsylvania	2,002	74.56	683	25.44
Philadelphia	4,495	82.01	986	17.99
Tennessee	17,758	84.80	3,182	15.20
Texas	21,631	79.66	5,523	20.34
Total	54,482	100.00	13,339	100.00

Source: Arizona State Library, Archives and Public Records, 1700 W. Washington, Phoenix, AZ 85007; 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; New Mexico State Records and Archives, 1205 Camino Carlos Rey, Santa Fe, NM 87507; Tennessee State Library and Archives, 403 7th Avenue North, Nashville, TN 37243 and Texas State Library and Archives Commission, 1201 Brazos St., Austin TX 78701.

Washington (Table 1). Most blacks in the sample were imprisoned in the Deep South or Border States—Kentucky, Missouri, and Texas. Because the purpose here is to consider black male activity levels, calories, and life expectancy, females, whites, and immigrants are excluded from the analysis.

All historical data have various biases, and prison and military records are the most common sources for historical anthropometric data. One common shortfall of military samples is a truncation bias imposed by minimum stature requirements, and BMRs and calories may have been related with this truncation bias (Sokoloff and Vilaflor, 1982, p. 457, Figure 1; A'Hearn, 2004).[5] For example, BMRs and calories are greater for taller individuals, and truncating shorter statures may upwardly bias military BMRs and calories. Fortunately, prison records do not directly suffer from such a constraint. However, prison records are not above scrutiny because prisons may have selected many of the materially poorest individuals who were drawn from lower socioeconomic groups, that segment of society most vulnerable to economic change (Bogin, 1991, p. 288; Komlos and Baten, 2004, p. 199; Nicholas and Steckel, 1991, p. 944; Carson, 2009a). However, if at the margins of subsistence, socioeconomic and demographic factors were more significant in BMR and calorie allocations, prison records may illustrate these effects more clearly.

There also is concern over entry requirements, and physical descriptions were recorded by prison enumerators at the time of incarceration as a means of identification, therefore, reflect pre-incarceration conditions. Between 1840 and 1920, prison officials routinely recorded the dates inmates were received, age, complexion, nativity, stature, and pre-incarceration occupation, and all records with complete age, height, weight, occupation, and nativity are used in this study. There was care recording inmate height and weight because accurate measurement had legal implications in identification if inmates escaped and were later recaptured. Arrests and prosecutions across states may have resulted in various selection biases that may limit external comparisons. However, stature and BMI variations within US prisons are consistent with

[5] Arbitrarily truncating shorter individuals may underestimate BMIs, because taller statures are associated with lower average BMIs (Carson, 2009b). Therefore, the prison data give a more consistent depiction of a non-truncated BMI distribution.

existing studies (Steckel, 1979; Margo and Steckel, 1982; Nicholas and Steckel, 1991, pp. 941-943; Komlos, 1992; Komlos and Coclanis, 1997; Bodenhorn, 1999).

Fortunately, inmate enumerators were thorough when recording inmate complexion and occupation. For example, enumerators recorded black complexions as black, negro, and different shades of mulatto. Enumerators recorded a broad continuum of occupations, which are classified here into four categories: merchants and high skilled workers are classified as white-collar workers; light manufacturing, craft workers, and carpenters are classified as skilled workers; workers in the agricultural sector are classified as farmers; laborers and miners are classified as unskilled workers (Tanner, 1977, p. 346; Ladurie, 1979; Margo and Steckel, 1992; p. 520). Unfortunately, prison enumerators did not distinguish between farm and common laborers. Since common laborers probably encountered less favorable biological conditions during childhood and adolescence, this probably overestimates the biological benefits of being a common laborer and underestimates the advantages of being a farm laborer (Carson, 2013).

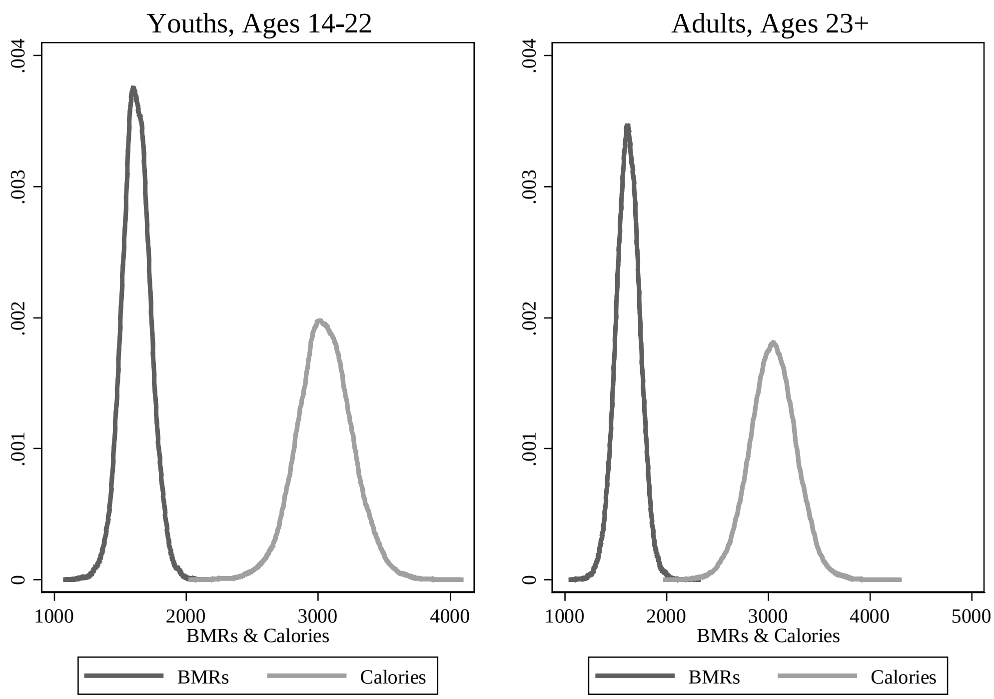
Table 2, Nineteenth Century Black and Mulatto BMIs by Demographics, Residence, and Occupation

	Black				*Mulatto*			
Ages	N	%	BMI	Centimeters	N	%	BMI	Centimeters
Teens	11,459	21.03	22.66	167.43	2,585	19.38	22.33	168.48
20s	28,851	52.96	23.89	170.69	7,277	54.55	23.33	171.13
30s	8,757	16.07	24.15	170.86	2,317	17.37	23.62	171.25
40s	3,444	6.32	24.30	170.23	772	5.79	23.91	170.99
50s	1,400	2.57	24.41	169.42	278	2.08	23.91	171.20
60s	457	.84	24.28	169.47	100	.75	23.59	169.19
70s	114	.21	23.45	168.16	10	.07	24.83	167.26
Residence								
Arizona	158	.29	23.33	171.23	36	.27	23.38	173.27
Colorado	408	.75	24.13	170.62	75	.56	23.81	170.15
Idaho	31	.06	23.81	170.28	5	.04	24.40	170.24
Kentucky	5,084	9.33	23.48	169.06	1,083	8.12	22.64	170.42
Missouri	2,530	4.64	23.18	169.22	1,762	13.21	22.72	169.79
New Mexico	344	.63	23.82	171.57	0	0		
Oregon	41	.08	24.49	169.41	4	.03	26.23	167.40
Pennsylvania	2,002	3.67	23.67	168.34	683	5.12	23.41	168.76
Philadelphia	4,495	8.25	23.53	168.10	986	7.39	23.11	168.68
Tennessee	17,758	32.59	23.88	168.93	3,182	23.85	23.57	169.78
Texas	21,631	39.70	23.73	171.58	5,523	41.40	23.32	171.95
Received								
1840s	17	.03	23.93	174.63	3	.02	24.23	182.46
1850s	36	.07	23.96	171.08	19	.14	24.25	171.02
1860s	952	1.75	23.94	168.52	28	.21	23.90	170.88
1870s	6,777	12.44	24.00	169.91	838	6.28	23.31	171.02
1880s	10,372	19.04	23.64	170.75	2,136	16.01	23.41	171.31
1890s	11,843	21.74	23.74	169.91	2,442	18.31	23.42	170.45
1900s	12,534	23.01	23.67	169.38	3,785	28.38	23.23	170.24
1910s	11,205	20.57	23.62	170.04	3,885	29.13	23.00	170.25
1920s	746	1.37	23.67	169.94	203	1.52	23.45	169.42
Occupations								
White-Collar	1,141	2.09	23.67	169.52	606	4.54	23.12	169.99
Skilled	3,736	6.86	23.81	169.90	1,411	10.58	23.28	170.61
Farmer	5,207	9.56	23.85	171.41	1,204	9.03	23.55	172.11
Unskilled	30,700	56.35	23.66	170.31	7,851	58.86	23.17	170.71
No Occupation	13,698	25.14	23.77	168.24	2,267	17.00	23.33	169.65
			23.71	169.95			23.24	170.61

Source: See Table 1.

Table 2 presents black inmates' age, birth decade, occupations, and nativity statistics. Incarceration was most common among the young; 74 percent of blacks were in their teens and 20s (Table 2; Hirschi and Gottfredson, 1983). Blacks were primarily from the South; only a few were from the West, and most were observed between 1880 and 1910. Reflecting 19th century US prejudice and the lack of institutions necessary for skill acquisition, most blacks in the sample were unskilled or without listed occupations.

Figure 1, Nineteenth Century Black Basal Metabolic Rates and Calories by Age



Source: See Table 1.

How BMRs and calories are distributed provides insight into a population's physical activity and nutrition, and Mifflin et al. equations offer a flexible means to assess how BMRs and calories are distributed. Figure 1 presents BMR and calorie kernel density estimates and demonstrates that black BMR and calorie distributions were symmetric; neither too few nor too many calories were available.[6] Average black youth and adult BMRs were 1,620 and 1,619 calories per day, respectively. Average black youth and adult calories were 3,049 and 3,043 calories per day. These values compare to 3,270 per day for late 19th century Alabama males (Higgs, 1977, p. 106).[7] Fogel and Engerman (1974, pp. 112-113) estimate that black male diets under slavery were 4,185 calories per day,[8] which exceeded that of free men in 1879 by more than 10 percent. Sutch (1976, p. 262) finds that slaves calorie rations were about 3,169 per day. During a period of increased modern obesity, these 19th century diets contrast with modern US calories of 3,654 per day (Rosen, 1999, p. 14; Putnam, 2000; Shapouri and Rosen, 2007; Floud et al., 2011, p. 314). Average sub-Sahara African daily calories are only 2,176 calories per day, indicating that 19th century black calories were greater than their modern African counterparts but less than calories available for modern Americans of African descent.

4. Demographics, Socioeconomics Status, Geography, and Black Calories

4.1 Quantile Regression

Across their BMR and calorie distributions, African-Americans experienced different relationships between birth periods, demographics, occupations, and residential status. To better

---

[6] BMR and calorie distributions are less skewed than income and health distributions because the tails of the BMR and calorie distributions are restricted to threshold environments for survival in the left tail and limited capacity to use energy in the right (Floud et al., 2011, p. 50).

[7] These 19th century male equivalents also received 62 grams of protein per day.

[8] Sutch (1976, p. 261) indicates Fogel and Engerman's estimates are overstated. His calorie correction for Fogel and Engerman is 3,488 per day.

understand the interaction between physical activity and calories with socioeconomic and demographic characteristics, a quantile regression function is constructed. Let y_i represent BMR_i and $Calorie_i$ values for the ith individual and x_i the vector of covariates representing birth cohort, socioeconomic status, and demographic characteristics. The conditional quantile function is

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

which are quantile models for BMR and calories at the pth quantile, given x_i.[9] The interpretation of the coefficient θ_i is the relationship between the ith covariate on the BMR and calorie distributions at the pth quantile. For example, the unskilled coefficient at the median (50th quantile) is the BMR difference that keeps an average unskilled workers' BMR at the median relative to workers with no listed occupations. When estimating BMR and calorie regressions, quantile estimation offers several advantages over other estimation techniques. Two advantages in anthropometric research are more robust estimation in the face of an unknown truncation point and greater description of covariate effects across the BMR and calorie distributions.

We now test how demographics, observation period, occupations, and residence were related with late 19th and early 20th century African-American BMRs and calories per day. To start, BMRs and calories for the ith individual are assumed to be related with complexion, age, observation period, residence, and socioeconomic status.

$$BMR_i^p = \alpha^p + \beta_M^p Mulatto_i + \sum_{a=1}^{15} \beta_a^p Age_i + \sum_{t=1}^{10} \beta_t^p Decade\,\mathrm{Re}\,ceived_i + \sum_{r=1}^{10} \beta_r^p\ \mathrm{Re}\,sidence_i$$
$$+ \sum_{l=1}^{3} \beta_l^p Occupation_i + \varepsilon_i^p$$

and

[9] The coefficient vector θ is obtained using techniques presented in Koenker and Bassett (1982) and Hendricks and Koenker (1992).

$$Calorie_i^p = \alpha^p + \beta_M^p Mulatto_i + \sum_{a=1}^{15} \beta_a^p Age_i + \sum_{t=1}^{10} \beta_t^p Decade\,\mathrm{Re}\,ceived_i + \sum_{r=1}^{10} \beta_r^p\,\mathrm{Re}\,sidence_i + \sum_{l=1}^{3} \beta_l^p Occupation_i + \varepsilon_i^p$$

A complexion dummy variable is included for mulatto skin pigmentation (Steckel, 1979; Komlos, 1992, p. 312; Bodenhorn, 1999; Carson, 2008). Age dummy variables are included for youth ages 14 through 22; adult age dummies are included in ten year intervals from the 30s through the 70s. Decade received dummy variables are in ten year intervals from 1840 through 1920. Residence dummy variables are included for Arizona, Colorado, Idaho, Kentucky, Missouri, New Mexico, Oregon, Pennsylvania, Philadelphia, and Tennessee. Occupation dummy variables are for white-collar, skilled, farmers, and unskilled occupations.

Table 3 and 4's model 1 present least squares estimates for the black and mulatto pooled sample; models 2 through 5 demonstrate how BMRs and calories varied across distributions with demographic, occupation, birth period, and nativity. Models 6 and 7 present black and mulatto least squares regressions used in the BMR and calorie decompositions presented in the next section.

Table 3, Nineteenth Century Black Basal Metabolic Rates

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*
	25th	*50th*	*75th*	*90th*	*95th*	*Black*	*Mulatto*
Intercept	1579.48***	1647.80***	1719.29***	1786.36***	1827.15***	1652.60***	1646.11***
Race							
Black	Reference	Reference	Reference	Reference	Reference		
Mulatto	-2.12	-2.28*	-2.74	-.088	-.418		
Ages							
14	-186.28***	-173.67***	-182.87***	-176.33***	-174.37***	-184.76***	-170.54***
15	-119.48***	-130.02***	-135.11***	-154.52***	-164.06***	-136.84***	-122.19***
16	-77.42***	-84.98***	-95.63***	-98.85***	-110.42***	-88.29***	-83.56***
17	-38.60***	-45.51***	-59.02***	-63.53***	-68.85***	-50.67***	-41.75***
18	-20.36***	-27.27***	-37.05***	-42.11***	-47.20***	-31.73***	-18.85***
19	.155	-8.28***	-15.76***	-24.84***	-28.01***	-12.31***	-1.76
20	8.20***	5.99**	-3.23	-8.45***	-11.46***	.265	13.09***
21	10.00***	9.19***	3.07*	2.28	1.04	8.50***	4.76
22	12.79***	9.85***	5.47*	.420	-6.68*	7.26***	11.15***
23-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30s	-37.58***	-33.45***	-32.14***	-29.16***	-29.37***	-34.71***	-30.78***
40s	-95.72***	-91.01***	-85.51***	-81.94***	-77.28***	-92.21***	-76.82***
50s	-153.04***	-144.32***	-138.54***	-140.47***	-135.06***	-149.56***	-124.87***
60s	-214.53***	-213.88***	-209.20***	-206.23***	-195.38***	-207.64***	-215.83***
70s	-287.74***	-307.21***	-292.55***	-307.52***	-268.23***	-304.20***	-251.34***
Observation Period							
1840s	141.54***	126.74***	97.37***	71.08	91.92**	100.63***	222.58***
1850s	48.19***	39.77*	44.98**	17.43	-9.18	41.66***	42.61
1860s	12.68***	16.29***	25.82***	20.01***	15.50	17.61***	46.17**
1870s	16.85***	19.53***	20.80***	21.97***	26.23***	19.06***	19.06***
1880s	12.73***	12.89***	9.92***	9.64***	8.72***	11.67***	11.43***
1890s	7.06***	4.79***	3.30**	4.13**	2.08	6.07***	4.46
1900s	Reference	Reference	Reference	Reference	Reference	Reference	Reference
1910s	-3.76**	-2.90	-2.76**	1.96	3.81	-2.37	-7.27***
1920s	-6.73	-5.74	.073	1.02	.681	-1.25	-16.9**
Residence							
Arizona	-7.73	-1.49	3.96	-17.62*	-30.17*	-16.65*	25.88
Colorado	-7.48	-4.13	-13.92	-24.44**	-11.18	-7.19	-10.99
Idaho	-10.32	-6.58	-31.61*	-22.43	-13.42	-17.70	23.58
Kentucky	-42.11***	-41.07***	-40.96***	-38.29***	-37.46***	-24.46***	-39.28***
Missouri	-52.83***	-51.00***	-47.25***	-52.22***	-53.55***	-49.73***	-46.98***
New Mexico	-2.42	-4.24	-6.39	-18.08**	-14.10	-1.45	
Oregon	5.62	-16.80**	-24.87	-31.34	-27.56	-14.58	4.98
Pennsylvania	-57.53***	-51.44***	-47.91***	-43.16***	-45.85***	-54.48***	-50.65***
Philadelphia	-59.53***	-59.63***	-55.71***	-58.10***	-60.77***	-59.86***	-56.31***
Tennessee	-17.73***	-17.51***	-15.28***	-14.53***	-11.51***	-18.11***	-11.46***

Texas	Reference	Reference	Reference	Reference-	Reference	Reference	Reference
Occupations							
White-Collar	-8.25***	-12.03**	-12.10***	-15.47***	-7.96	-7.59**	-16.48***
Skilled	-5.77**	-.655	2.09	-2.28	6.40*	-1.55	-3.30
Farmer	20.93***	21.61***	24.90***	23.61***	27.26***	21.99***	25.45***
Unskilled	10.05***	9.55***	11.34***	11.29***	11.85***	10.39***	7.92**
No Occupation	Reference	Reference	Reference	Reference	Reference	Reference	Reference
N	67,821	67,821	67,821	67,821	67,821	54,482	13,339
R^2	.1150	.0922	.0776	.0691	.0609	.1870	.1614

Source: See Table 1.

Table 4, Nineteenth Century Black Calories

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*
	25th	*50th*	*75th*	*90th*	*95th*	*Black*	*Mulatto*
Intercept	2966.23***	3094.63***	3229.13***	3355.62***	3431.89***	3104.02***	3091.68***
Race							
Black	Reference	Reference	Reference	Reference	Reference		
Mulatto	-4.27	-4.40	-5.36*	-.404	-.716		
Ages							
14	-349.67***	-326.27***	-343.96***	-331.76***	-328.00***	-347.57***	-320.69***
15	-224.83***	-244.09***	-249.77***	-290.52***	-308.62***	-257.42***	-230.03***
16	-145.41***	-159.81***	-179.40***	-185.64***	-207.38***	-166.14***	-157.27***
17	-72.46***	-85.47***	-110.84***	-119.59***	-129.08***	-95.32***	-78.44***
18	-38.27***	-51.16***	-69.75***	-79.38***	-88.36***	-59.66***	-35.37***
19	.254	-15.17***	-29.40***	-47.15***	-51.98***	-23.73***	-3.30
20	15.44***	11.38***	-5.87	-15.97***	-21.42***	.523	24.61***
21	18.74***	17.34***	6.06	4.43	2.21	16.01***	9.09
22	24.22***	18.61***	10.22***	.971	-12.19*	13.65***	21.04***
23-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30s	-70.48***	-62.69***	-60.18***	-54.79***	-55.12***	-65.31***	-57.82***
40s	-179.90***	-170.76***	-160.81***	-154.37***	-145.31***	-173.48***	-144.47***
50s	-285.50***	-271.77***	-259.92***	-262.94***	-253.97***	-281.29***	-234.54***
60s	-400.39***	-401.61***	-389.54***	-387.91***	-367.39***	-390.67***	-405.21***
70s	-540.33***	-573.79***	-550.21***	-578.48***	-504.00	-572.26***	-470.57***
Observation Period							
1840s	266.25***	238.06***	182.75***	133.12	171.55*	188.93***	418.10***
1850s	89.31***	75.68*	83.96**	32.14	-16.55	78.47***	79.88
1860s	23.65***	30.77***	48.65***	37.66***	28.77*	33.07***	86.97**
1870s	31.78***	36.74***	38.96***	41.41***	49.19***	35.83***	35.88***
1880s	23.92***	24.38***	18.86***	18.01***	16.50**	21.94***	21.49***
1890s	13.40***	30.09***	6.17	7.79*	3.63	11.41***	8.38
1900s	Reference	Reference	Reference	Reference	Reference	Reference	Reference
1910s	-7.15**	-5.38**	-4.99	3.40	6.53	-4.51	-13.77***
1920s	-13.18	-10.29	.517	3.61	.292	-2.39	-31.87**
Residence							
Arizona	-14.67	-2.44	8.17	-32.83**	-56.36**	-31.41*	48.28
Colorado	-13.52	-8.06	-26.12***	-45.59**	-20.29	-13.67	-21.27
Idaho	-19.54	-12.74	-59.27	-43.18	-24.65	-33.24	44.40
Kentucky	-79.32***	-77.12***	-76.72***	-71.97***	-70.23***	-79.87***	-73.95***
Missouri	-99.07***	-95.99***	-88.41***	-97.51***	-100.14***	-93.58***	-88.32***
New Mexico	-.278	-8.28	-18.90	-35.50*	-25.86	-2.80	
Oregon	10.45	-31.78	-46.50	-59.21	-53.15	-27.83	11.58
Pennsylvania	-108.05***	-96.90***	-89.88***	-81.53***	-86.29***	-102.38***	-95..09***

Philadelphia	-111.45***	-111.97***	-104.04***	-109.04**	-114.33***	-112.62***	-105.81***
Tennessee	-33.20***	-33.00***	-28.97***	-27.73***	-22.22***	-34.21***	-21.63***
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Occupations							
White-Collar	-64.54***	-73.19***	-78.55***	-84.07***	-74.07***	-66.35***	-82.79***
Skilled	-50.53***	-42.09***	-38.97***	-48.84***	-33.45***	-44.08***	-47.24***
Farmer	73.68***	76.29***	83.99***	83.28***	90.74***	77.08***	83.68***
Unskilled	23.85***	22.89***	26.11***	25.93***	27.35***	29.13***	24.53***
No Occupation	Reference	Reference	Reference	Reference	Reference	Reference	Reference
N	67,821	67,821	67,821	67,821	67,821	54,482	13,339
R^2	.1236	.1011	.0866	.0783	.0698	.2017	.1841

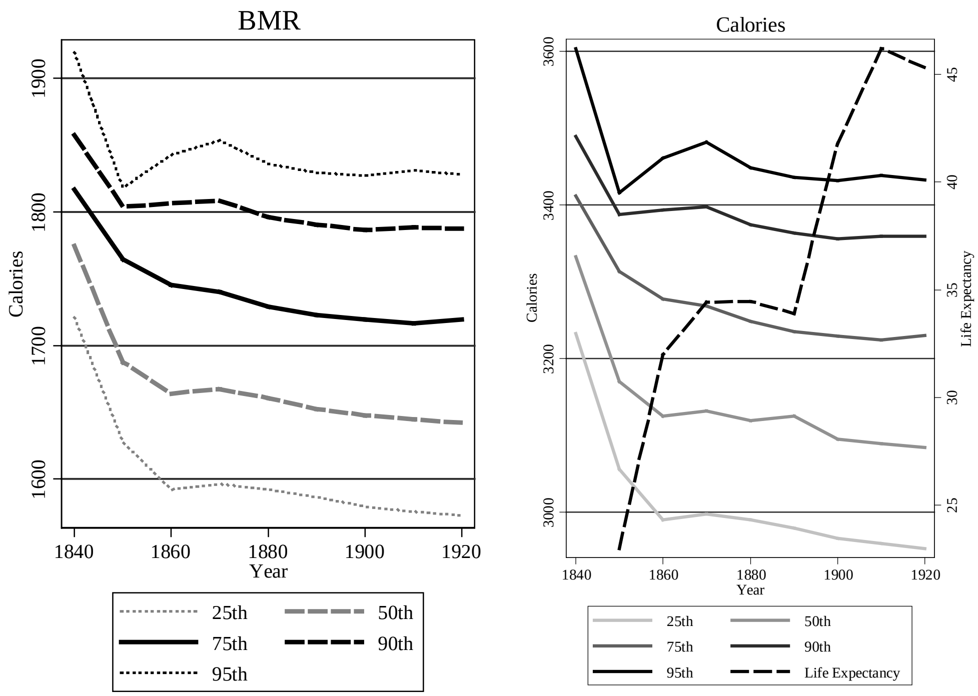
Source: See Table 1.

Three general patterns emerge when comparing black BMR and calories. First, the basal metabolic rate is a measure for physical activity and fitness. High BMRs represent greater physical activity, and with the end of slavery, Southern agriculture collapsed, and throughout the late 19th and early 20th centuries, black BMRs decreased across their respective distributions (Figure 2; Floud et al. 2011, p. 314). Much of the decline in BMR was related to slavery and emancipation. Ransom and Sutch (1997, pp. 8, 41-47) suggest that the post bellum Southern agricultural collapse is explained by blacks, having been forced into strenuous work regimes under slavery that, once freed, African-Americans chose leisure, and this is consistent with declining late 19th and early 20th century basal metabolic rates. After emancipation, blacks were better off than under slavery (Potsell, 1951), in part, because less work effort was required and they were able to forego as extensive work regimes (Ransom and Sutch, 1977, p. 12; Higgs, 1977, pp. 105-107).

With the end of slavery, black calories decreased across their distribution. Part of the calorie decline was related to diets, and Komlos (1987) demonstrates there was a general decline in late 19th century US net nutrition. Moreover, emancipation also depreciated to zero slave master's accumulated knowledge over slave feeding practices (Steckel, 1992, p. 502), and Southern food production after slavery decreased by about 50 percent (Ransom and Sutch, 1977, pp. 151-152). Slave masters also had different incentives than free blacks to change dietary mixes in response to changes in relative food prices and income changes. Furthermore, efficiency wages were related with slave nutrition, and because slave health was slave owner wealth, slave masters had incentives to maintain slave diets (Rees et al., 2003; Komlos and Coclanis, 1997, pp. 453-454; Carson, 2008).

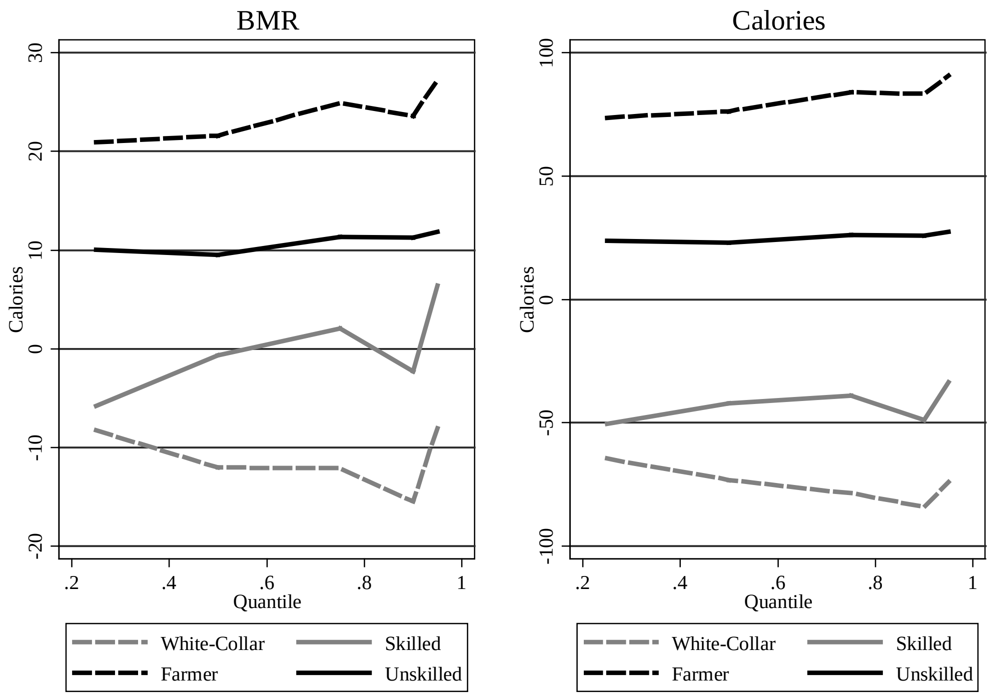
There is also a long standing debate regarding the roles between diet and disease for the increase in 19th century life expectancy (Kiple and King, 1981; Mckeown, 1976; Fogel, 1986). Three sources are ascribed to increasing modern life expectancy: better nutrition, improved public sanitation, and enhanced medical intervention (Mckeown, 1976; Fogel, 1986; Haines and Anderson, 1988; Preston, 1975, pp. 237-240; Kim, 2000, pp. 1381-1382). Between 1840 and 1920, black life expectancy increased by 97 percent, while average black calories declined by 7.5 percent, indicating that black nutrition was not the primary source of increased black life expectancy (Floud et al., 2011, p. 300; Historical Statistics, 2000; Meeker, 1976). Alternatively, large scale water treatment facilities and sanitation systems were constructed, and benefits from these projects may have disproportionately favored blacks, particularly in the American South (Troesken, 2004, pp. 1-8, and 46-50). In sum, black physical activity and net nutrition declined during the late 19th and early 20th centuries across their BMR and calorie distributions, and increasing black life expectancy was not likely due to improved nutrition (Oeppen and Vaupel, 2002).

Figure 2, Nineteenth Century Black Basal Metabolic and Calorie over Time and across Distributions



Source: Tables 3 and 4.

Figure 3, Nineteenth Century Black Basal Metabolic and Calories Marginal Effects by Occupations across Distributions



Source: Tables 3 and 4.

Second, BMRs and calories are related to occupations and socioeconomic status, and physically active farmers had higher BMRs and received greater calorie allocations per day than workers in other occupations (Figure 3). Part of black farmer's calorie requirements were because black farmers were more physically active than workers in other occupations. For example, BMIs and BMRs represent an individual's physical fitness and activity (Table 2; Poston et al., 1999; Must and Evans, 2011, p. 25). A high BMI and high BMR indicates an individual is physically active, while a high BMI and low BMR indicates an individual is less active. Farmer's and unskilled workers had greater BMRs and BMIs across their distributions, indicating that black farmers and unskilled workers, on average, were physically more active and received more calories per day than workers in other occupations (Carson, 2012b). On the other hand, white-collar and skilled black workers were physically less active and removed from rural diets. Therefore, black farmers and unskilled workers were more physically active, had higher BMRs, and consumed more calories per day than workers in other occupations (Wardlaw, Hample, and Disilvestro, 2004; Stevens et al. 2002; Poston et al. 1999; Must and Evans, 2011).

Third, BMRs and calories varied by residence, and rural Texans had both higher BMRs and consumed more calories per day than blacks elsewhere within the US (Higgs, 1977, p. 107). Compared to the North, Southern black diets had more fats, and the antebellum South had greater access to nutrition and animal proteins (Hilliard, 1972; Ransom and Sutch, 1977, pp. 11-12, 151-152). Primary staples in Southern diets were corn and fatty pork (Hilliard, 1972, pp. 62-69; Higgs, 1977, pp. 105-108; Fogel, 1994, p. 136; Bodenhorn, 1999, pp. 988-989; Comer, 2000, p. 1311). On the other hand, BMRs and calories were lower in the upper South, which was agriculturally less productive than the Deep South, and primary crops in the Upper South were corn and tobacco, and the supply of animal proteins came largely from feral pigs (Cuff, 1992, p. 57; Cochrane, 1977, pp. 72-77). Still farther north, Philadelphia blacks had both the lowest BMRs and received the fewest calories per day (Comer, 2000, p. 1311). Northeastern diets were starchy and contained fewer animal proteins than other locations (Cochrane, 1977, p. 72; Shergold, 1982, pp. 185-195), indicating that urban black workers were physically less active and received fewer calories per day than workers in rural locations. Consequently, 19th century black BMRs and calories varied by residence, and African-Americans in the Deep South had higher BMRs and received more calories because the South was agriculturally more productive, which required greater physical activity, but Southern black physical activity was compensated with more calories per day.

5. Differences in Black and Mulatto Physical Activity and Calories

To account for black and mulatto physical activity and nutritional differences, a Blinder-Oaxaca decomposition is constructed on the black and mulatto BMR and calorie differences (Oaxaca, 1973). These decompositions are used to identify statistical discrimination but are also used to distinguish between differences in dependent variables that are due to differences between returns to characteristics and differences in average characteristics. Let γ_b and γ_m equal black and mulatto BMR and calories. α_b and α_m are the autonomous BMR and calorie components that accrue to blacks and mulattos. β_b and β_m are the black and mulatto BMR and calorie returns associated with BMR and calorie enhancing characteristics, such as age and residence. X_b and X_m are black and mulatto characteristic matrices, and blacks are the base structure.

Black and mulatto BMR and calorie equations are

$$\gamma_b = \alpha_b + \beta_b X_b$$

and

$$\gamma_w = \alpha_w + \beta_w X_w$$

The differences between blacks and mulattos BMRs and calories are

$$\Delta\gamma = \gamma_b - \gamma_m = \alpha_b + \beta_b X_b - \alpha_m - \beta_m X_m$$

Subtracting and adding $\beta_m X_b$ to the right hand side of the equation and rearranging terms leads to

$$\Delta\gamma = \gamma_b - \gamma_m = (\alpha_b - \alpha_m) + (\beta_b - \beta_m) X_m + (X_b - X_m)\beta_b$$

The first right hand side element, $(\alpha_b - \alpha_m)$, is the black and mulatto physical activity and calorie differential due to non-identifiable characteristics, such as differences in diets and genetics. The second right hand side factor, $(\beta_b - \beta_m)X_m$, is the activity and calorie component associated with differences in returns to characteristics. The third right hand side expression, $(X_b - X_m)\beta_b$, is the average activity and calorie component associated with differences associated with differences in average characteristics.

Table 5, Black and Mulatto BMR and Calorie Decompositions

BMRs	$(\beta_b - \beta_m)\bar{X}_b$	$(\bar{X}_b - \bar{X}_m)\beta_m$	$(\beta_b - \beta_m)\bar{X}_m$	$(\bar{X}_b - \bar{X}_m)\beta_b$
Levels				
Total	-13.99	2.40	1.19	-12.77
Sum		-11.59		-11.59
Proportions				
Intercept	-.560		-.560	
Ages	1.71	.334	.532	1.51
Received	-.093	-.261	-.165	-.189
Residence	.273	-.241	.240	-.207
Occupations	-.118	-.040	-.150	-.009
Total	1.21	-.210	-.102	1.02
Sum		1		1
Calories				
Levels				
Total	-2.45	-14.84	4.01	-21.30
Sum		-17.29		-17.29
Proportions				
Intercept	-.714		-.714	
Ages	.768	1.70	.567	1.90
Received	-.117	-.329	-.208	-.238
Residence	.350	-.302	.307	-.259
Occupations	-.146	-.209	-.185	-.170
Total	.141	.859	-.232	1.23
Sum		1		1

Source: See Tables 2, 3, and 4.

Using coefficients from Tables 3 and 4's, Models 6 and 7, black and mulatto physical activity and calorie decompositions are presented in Table 5. Much of the difference between black and mulattos' physical activity and nutrition were due to unidentifiable sources in the intercept. The majority of observable black and mulatto physical activity differences were due to blacks having greater physical activity returns associated with age and residence. Mulattos had greater physical activity returns associated with period received and occupations. The majority of the black and mulatto calorie differences were due to blacks having greater averages associated with characteristics, and age and residence returns were an important source for the black calorie advantage. The mulatto calorie advantage was associated with period received and occupations; however, the greatest source of the mulatto net nutrition advantage was due to unidentifiable sources in the intercept but greater mulatto returns were not sufficient to offset the aggregate calorie gains that accrued to darker black workers. Therefore, darker complexioned blacks received more calories per day and differences between blacks and mulattos varied by both returns and average characteristics.

6. Conclusion

This study uses two less frequently used biological measurements—the basal metabolic rate and calorie accounting—to consider nutritional patterns on a generation's old question for late 19th and early 20th century biological living conditions, and BMR and calorie accounting offers insight into both physical activity and calories required to maintain African-American health. There is a long-standing debate for why 19th century Southern agriculture declined, and results reported here indicate that black physical activity declined with emancipation. Under slavery, slave masters had incentives to provide their slaves with adequate nutrition to maintain health. Moreover, part of the decrease may be associated with blacks, having forced into strenuous physical activity under slavery, were less physically active after emancipation, and declining BMIs and BMRs indicates that blacks physical activity declined with the transition to a free labor force (Ransom and Sutch, 1977, pp. 41-47; Sundstrum, 2013, p. 320). Between 1840 and 1920, black life expectancy increased by 97 percent, while average black calories declined by nearly eight percent, indicating that black nutrition was not the primary cause of increased black life expectancy. Development policy implications are that public sanitation facilities are of greater import than nutrition in isolation. Physically active black farmers had greater BMRs and received greater calorie allocations per day than workers in other occupations. Primary staples in Southern black diets were corn and pork (Bodenhorn, 1999, p. 989; Fogel, 1994, p. 136; Hillard, 1972), and an important source of black calories was the large proportion of calories supplied by meat and animal proteins (Bodenhorn, 1999, p. 988; Fogel 1994, pp. 132-137). However, while abundant in calories, black diets did not have the same quality as whites, and a high proportion of black calories were supplied from fatty pork (Hilliard, 1972, pp. 56-57). Blacks in the Deep South were more physically active and received more calories per day than from elsewhere within the US. Blacks in Kentucky and the Upper South had lower BMRs and received fewer calories per day than diets in the Deep South. Blacks in urban Philadelphia and the Northeast had the lowest BMRs and received the fewest calories per day than anywhere in the US, indicating that urban areas during economic development were particularly exacting on black health. Therefore, there were complex relationships between late 19th century black physical activity, nutrition, and life expectancy related with the intuitional transition to a free labor force, and black nutrition was not likely the primary factor that increased black life expectancy as much as the installation of large water treatment facilities and sanitation systems that favored African-Americans, especially in the American South.

References

A'Hearn, B., 2004. A Restricted Maximum Likelihood Estimator for Truncated Height Samples. *Economics and Human Biology* 2, 5-20.

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

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

Bogin, Barry, "Measurement of Growth Variability and Environmental Quality in Guatemalan Children," *Annals of Human Biology*, 18(4), 1991, pp. 285-294.

Bryne, Heide and Jack Wilmore (2001). "The Relationship of Mode and Intensity of Training on Resting Metabolic Rate in Women." *International Journal of Sport Nutrition and Metabolism*, 11, 1-14.

Carson, Scott Alan. (2008) "The Effect of Geography and Vitamin D on African-American Stature in the 19th Century: Evidence from Prison Records," *Journal of Economic History*, 68(3), pp. 812-830.

Carson SA (2009a) Geography, insolation, and vitamin D in 19th century US African-American and white statures. *Explorations in Economic History* 46: 149-159

Carson SA (2009b) Racial differences in body-mass indices of men imprisoned in 19th century Texas. *Economics and Human Biology* 7: 121-127

Carson. Scott Alan (2012a) "The Body Mass Index of Blacks and Whites in the United States during the 19th Century," *Journal of Interdisciplinary History*, 371-391.

Carson, Scott Alan (2012b). "A Quantile Approach to the Demographic, Residential, and

Socioeconomic Effects on 19th Century African-American Body Mass Index Values." *Cliometrica* 6, pp. 93-209.

Carson, Scott Alan. (2013). "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.

Cawley, John. 2011 "The Economics of Obesity." In: *The Oxford Handbook of The Social Science of Obesity*. John Cawley (ed.) Oxford: Oxford University Press, 120-137.

Cochrane, Willard. *The Development of American Agriculture.* Minneapolis: University of Minnesota Press, 1979.

Comer, James (2000) "North America from 1492 to the Present." In Kenneth Kiple and Kriemheld Ornelas (Eds.). *The Cambridge Word History of Food.* Cambridge: Cambridge University Press. pp. 1304-1323.

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

Cuff, Timothy (1992). "A weighty issue revisited: new evidence on commercial swine weights and pork production in mid-nineteenth century America" *Agricultural History* 66 (4), 55-74.

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

Federico, Giovanni. (2013). "The Economic History of Agriculture." In: Robert Whaples and Randall Parker (Eds.). *Routledge Handbook of Modern Economic History*. New York: Routledge Press, pp. 156-166.

Flegal, K., Carroll, M., and Ogden, C, (2010) 'Prevalence and trends in obesity among US adults, 1999-2008', *Journal of the American Medical Society,* 303: 235-241.

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 W. and Stanley Engerman, *Time on the Cross.* New York: W. W. Norton, 1974.

Fogel, Robert, Stanley Engerman, James Trussell, Roderick Floud, Clayne Pope, and Larry Wimmer, 1978, "Economics of Mortality in North America, 1650-1910: A Description of a Research Project," *Historical Methods,* 11(2), pp. 75-108.

Fogel, Robert W. "Nutrition and the Decline in Mortality since 1700: Some Preliminary Findings." In *Long-term Factors in American Economic Growth.* edited by Stanley Engerman and Robert Gallman. Chicago, IL: University of Chicago Press, 1986. 439-527.

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

Fogel, Robert W. "New Findings on Secular Trends in Nutrition and Mortality: Some Implications for Population Theory." In *Handbook of Population and Family Economics, Volume 1B.* edited by Mark Rozenwieg and Oded Stark. Amsterdam; ElSevier, 1997. 443-469.

Fogel, Robert W. and Stanley Engerman, *Time on the Cross.* New York: W. W. Norton, 1974.

Frankenfield, David C., William Rowe, Stanley Smith, and R. N. Cooney. (2003). "Validation of Several Established Equations for Resting Metabolic Rate in Obese and Nonobese People." *The Journal of the American Dietetic Association* 103 9:1152-1159.

Frankenfield, David, Roth-Yousey, Lori, and Compher, Charlene (May 2005). "Comparison of Predictive Equations for Resting Metabolic Rate in Healthy Nonobese and Obese Adults: A Systematic Review". *Journal of the American Dietetic Association* 105 (5): 775–789.

Haines, Michael and Barbara Anderson. "New Demographic History of the Late the Late 19th Century United States." *Explorations in Economic History.* 25, no. 4 (1988): 341-365.

Harris, Arthur and Francis Benedict. 1919. “A Biometric Study of Basal Metabolism in Man.” Carnegie Institution of Washington. Washington DC.

Hendricks W, Koenker R (1992) Hierarchical spline for conditional quantiles and the demand for electricity. *Journal of the American Statistical Association* 87: 58-68.

Higgs, Robert. *Competition and Coercion.* Chicago: University of Chicago Press, 1977.

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

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

Kim, John M. “Nutrition and the Decline of Mortality.” In Kenneth Kiple and Kriemheld Ornelas (Eds.). *The Cambridge Word History of Food.* Cambridge: Cambridge University Press. pp. 1381-1389.

Koenker R, Bassett G (1982) Tests of linear hypotheses and l_1 estimators. *Econometrica* 50: 1577-1584

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

Komlos, J., 1992. Toward an Anthropometric History of African-Americans: The Case of the Free Blacks in Antebellum Maryland. In: Goldin C., Rockoff, H., (Eds.)

Strategic Factors in Nineteenth Century American Economic History: A Volume to Honor Robert W. Fogel. University of Chicago Press, Chicago.

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

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

Koshimizu, Takako, Yoshiko Matsushima , Yukari Yokota, Kae Yanagisawa, Satsuki Nagai, Koji Okamura, Yutaka Komatsu, and Takashi Kawahara. (2012). “Basal Metabolic Rate and Body Composition of Elite Japanese Male Athletes.” *Journal of Medical Investigation*, 59, 253-260.

Ladurie, Le Roy E., 1979. The Conscripts of 1968: A Study of the Correlation between Geographical Mobility, Delinquency and Physical Stature and Other Aspects of the Situation of the Young Frenchman Called to Do Military Service that Year. In: Reynolds, B., Reynolds, S., (Eds.) *The Territory of the Historian.* University of Chicago Press, Chicago.

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

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

McKeown, Thomas. *The Modern Rise of Population.* New York: Academic Press. 1976.

McKeown, Thomas. "Food, Infection and Population." *Journal of Interdisciplinary History.*

(Autumn, 1983): 227-247.

McKeown, Thomas and R. G. Record. "Reasons for the Decline of Mortality in England and Wales during the Nineteenth Century." *Population Studies*, 16, no. 2 (1962): 94-122.

Meeker, Edward. (1976). "Mortality Trends of Southern Blacks, 1850-1910: Some Preliminary Findings." *Explorations in Economic History* 13, pp. 13-42.

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.

Mitka, Mike. (2013). "Do Flawed Data on Caloric Intake from NHANES Present Problems for Researchers and Policy Makers?" *Journal of the American Medical Association* 310(20). pp. 2137-2138.

Must, Aviva and Whitney Evans. 2011. "The Epidemiology of Obesity" In: Cawley, John (ed.) *The Oxford Handbook of the Social Science of Obesity*. 9-34.

Neel, James (1962) "Diabetes Mellitus: A "Thrifty" Genotype Rendered Detrimental by "Progress"? *American Journal of Human Genetics* 14, 453-362.

Nicholas, S., Steckel, R., 1991. Heights and Living Standards of English Workers During the Early Years of Industrialization. *Journal of Economic History* 51, 937-957.

Oeppen, Jim and James Vaupel, 2002. "Broken Limits to Life Expectancy." *Science* 286. pp. 1029-1031.

Oaxaca Ron L. "Male Female Wage Differentials in Urban Labor Markets." *International Economic Review* 14, 3 (October 1973): 693-709.

Poehlman, Eric, Christopher Melby, Stephen Badylak and Jorge Calles. (1989). "Aerobic Fitness and Resting Energy Expenditures in Young Adult Males." *Metabolism*, 38, pp. 85-90.

Poehlman, Eric, Christopher Melby, and Stephen Badylak. (1988). "Resting Metabolic Rate and Post Prandial Thermogenesis in Highly Trained and Untrained Males." *American Journal of Clinical Nutrition*, 47, pp. 793-798.

Popkin, Barry. (1993). "Nutritional Patterns and Trends." *Population Development Review*, 19, pp. 138-157.

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

Poston. Walker S. Carlos and John Foreyt. 1999. "Obesity in an Environmental Issue." *Atherosclerosis* 146: 201-209.

Prentice, A. M., 2005, "Starvation in Humans: Evolutionary Background and Comtemporary Implications." *Mechanisms of Aging and Development* 126(9), pp. 976-981.

Prentice, A. M., B.J. Hennig, and A.J. Fulford. 2008. "Evolutionary Origins of the Obesity Epidemic: Natural Selection of Thrifty Genes or Genetic Drift Fallowing Predation Release?" *International Journal of Obesity* 32(11), pp. 1607-1610.

Preston, Samuel (1975). "The Changing Relation between Mortality and Level of Economic Development." *Population Studies 29, 2*, pp. 231-248.

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

Ransom, Roger and Richard Sutch. (1977). *One Kind of Freedom: The Economic Consequences of Emancipation.* Cambridge: Cambridge University Press.

Rees, R., John Komlos, Ngo Long and Ulrich Woitek. "Optimal Food Allocation in a Slave Economy." *Journal of Population Economics*, v. 16, (2003): 21-36.

Rosen, Stacey 1999. "Most-But Not All-Regions See Food Gains," *Food Consumption and*

Spending, pp. 13-19.

Rosenbloom, Joshua. (2002). *Looking for Work: Searching for Workers.* Cambridge: Cambridge University Press.

Shapouri, Shahla and Stacy Rosen 2007. “Global Diet Composition: Factors Behind the Changes and Implications and the New Trends,” *Food Security and Assessment* 2007, pp. 28-37.

Shergold, Peter R. 1982. *Working Class Life: The American Standard in Comparative Perspective, 1899-1913.* Pittsburgh: University of Pittsburgh Press.

Sokoloff, K. & Villaflor, G. (1982) “Early Achievement of Modern Stature in America,” *Social Science History* 6, 453-481.

Speakman, J.R. (2008). “Thrifty Genes for Obesity, an Attractive but Flawed Idea, and an Alternative Perspective: the ‘Thrifty Gene’ Hypothesis.” *International Journal of Obesity.* 32 (11), pp. 1611-1617.

Speakman, John R. and Colin Selman (2003). “Physical activity and resting metabolic rate.” Proceedings of the Nutritional Society, 62, pp. 621-630.

Steckel, R., 1979. Slave Height Profiles from Coastwise Manifests. *Explorations in Economic History* 16, 363-380.

Steckel, R.H. (1983) ‘Height and per capita income’, *Historical Methods*, 16: 1-7.

Steckel, Richard, “ Work, Disease, and Diet in the Health and Mortality of American Slaves,” in *Without Consent or Contract: Conditions of Slave Life and the Transition to Freedom,* edited by R. W. Fogel and S. L. Engerman, New York: Norton, 1992: 508-521.

Strauss, John and Duncan Thomas (1998), “Health, Nutrition, and Economic Development.” *Journal of Economic Literature*, 36: 766-817.

Stevens, June, Jianwen Cai, Kelly Evenson, and Ratna Thomas. 2002. "Fitness and Fatness as Predictors of Mortality from All Causes and from Cariovascular Disease in Men and Women in the Lipid Research Clinics Study." *American Journal of Epidemiology*. 156: 2002.

Sundstrum, William. (2013). "African-Americans since Emancipation." In: Robert Whaples and Randall Parker (Eds.). *Routledge Handbook of Modern Economic History.* Routledge Press: New York, pp. 316-340.

Sutch, Richard. (1976). "Care and Feeding of Slaves." In Paul David, Herbert Gutman, Richard Stutch, Peter Temin, and Gavin Wright. (Eds.) *Reckoning with Slavery*. Oxford: Oxford University Press. pp. 231-301.

Tanner, J.M., 1977. Human Growth and Constitution. In: Harrison, G.A., Weiner, J.S., Tanner, J.M., Barnicot, N.A. (Eds.), *Human Biology: an Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press, Oxford.

Troesken, Werner. (2004). *Water, Race, and Disease.* MIT Press: Cambridge.

US Bureau of the Census, 1975. *Bicentennial Edition: Historical Statistics of the United States, Colonial Times to 1970.* Washington, DC. US Government Publishing Office.

Wardlaw, Gordon, Jeffrey Hampl, and Robert Disilvestro. 2004. *Perspectives in Nutrition, 6th Edition.* New York: McGraw Hill.

Weijs, Peter, Hinke M. Kruisenga, Aimee van Dijk, Barbara van der Meij, Jacqueline Langius, Dirk Knol, Robert Strack van Schijndel, Marian van Bokhorst-de van der Schueren. 2008. "Validation of Predictive Equations for Resting Energy Expenditure in Adult Outpatients and Inpatients." *Clinical Nutrition* 27, pp. 150-157.

Williams, P. T. and P. D. Wood. (2006). "The Effects of Changing Exercise Levels on Weight and Age- Related Weight." *International Journal of Obesity* 30, 3, 543-551.