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Abstract

Little is known about late 19th and early 20th century BMIs on the US Central Plains. Using data from the Nebraska state prison, this study demonstrates that the BMIs of dark complexioned blacks were greater than for fairer complexioned mulattos and whites. Although modern BMIs have increased, late 19th and early 20th century BMIs in Nebraska were in normal ranges; neither underweight nor obese individuals were common. Farmer BMIs were consistently greater than non-farmers, and farm laborer BMIs were greater than common laborers. The BMIs of individuals born in Plains states were greater than for other nativities, indicating that rural lifestyles were associated with better net current biological living conditions.

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

Keywords: 19th century Nebraska, industrialization, BMIs.

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1. Introduction

Nineteenth century US economic development coincided with agricultural change, and geographic regions that are productive agricultural regions in the 21st century are not the same as those in the 19th century. For example, the American South was among the leading 19th century US agricultural regions (Conrad and Meyer, 1971, p. 342; Ransom and Sutch, 1977; Cochrane, 1979, p. 337-343), but its advantage declined as other regions came into agricultural prominence. As the US frontier advanced westward, agricultural production followed, and by the mid-20th century, the value of agricultural production moved from Southern to Midwestern states, particularly Indiana and Illinois, and later the Dakotas, Kansas, and Nebraska. This transformation occurred as numerous immigrants streamed onto the Central Plains, and the Homestead Act changed immigrants' access to land and opportunity. Nebraska is one agriculturally productive state that developed during the late 19th century and received a considerable share of European and eastern state immigrants (Stewart, 2006, p. 549), and health and biological conditions in Nebraska were related to its economic growth.

The body mass index (BMI) is one commonly used measure that reflects health and is the net current balance between nutrition, work effort, and the physical environment.[1] Before the rise

[1] $\text{BMI} = \frac{\text{Weight in Ki log rams}}{(\text{Heightin in Meters})^2}$

of the modern obesity epidemic, BMIs increased when economic conditions improved and decreased when economic conditions deteriorated. This study, therefore, uses 19th century height and weight records from the Nebraska state prison to assess how BMIs varied on the Central Plains during agricultural development. Historical BMI studies provide important insight on the evolution of health during economic development. For BMIs less than 20, Waaler (1984) and Koch (2011) find inverse relationships between modern BMIs and mortality risk. Costa (1993) applies Waaler's results to a historical population and finds the modern BMI relationship applies historically, and Jee et al. (2006, pp. 780, 784-785) find the relationship is stable across racial groups. Costa (2004, pp. 8-10) and Carson (2009a and 2012) demonstrate there were considerable differences between 19th century African-American and white BMIs, and blacks had greater BMIs than whites. Costa also finds that BMI values increased between 1860 and 1950, and Cutler, Glaezer, and Shapiro (2003) find that US BMIs have increased since the beginning of the 20th century, not because people are less active, but because they consume more calorie dense foods. On the other hand, Lackdawalla and Phillipson (2002, p. 25) indicate that about 60 percent of increased modern obesity is due to decreased physical activity. However, because BMI variation also reflects early life conditions, interpreting BMI variation is more problematic than interpreting other biological markers (Ravelli and Stein, 1976; Thompson and Gordon-Larsen, 2011, p. 72). For example, if an individual is poorly nourished as a youth, their statures may be short, their frames may be smaller, and their basal metabolic needs will be relatively low. Improved nutrition in later life, therefore, results in greater BMI values. Alternatively, a well-nourished youth may have larger frames, their basal metabolic needs higher, resulting in lower BMIs in later life (Herbert et al., 1993, p. 1368; Costa, 2004, p. 4).

It is against this backdrop that this study considers three paths of inquiry into the early 20th century black and white BMI variation in Nebraska. First, what was the relationship between complexion and BMIs on the Central Plains? The question is important because individuals in the late 19th and early 20th centuries who had fairer complexions were taller than individuals with darker complexions (Steckel, 1979, pp. 373; Margo and Steckel, 1982, pp. 520-521 and 525; Carson, 2009b). However, African-Americans with darker complexions on the northern Central Plains had greater BMI values than whites and mulattos; therefore, there is no evidence BMIs for individuals with darker complexions were lower than for fairer complexioned whites or mulattos. Second, how did black and white BMIs vary overtime in the late 19th and early 20th centuries? Unlike Nebraska statures, black and white BMIs declined and remained constant throughout the late 19th and early 20th centuries. Third, what was the relationship between Nebraska BMIs and socioeconomic status? Reflecting better net current rural health and mild disease environments, 19th century black and white farmer BMIs were consistently greater than for workers in other occupations.

II. Nineteenth Century Nebraska

A vital part of US geography, Nebraska is comprised of three distinct prairie grasslands (Figure 1), and Nebraska is unique because it is one of the few Plains states that had each of the tall, mixed, and short grass prairies common to the region. Nebraska is also noteworthy because its precipitation varied considerably across the state. On Nebraska's eastern boarder are tall-grass prairies, which receive an average 40 inches of rain fall per year. These tall grass prairies have rich plant cover and once had grasses that reached two meters in height. To the west and in central Nebraska are mixed grass prairies, which receive 20 to 25 inches of rain fall per year and have productive farmland that support corn and wheat production and produce other grains. To

Nebraska's far west are short grass prairies, which receive less than 20 inches of rainfall per year and are dominated by short grasses used as range land for buffalo that supported various indigenous cultures and later domesticated cattle. These three Nebraska grasslands create a unique ecological environment to contrast tall-grass prairies that specialized in corn production with short grass prairies that specialized in beef production and diverse crops.

[Insert Figure 1 here]

The Missouri River borders the eastern edge of Nebraska and is the longest river in the US, draining nearly one sixth of the water from the North American continent. Originating in Montana's western Rockies, the River flows east across Montana, Wyoming, Colorado, the Dakotas, and Nebraska before draining into the Mississippi River near Saint Louis, Missouri. These states and territories relied heavily on the Missouri River and its tributaries to first support Native American cultures and vast buffalo herds before European settlement and later supported domesticated agriculture, livestock, and irrigation systems after European settlement. Its three grass prairies, varying precipitation, and proximity to the Missouri River, therefore, shaped Nebraska's economic development with low cost access to transportation and trade.

Nebraska's most distinctive late 19th and early 20th century political and economic developments were its central location within the US, military expeditions, land distributions, rise of its agricultural sector, and construction of the transcontinental railroads. Given its central location within the US, Nebraska was an important location in the early fur trade, and early French-Canadian trappers used the Missouri River as a low-cost transportation route to transport their furs to eastern states and European markets. The Missouri River was also an early means by which the US government explored its newly acquired Louisiana Purchase. Between 1804

and 1806, Thomas Jefferson sent explorers Meriwether Lewis and William Clark to navigate the Missouri River as part of their voyage to the Pacific. During this expedition, Lewis and Clark explored the Missouri River's western border with Nebraska.

The 1862 Homestead Act made Nebraska and other parts of the Midwest accessible to immigrants from the eastern US and Europe. As Nebraska's public domain was transferred from public ownership to the private sector, wealth and agricultural productivity increased (Cochrane, 1979, pp. 81-85). With increased population from Eastern states and Europe, Nebraska's agricultural sector expanded, and previously unoccupied prairies were brought into cultivation (Cochrane, 1979; Atack, Bateman and Parker, 2000, pp. 254-258). The reaper, steel plow, barbed wire, and refrigeration simultaneously came into use (Cummings, 1940, p. 36-40; Cochrane, 1979, pp. 190-199; Craig, Goodwin, and Grennes, 2004). However, this agricultural boom was short-lived, and between 1874 and 1877, large insect infestations devoured much of Nebraska's agricultural output (Cochrane, 1979, p. 93). Many jubilant settlers abandoned their Nebraska homesteads and returned east to more stable, familiar surroundings (Cochrane, 1979, pp. 85-86; Stewart, 2009, p. 238-239). Nevertheless, by the 1880s, Nebraska's agricultural sector rebounded and began a series of boom and bust cycles that lasted throughout the late 19th and early 20th centuries.

After the Civil War, Nebraska's central proximity within the US also made it a vital link in the 19th century US transportation revolution. In 1865, the Union Pacific Railroad started west from Omaha to unite with the Central Pacific Railroad that started east from Sacramento, and construction brought Irish immigrants and Confederate veterans to Nebraska by way of the transcontinental railway. To increase profits, the railroads actively recruited passengers to the

Midwest from the northern US and Europe by selling them railroad land grants from between $2 and $10 per acre (Cochrane, 1979, pp. 84-85). Therefore, Nebraska's 19th century economic development was related to early US exploration, the Missouri River, land distribution, rise of US agriculture, and the development of the transcontinental rail system, which were related with health and biological conditions on the Central Plains.

III. The 19th century Nebraska County Prison

Throughout the 19th century, there were two penal reform approaches that were prominent in the US: the New York and Pennsylvania systems. On the one hand, the New York system, maintained that prisoners were most effectively rehabilitated when they were set to hard manual labor. On the other side of the prison debate was the Pennsylvania system, which maintained that prisoner rehabilitation was most effectively accomplished with solitary confinement, when prisoners were given time to reflect on their offenses. The 19th century Nebraska prison followed the New York system, and early prison inmates were set to hard manual labor and constructed much of the Nebraska prison. After prison ward blocks were completed, Nebraska prisoners were put to work constructing other prison facilities.

The Nebraska Territory's first legislated act in 1856 was a statute to construct a state penitentiary. However, it was not until 1869 that the Nebraska state penitentiary came into operation. Between 1856 and 1869, space in surrounding state prisons was rented to house Nebraska prisoners, and the Nebraska state government paid 50 cents per day to room and board each prisoner. During this 15 year interlude, Nebraska territorial representatives lobbied the US congress to construct a state prison in Nebraska. However, with strained national resources after

the Civil War, it was not until 1869 that inmates were housed in a permanent Nebraska correctional facility.

All historical height and weight data have selection biases, and the two most common sources of historical height and weight data are military and prison records. One common problem with military records is a truncation bias imposed by minimum stature requirements, and BMIs may have been related to this stature truncation. By arbitrarily truncating shorter individuals in military records, their statures are downwardly biased because only taller individuals with lower BMIs remain in military samples (Floud et al. 2011, p. 85; Sokoloff and Vilaflor. 1982, p. 457, Figure 1; Carson, 2012). Because BMIs are inversely related with height, taller military statures are associated with low BMIs (Herbert et al., 1993, p. 1438; Cuff, 1993; Aloia, et al., 2006, pp. 1632 and 1634). Fortunately, prison records do not suffer from this truncation bias. The prison data likely selected many of the materially poorest individuals, although there are skilled and agricultural workers in the sample. While prison records are not random, the selectivity they represent have their own advantages in BMI studies, such as being drawn from lower socioeconomic groups, that segment of society most vulnerable to economic change (Bogin, 1991, p. 288).[2] Together, over 10,496 male inmates from the Nebraska prison were incarcerated between 1869 and 1944.[3] Prison guards routinely recorded the dates inmates were received, age at incarceration, complexion, nativity, height, weight, pre-incarceration

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

[3] Birth years were from 1832 through 1926.

occupation, and crimes. Because there are too few females in the sample for comparison, females are excluded from the analysis; however, female BMIs within other US prison height and weight are considered elsewhere (Carson, 2011; Carson, 2013).

Fortunately, prison enumerators were quite thorough when recording inmate complexion and occupation. For instance, enumerators recorded white inmate complexions as light, fair, dark, and sallow. The white inmate complexion classification is also supported by the complexion of European immigrants, who were of fair complexion and were also recorded as light, medium, and dark. Enumerators recorded African-American complexions as black, copper, and various shades of mulatto, from which race and ethnicity are inferred (Carson, 2009). While mulatto inmates possessed genetic traits from both black and white ancestry, throughout the 19th century, mulattos were treated as blacks, and when appropriate, are grouped here with black inmates.

Prison officials recorded a broad continuum of occupations, and defined them narrowly, recording over 100 different occupations from the developing Nebraska economy. These occupations are classified here into six categories. General day laborers are classified as unskilled workers, and ranch and farm laborers are classified as farm laborers. Farmers produced a diverse array of agricultural outputs, which may have translated into taller farmer statures. Ranchers' agricultural production was more specialized in beef production. Carpenters, cabinet makers, and various other craftsmen are classified as skilled workers. High-skilled workers and merchants are classified as white-collar workers.

[Insert Table 1 here]

Table 1 presents average BMIs for black and white males incarcerated in the 19th century Nebraska prison by birth year, occupations, and nativity. Whites were a larger proportion of the prison sample than blacks; 89 percent of the Nebraska prison population was white. Occupations reflect socio-economic status, and while prison inmates typically come from the lower working classes, there was a sizable share of inmates from white-collar and skilled occupations. White inmates were 349 percent and 45 percent more likely than blacks to occupy white-collar and skilled occupations, respectively. In agriculture, whites were 537 percent more likely than blacks to work in planting and stock raising occupations. Blacks were 77 percent more likely than whites to occupy unskilled occupations. Nativity within the prison was mostly from Plains states, which includes Nebraska.[4]

IV. Nineteenth Century Nebraska Black and White BMI Distributions

The shape of the BMI distribution tells us much about the net current biological conditions facing a population. On the one hand, late 19th and early 20th century BMIs in Plains states may have been low because of meager diets relative to work expenditures, which continued into the 19th century. On the other hand, BMIs may have increased as Plains' states settlement produced more nutritious diets relative to calories devoted for work and to fend off disease. Given similar means, if the BMI distribution is positively skewed, there are a disproportionate number of underweight individuals, and if the BMI distribution is negatively skewed, there is a disproportionate number of overweight individuals.

Using the World Health Organization (WHO) BMI classification coding system for modern standards, individuals in the Nebraska sample with BMIs greater than 30.00 are obese;

[4] Carlino and Sill (2000) regional breakdown.

BMIs between 24.99 and 29.99 are classified as overweight; BMIs between 18.50 and 24.99 are classified as normal; BMIs less than 18.50 are classified as underweight. Because BMIs are sensitive to age, two groupings are considered in Figure 2: youths and adults.

[Insert Figure 2 here]

Figure 2 illustrates that the majority of late 19th and early 20th century black and white BMIs in Nebraska fell within the normal BMI category, and neither starvation nor obesity were the historical precedent in Nebraska. Average black youth and adult BMIs were 22.23 and 22.99, respectively. Average white youth and adult BMIs were 21.62 and 22.52, respectively, indicating that average black BMIs were between two and six percentage points higher than for whites (Costa, 2004, p. 4; Flegal et al., 2010, p. 240). However, heavier 19th century black BMIs are not necessarily a sign of more robust health, because blacks were shorter than whites, and shorter statures are associated with heavier BMIs (Herbert et al., 1993, p. 1438). Moreover, it is striking that proportionally so many whites relative to blacks fell into the underweight category. Morbid obesity is a BMI>40, and is linked to greater risks of cardiovascular disease, diabetes mellitus, and certain cancer (Pi-Sunyer, 1991, p. 1599s; Kenchaiah, 2002, p. 306-312; Calle et al, 2003, pp. 1628-1630). Cases of 19th century black and white morbid obesity in the Nebraska sample were nearly non-existent. Only .18 percent of blacks and .03 percent of whites in the Nebraska prison were morbidly obese. These historical BMIs are compared to modern standards, where approximately 73.9 percent of modern adult American men are overweight, and 35.5 percentage obese (Sturm and Wells, 2001, p. 231; Calle, et al, 1999, p. 1103). Therefore, compared with a modern developed economy, blacks and whites in Nebraska were in moderate weight ranges, obesity was uncommon, and morbid obesity among the working class was nearly unheard of.

V. Black and White Demographics, Occupations, and BMIs: A Qualitative Response Model

The underweight, normal, overweight, and obese categories give a natural ranking for late 19th and early 20th century BMI classifications, and multinomial logit models are used here to illustrate how black and white BMIs were related with personal characteristics. To start, the BMI of the i^{th} individual at time t is classified as underweight, overweight, and obese relative to the normal category, where p_j is the probability of falling into the j^{th} BMI category.

$$\log\left(\frac{p_j}{p_{Normal}}\right) = \alpha + \beta_c Centimeters_i + \sum_{r=1}^{2}\beta_r Race_i + \sum_{a=1}^{15}\beta_a Age_i + \sum_{l=1}^{4}\beta_l Occupations_i + \sum_{n=1}^{22}\beta_n Nativity_i + \sum_{t=1770}^{1890}\beta_t Decade\,\mathrm{Re}ceived_i + \varepsilon_i$$

Centimeters are included to account for the inverse relationship between BMI and stature (Herbert et al., 1993; Carson, 2009; Carson, 2012). Black and mulatto complexion dummy variables account for skin complexion. Dummy variables are included for individual youth ages 16 through 22; adult age dummies are in 10 year age intervals from the 30s through 60s. Occupation dummy variables are for unskilled, farm laborers, farmers, ranchers, skilled, and white-collar workers. Nativity dummy variables are included for national and international nativities. Year received dummy variables are in ten year intervals from 1900 through 1944. Coefficients are reported in odds ratios, which represent the probability of being in a given BMI classification relative to the normal category. For example, in Table 2's Model 7, the odds ratio for 50 year olds of 1.62 indicates that 50 year olds were 62 percent more likely than the 20 year old control group to be in the overweight BMI category. Black and white least squares estimates are also presented and used in the next section's black and white BMI Oaxaca decompositions.

[Insert Table 2 here]

Three general patterns emerge when comparing 19th century black and white BMIs. First, 19th century whites were taller than mulattos and darker complexioned blacks, and the difference is typically attributed social preferences that disproportionately favored fairer complexioned mulattos (Margo and Steckel, 1982, p. 525; Steckel, 1979, p. 373). However, if mulattos received better biological treatment because of social preferences, fairer complexioned mulattos should have greater BMIs than darker complexioned blacks the farther north they were located (Carson and Hodges, 2012). Nineteenth century black BMIs in Nebraska were greater than white BMI values (Carson, 2009, p. 126; Carson, 2012, p. 382), indicating a mulatto BMI advantage did not exist on the high Central Plains. However, BMIs for darker complexioned blacks were greater after controlling for heights, and blacks also had greater BMIs, in part, because muscle is heavier than fat, and blacks are leaner and have lower percent body fat than whites (Flegal et al., 2010, p. 240; Flegal et al., 2009, p. 507; Fernandez et al., 2003; Aloia et al, 1999, p. 116; Evans et al., 2006). During the early 20th century, US black incomes probably increased, and blacks devoted a higher share of their incomes than whites to food acquisition, which may have been associated with heavier black BMIs (Higgs, 1977, p. 107; Komlos and Lauderdale, 2005).

[Insert Figure 3 here]

Second, to the degree that BMI represents net current access to calories relative to energy expended for work and to fend off disease, Nebraska BMIs during the early 1900s suggests a period of decreasing or stagnant net nutrition. Floud et al., (2011, p. 314) and Putnam (2000) demonstrate that 19th century US calories decreased between 1900 and 1950, which is similar to BMI variation in Nebraska, which was likely the result of industrialization and the separation of

food consumption from food production (Carson, 2008, p. 368; Komlos, 1987). Moreover, the likelihood that blacks and whites were overweight increased, while the likelihood of underweight blacks and whites decreased, indicating that black and white BMIs on the Central Plains decreased mildly in the early 20th century (Figure 3; Coclanis and Komlos, 1995, pp. 103 and 108). Unlike modern samples, black and white BMIs in Nebraska show little evidence of a trend toward obesity on the Central Plains, and the increase in the 20th century US obesity trend did not have its origins in the 19th century.

[Insert Figure 3 here]

Third, black and white BMIs varied by socioeconomic status, and farmer BMIs were greater than for workers in other occupations by about three percentage points, indicating that rural diets and less exposure to virulent and infectious diseases accrued to farmers, but the difference was small. Nebraska farmer BMIs may have been greater than workers in other occupations because BMI represents an individual's composition between muscle and fat. Part of farmers' heavier BMIs was related to physical activity, which is related to occupations. Physically more active occupations decreased fat and increased muscle, and for the same tissue volume, muscle is heavier than fat (Carson, 2009, p. 126). Rural farmers were also in close proximity to nutritious diets and removed from disease environments (Komlos, 1985; Komlos, 1987). White-collar and skilled workers were physically less active, were removed from food production, and had lower BMI values.

Other patterns are consistent with expectations. BMIs varied considerably by Nebraska, US, and international nativities, and BMIs on the Central Plains were greater than for individuals born elsewhere. If BMI represents the net current difference between diets, work expenditures, and disease, BMIs in industrialized cities were lower than elsewhere within the US because

urban white-collar and skilled workers are physically less active than farmers, have lower muscle content, and are removed from rural diets and nutrition (Komlos, 1985). Nineteenth century Nebraska was close to agricultural and beef producing regions, and animal proteins and amino acids are vital in maintaining muscle mass and health, especially in agricultural regions, indicating the relative price of acquiring dairy production and nutrition was low in Nebraska.

VI. Explaining the Nebraska Black-White BMI Differential

To more fully account for the source of the black-white BMI differential, a Blinder-Oaxaca BMI decomposition is calculated. A Blinder-Oaxaca decomposition is a statistical technique used to detect discrimination but is also used to explain differences between dependent variables that are due to returns to characteristics and average characteristics. Let BMI_w and BMI_b represent the BMIs of whites and blacks, respectively; α_b and α_w are the autonomous BMI components that accrue to blacks and whites; β_b and β_w are the black and white BMI returns associated with specific stature enhancing characteristics, such as age and occupation. X_b and X_w are black and white characteristic matrices, and black BMIs are assumed to be the base structure (Oaxaca, 1973, pp. 693-709).

$$\text{Black BMI function:} \quad BMI_b = \alpha_b + \beta_b X_b$$

$$\text{White BMI function:} \quad BMI_w = \alpha_w + \beta_w X_w$$

The black and white stature gap is the difference between white and black statures.

$$\Delta BMI = BMI_b - BMI_w = \alpha_b + \beta_b X_b - \alpha_w - \beta_w X_w$$

Adding and subtracting $\beta_w X_b$ to the right and side of the equation and collecting like terms leads to

$$\Delta BMI = BMI_b - BMI_w = (\alpha_b - \alpha_w) + (\beta_b - \beta_w)X_b + \beta_w(X_b - X_w)$$

The first right-hand element, $(\alpha_b - \alpha_w)$, is the portion of the BMI differential due to non-identifiable sources, such as greater bone mineral density and greater percent muscle mass that favored blacks. The second right hand-side element, $(\beta_b - \beta_w)X_b$, is that component of the BMI differential due to characteristics. The third right-hand side element, $\beta_w(X_b - X_w)$, is the part of the BMI differential due to differences in characteristics and is undetermined because whites probably had characteristics associated with greater BMI values, but blacks were shorter.

[Insert Table 3 here]

Using coefficients from the BMI regressions (Tables 1 and 2, Model 5 and 6), BMI decompositions indicate the majority of heavier black BMIs were from non-identifiable characteristics in the intercept, such as greater bone mineral density and lean muscle mass that favored blacks (Barondess et al., 1997; Wagner and Hayward, 2000). However, the majority of the BMI differential due to observable characteristics that was associated with stature, indicating 19th century net current biological conditions were related with net cumulative biological conditions. Measured in proportions, whites had greater BMI returns associated with age, occupations, and decade received. Blacks had greater BMI returns associated with nativity, and Northeastern blacks had significantly greater BMI returns than their white counterparts. Blacks had greater BMI returns associated with nativity. Therefore, at North American latitudes, the greatest share of the black-white BMI differential was due to black stature returns; however, much of the black-white BMI differential is explained by non-identifiable characteristics, such as

differences in lean muscle mass and greater bone mineral density (Barondess et al., 1997, pp. 967-971; Flegal et al., 2010, p. 240).

VII. Discussion

For 19th century blacks and whites in Nebraska, the underclass was reasonably well nourished because of access to agricultural production. Unlike modern BMIs, 19th century Nebraska black and white BMIs were symmetrically distributed and widespread wasting was not common. Rather, black and white BMIs in Nebraska were in normal, healthy BMI categories; therefore, 19th century health on the Central Plains that was poor by modern standards was not related to BMIs. Unlike stature studies, there was no 19th century mulatto BMI advantage, and fairer complexioned individual BMIs were lower than for individuals with darker complexions. Farmers, who were physically active and obtained abundant calories, had greater BMI values than workers in other occupations. Nutrition relative to work expenditures was predictably good in agricultural producing states, such as Nebraska, even among the working class, as it was throughout US history because of abundant agricultural resources and access to animal proteins. Therefore, 19th century BMIs in the US were the result of a complex set of demographic and socioeconomic characteristics, and relationships between BMI and observable characteristics reflect economic development.

References

Aloia, J.F., Vaswani A., Ma R., and Flaster E. (1999) 'Comparison of body composition in black and white premenopausal women', *Journal Laboratory Clinical Medicine*, 129: 294-299.

Asao, Keiko, W. H. Linda Kao, Kesha Baptiste-Roberts, Karen Bandeen-Roche, Thomas Erlinger, and Frederick Bancati. 2006, "Short Stature and the Risk of Adiposity, Insulin Resistence, and Type 2 Diabetes in Middle Age." Diabetes Care. 29(7), 1632-1637.

Atack, Jeremy, Bateman, Fred, and William Parker (2000). "The Farm, the Farmer, and the Market" In Engerman, Stanley and Robert Gallman (eds.) *Cambridge Economic History of the United States, Vol. 2* Cambridge: Cambridge University Press, 245-284.

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.

Bodenhorn, H. 1999. A troublesome caste: height and nutrition of antebellum Virginia's rural free blacks. *Journal of Economic History* 59: 972-996.

Bogin, B. 1991. Measurement of growth variability and environmental quality in Guatemalan children. *Annals of Human Biology* 18: 285-294.

Calle, Eugenia, Carmen Rodriguez, Kimberly Walker-Thurmond, Michael Thun, "Overweight, Obesity and Mortality from Cancer in a Prospectively Studied Cohort of U.S. Adults," *New England Journal of Medicine,* 348(17), 2003, pp. 1625-1638.

Calle, Eugenia, Michael Thun, Jennifer Petrelli, Carmen Roriguez, and Clark Meath. "Body-Mass Index and Mortality in a Prospective Cohort of U.S. Adults." *New*

England Journal of Medicine 341, no. 15 (1999): 1097-1104.

Carlino, Gerald and Keith Sill (2001) "Regional Income Fluctuations: Common Trends and Common Cycles." Review of Economics and Statistics. 83: 446-456.

Carson, Scott Alan. (2012), "Nineteenth Century Race, Body Mass, and Industrialization: Evidence from American Prisons," *Journal of Interdisciplinary History*. pp. 371-391.

Carson, Scott Alan and Paul Hodges. (2012), "'Black and white body mass index values in 19th century developing Philadelphia County." *Journal of BioSocial Science*. 44(3), pp. 273-288).

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, S. A. 2009a. Racial differences in body-mass indices of men imprisoned in 19th century Texas. *Economics and Human Biology* 7: 121-127.

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

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

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

Coclanis, Peter A. and John Komlos. "Nutrition and Economic Development in Post Reconstruction South Carolina." *Social Science History,* 19 no. 1, (Spring 1995): 91-115.

Coclanis, Peter A. and John Komlos. "Nutrition and Economic Development in Post

Reconstruction South Carolina." *Social Science History,* 19 no. 1, (Spring 1995): 91-115.

Conrad, Alfred H. and John R. Meyer. *The Economics of Slavery and other Studies in Econometric History.* Chicago, IL: Aldine Publishing Company, 1964.

Costa D. 2004. The measure of man and older age mortality: evidence from the Gould sample. *Journal of Economic History* 64: 1-23.

Costa, D. 1993. Height, wealth and disease among native-born in the rural, antebellum north," *Social Science History* 17: 355-383.

Craig, Lee, Barry Goodwin, and Thomas Grennes. 2004. "The Effect of Mechanical Refrigeration on Nutrition in the U.S." *Social Science History* 24(2), pp. 325-336.

Cuff, T. 1993. The body mass index values of mid-nineteenth century west point cadets: A theoretical application of Waaler's curves to a historical population. *Historical Methods* 26: 171-182.

Cummings, Richard O. 1940. *The American and His Food: A History of Food Habits in the United States.* University of Chicago: Chicago.

Cutler, D. M., E. L. Glaeser, and J. Shapiro. 2003. Why have Americans become more obese? *Journal of Economic Perspectives* 17: 93-118.

Evans, E. M., D. A. Rowe, S. C. Racette, K. M. Ross, and E. Mcauley. 2006. Is the current BMI obesity classification appropriate for black and white post-Menopausal women? *International Journal of Obesity* 30: 837-843.

Fernandez, Jose, Moonseong Heo, Steven Heymsfield, Richard Pierson, Xavier Pi-

Sunyer, Zimian Wang, Jack Wang, Matthew Hayes, David Allison, Dympna Gallagher. (2003), "Body Compositin and Dual Energy X-ray Absoptiometry in Black Compared to White Women." *American Journal of Clinical Nutrition* 10: 114-119.

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

Flegal, K., Shepherd, J., Looker, A., Graubard, B., Borrud, L., Ogden, C., Harris, T., Evenhart, J., and Schenker, N. (2009) 'Comparisons of percentage body fat, body mass index, waist circumference, and waist-stature in adults', *American Journal of Clinical Nutrition*, 89: 500-08.

Floud, Roderick, Robert Fogel, Bernard, and Sok Chil Hong. 2011. *The Changing Body: Health, Nutrition, and Human Development World since 1700.* Cambridge University Press: Cambridge.

Haines, Michael. 2004. "Growing Incomes, Shrinking People—Can Economic Development Be Hazardous to your Health." *Social Science History.* 28(2). pp. 249-270.

Haines, Michael, Lee Craig and Thomas Weiss. "The Short and the Dead: Nutrition, Mortality and the "Antebellum Puzzle in the United States," *Journal of Economic History* 63, no. 2, (June 2003): 382-413.

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

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

Jee, H. J., J. W. Sull, J. Park, S. Y. Lee, G. Eliseo and J. Samet. 2006. Body-mass index and

mortality in Korean men and women. *New England Journal of Medicine,* 355: 779-787.

Kenchaiah, Satish, Jane Evans, Daniel Levy, Peter Wilson, Emelia Benjamin, Martin Larson, William Kannel and Ramachandran Vasan, "Obesity and the Risk of Heart Failure," *New England Journal of Medicine,* 347 (5), 2002, pp. 305-313.

Koch, D. 2011. Waaler revisited: the anthropometrics of mortality. *Economics and Human Biology* 9: 106-17.

Komlos, John (1985) "Stature and nutrition in the Hapsburg Monarchy: The standard of living and economic development in the 18th century." American Historical Review 90: 1149-1161.

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., Lauderdale, B.E., 2005, Underperformance in Affluence: The Remarkable Relative Decline in the U.S. Heights in the Second Half of the 20th Century. Social Science Quarterly 2, 283-305.

Lakdawalla, D. and T. Philipson. 2002. The growth of obesity and technological change: a theoretical and empirical examination. NBER Working Paper 8946.

Margo, Robert and Richard Steckel. "Heights of American Slaves: New Evidence on Nutrition and Health." *Social Science History* 6, no. 4 (Fall, 1982): 516-538.

Metzer, Jacob. M. "Rational Management, Modern Business Practices and Economies of Scale in Antebellum Southern Plantations." *Explorations in Economic History* 12, n. 2 (April, 1975): 123-150.

Oaxaca Ron L. (1973) "Male female wage differentials in urban labor markets." International Economic Review 14: 693-709.

Pi-Sunyer, F. Xavier, "Health Implications of Obesity," *American Journal of Clinical Nutrition*, 53, 1991, 1595s-1603s.

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

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

Ravelli G.P., Z. A. Stein , and M. W. Susser. 1976. Obesity in young men after famine exposure in utero and early infancy. *New England Journal of Medicine* 295: 349-53.

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

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

Stewart, James I. (2009), "Economic Opportunity or Hardship? The Causes of Geographic Mobility on the Agricultural Frontier, 1860–1880" *Journal of Economic History* 69, pp. 238-268.

Stewart, James I. "Migration to the Agricultural Frontier and Wealth Accumulation, 1860-1870," *Explorations in Economic History* 43, (2006): 547-577.

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

Sturm, R and KB Wells, "Does Obesity Contribute as much to Morbidity as Poverty or Smoking?" *Public Health*, 115, 2001, pp. 229-236.

Thompson, Amanda L. and Penny Gordon-Larsen. 2011. "The Anthropology of Obesity." in

Cawley, John (Ed.) *The Oxford Handbook of the Social Science of Obesity.* Oxford University Press: Oxford, pp. 60-86.

Waaler, H. T. 1984. Height, weight and mortality: the Norwegian experience. *Acta Medica Scandinavia* 679: 1-51.

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.

Table 1, Nineteenth Century Black and White Nebraska Prison

	Blacks				*Whites*			
Ages	N	%	Mean	S.D.	N	%	Mean	S.D.
Teens	79	7.05	21.73	2.01	584	6.23	21.33	2.08
20s	526	46.96	22.74	2.23	4,110	43.84	22.08	2.27
30s	325	29.02	22.99	2.73	2,642	28.18	22.47	2.66
40s	136	12.14	23.30	3.35	1,309	13.96	23.16	3.39
50s	40	3.57	23.95	3.56	522	5.57	23.24	3.19
60s	14	1.25	24.50	3.07	209	2.23	23.33	2.96
Decade Received								
1900s	206	18.39	23.16	2.49	1,207	12.87	22.60	2.61
1910s	240	21.43	22.71	2.39	1,788	19.07	22.09	2.49
1920s	299	26.70	22.80	2.58	2,127	22.69	22.36	2.58
1930s	302	26.96	22.84	2.61	3,283	35.01	22.54	2.89
1940s	73	6.52	23.11	3.72	971	10.39	22.20	2.72
Occupations								
White-Collar	20	1.79	22.33	2.64	754	8.04	22.70	3.17
Skilled	180	16.07	22.73	2.19	2,181	23.26	22.20	2.57
Farmer	39	3.48	23.09	2.85	2,078	22.16	22.71	2.75
Rancher					113	1.21	22.64	22.80
Unskilled	378	78.39	22.91	2.69	4,164	44.41	22.25	2.62
Farm Laborer	3	.27	22.92	3.04	86	.92	22.55	2.76
Nativity								
Northeast	12	1.07	25.28	5.45	112	1.19	22.64	3.01
Middle Atlantic	31	2.77	23.30	2.58	555	5.92	22.30	2.64
Great Lakes	94	8.39	23.15	2.66	1,277	13.62	22.39	2.89
Plains	423	37.77	22.86	2.45	5,298	56.51	22.43	2.69
Southeast	267	23.84	22.91	2.91	442	4.71	22.11	2.63
Southwest	220	19.64	22.61	2.15	385	4.11	22.01	2.47
Far West	28	2.50	22.75	2.55	349	3.72	21.79	2.18
Britain					114	1.22	22.60	2.78
Canada					86	.92	22.31	2.90
Europe					524	5.59	22.96	2.96
Other Native	45	4.02	22.73	2.95	234	2.50	22.10	2.64

Source: See Table 1.

Table 2, Nineteenth Century Black and White Nebraska OLS and Multinomial Regression Models

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 6*	*Model 7*
	OLS	*Underweight*	*Overweight*	*Obese*	*Black*	*White*
Intercept	30.82***	5.25[5]	16.64***	58.98	31.24***	31.07***
Height						
Centimeters	-.051***	1.04***	.972***	.949***	-.048***	-.052***
Race						
Black	.610***	.569**	1.42***	1.14	Reference	
Mulatto	.538*	3.71[-7]	1.78*	2.04	-.167	
White	Reference	Reference	Reference	Reference		
Ages						
16	-1.45***	9.75***	1.31	3.28[-8]	-1.08	-1.63***
17	-1.13***	2.33*	.105**	7.49[-7]	-1.70***	-1.06***
18	-.891***	2.09**	.391***	8.72[-7]	-1.41***	-.825***
19	-.764***	2.95***	.546**	.641	-.741*	-.703***
20	-.296***	1.00	.634**	.431	-.213	-.310***
21	-.330***	1.62*	.706*	.827	-.073	-.347***
22	-.357***	2.20***	.773	.718	-.818**	-.315***
23-29	Reference	Reference	Reference	Reference	Reference	Reference
30s	.279***	1.21	1.51***	2.71***	.187	.281***
40s	.850***	1.13	2.01***	7.07***	.409	.913***
50s	.926***	1.83**	2.59***	9.76***	.996*	.914***
60s	1.10***	2.90***	1.97***	12.30***	1.54*	1.17***
70s	.381	6.81***	3.58***	9.73**	2.43***	.294
Occupation						
White-Collar	.210*	1.20	1.33**	1.62*	-.435	.271**
Skilled	-.113*	.940	.927	.528**	-.193	-.084
Farmer	.327***	.581***	1.10	1.10		
Rancher	.387	.810	1.39	1.29		
Farmers & Ranch					.435	.343***
Farm Labor	.182	.810	1.43	.716	.451	.216
Unskilled	Reference	Reference	Reference	Reference	Reference	Reference
Nativity						
Northeast	.276	.645	.898	2.03	2.46*	.033
Middle Atlantic	-.227**	.729	.687**	.723	.129	-.266**
Great Lakes	-.166**	1.13	.958	.776	.222	-.204**
Plains	Reference	Reference	Reference	Reference	Reference	Reference
Southeast	-.288***	1.36	.787*	.729	.019	-.387***
Southwest	-.355***	.702	.645***	.496	-.199	-.330**
Far West	-.421***	.926	.589***	6.07[-7]***	.318	-.474***

British	-.227	.530	.837	.653		
European	.143	.705	1.09	.611		
Canada	-.186	2.64	1.24	4.29^{-7}		
Observation Period						
1900s	.419***	.526***	1.16	.895	.131	.480***
1910s	-.056	1.04	.901	.900	-.298	.020
1920s	.115	.761	.929	.853	-.194	.155
1930s	.200**	.793	.954	1.24	-.304	.267***
1940s	Reference	Reference	Reference	Reference	Reference	Reference
N	10,496	10,496	10,496	10,496	1,120	8,652
R^2	.0637	.0504	.0504	.0504	.0652	.0609

Source: See Table 1

Notes: Residence variables within Nebraska were added to the model but are statistically insignificant. *** significant at .01; ** significant at .05; * significant at .10.

Table 3. National-Century Nebraska BMI Decomposition

Levels	$(\beta_b - \beta_w)X_b$	$(X_b - X_w)\beta_w$	$(\beta_b - \beta_w)X_w$	$(X_b - X_w)\beta_b$
Sum	.559	-.096	.490	-.027
Total		.464		.464
Proportions				
Intercept	.367		.367	
Centimeters	1.48	.216	1.50	.199
Ages	-.228	-.074	-.234	-.069
Occupations	-.057	-.175	-.124	-.108
Nativity	.464	-.200	.384	-.121
Observation Period	-.819	.028	-.831	.040
Sum	1.21	-.210	1.06	-.060
Total		1		1

Source: See Tables 1 and 2, Models 6 and 7.

Figure 1, Nineteenth Century Nebraska Regions

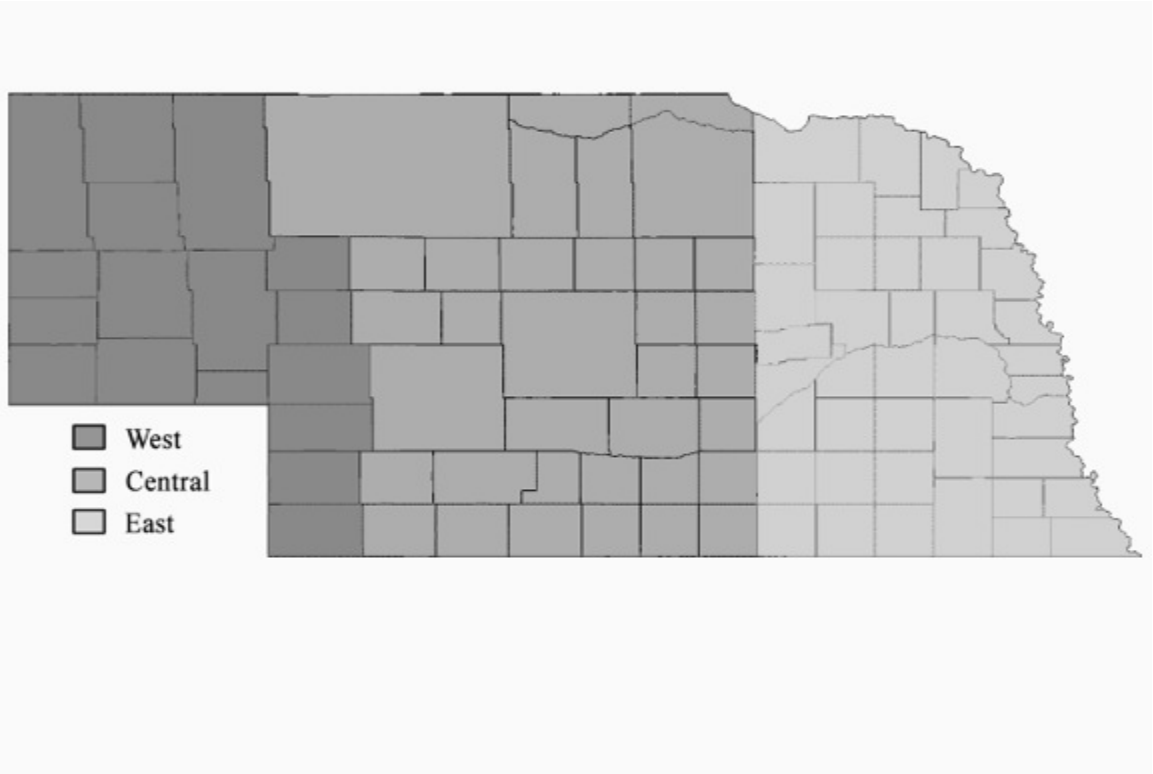

Figure 1, Nineteenth Century Nebraska Regions

Notes: Nebraska's eastern counties include Knox, Cedar, Dixon, Dakota, Antelope, Peirce, Wayne, Thurston, Madison, Stanton, Cuming, Burt, Platte, Colfax, Dodge, Washington, Nance, Merrick, Polk, Butler, Saunders, Douglas, Sarpy, Cass, Lincoln, Seward, York, Hamilton, Clay, Filmore, Saline, Boone, Lancaster, Otoe, Nemaha, Johnson, Richardson, Pawnee, Gage, Jefferson, Thayer, and Nucholls. Central counties include Boyd, Holt, Rock, Keya Paha, Brown, Cherry, Hooker, Thomas, Blaine, Loup, Garfield, Wheeler, McPherson, Logan, Custer, Valley, Greeley, Sherman, Howard, Lincoln, Dawson, Buffalo, Hall, Hayes, Frontier, Gosper, Phelps, Kearney, Adams, Hitchcock, Red Willow, Furnas, Harlan, Franklin, and Webster counties.

Western states include Sioux, Dawes, Sheridan, Box Butte, Scotts Bluff, Morrill, Garden, Banner, Kimball, Cheyenne, Deuel, Arthur, Keith, Perkins, Chase, and Dundy.

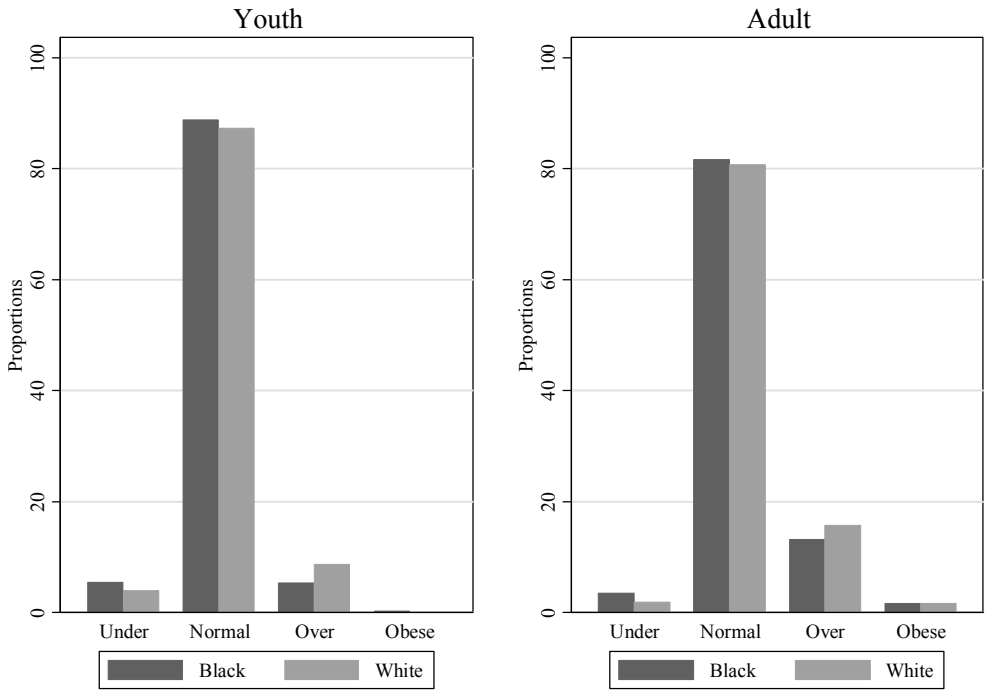

Figure 2, Nineteenth Century Nebraska Prison BMIs by Age and Ethnicity

Source: See Table 1.

Notes: Under and Over represent underweight and overweight BMI categories, respectively.

Youth ages are from 16 through 21. Adult ages are 22 and older.

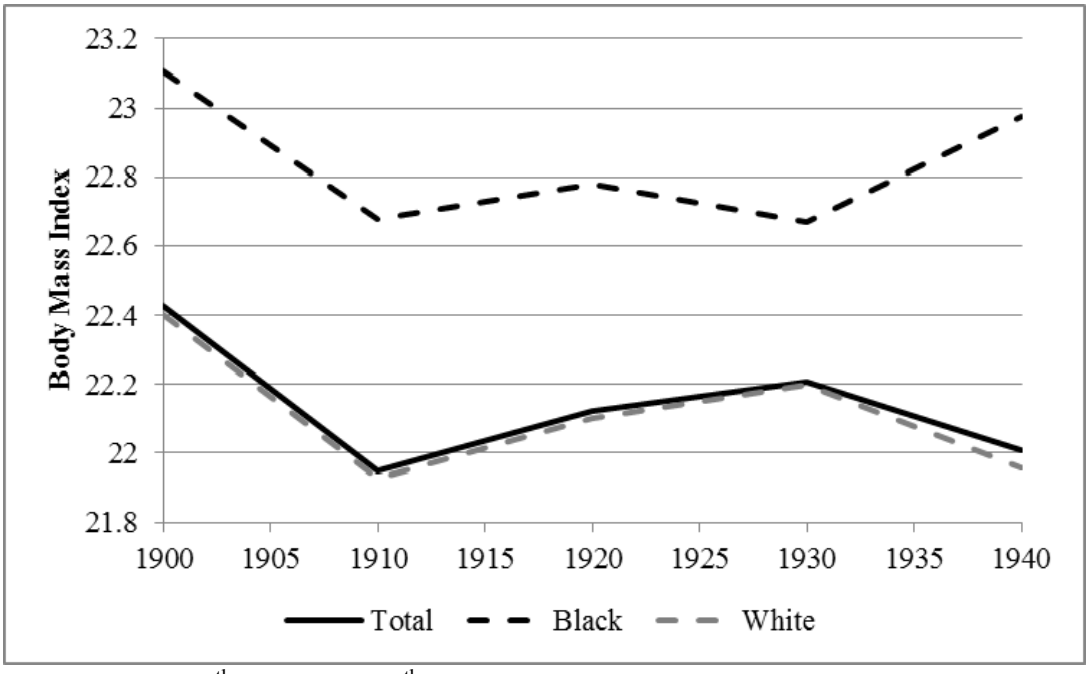

Figure 3, Late 19th and Early 20th Century Nebraska Black and White BMIs Overtime

Source: See Table 2.