Late 19th and Early 20th Century Social Feminism and Women's Suffrage: A Female-Male Net Nutrition Comparison using Differences-in-Decompositions

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Abstract: When other measures for economic welfare are scarce or unreliable, the body mass index (BMI) is a biological measure that reflects current net nutrition. This study uses a difference-in-decompositions framework to analyze how women's BMIs varied with the advent of early 20th century social feminism. Late 19th and early 20th century US economic development improved the relative status of women relative to both men before and after the transition to social feminism. Twentieth century women's BMIs were higher than 19th century women relative to men with the rise of social feminism. The primary source of female-male across-group variation was height and nativity, indicating there was net nutritional progress for women relative to men associated with changing cumulative net nutrition. The primary source of female-male within-group variation was nativity and socioeconomic status, indicating there was net nutritional progress relative to women born before the transition for women born after the rise of social feminism association with socioeconomic status.

Key words: BMI variation, Economic Transitions, Oaxaca Decompositions.
JEL Codes: C1, C4, D1, I1, and N3.

I. Introduction

The changing economic and social status of women during economic development is different from men because of biological, economic, and intuitional constraints (Burnette, 2013, pp. 307-309). Throughout the 19th and early 20th centuries, the economic and social role of women in the US changed considerably, and across the United States, women's changing biological living standards occurred at uneven rates. Nevertheless, women's roles within the household and the economy changed with economic and political change. Various factors combined to influence the material, economic, and social roles between women and men that frequently cannot be measured with standard welfare measures. In traditional economies, greater strength is required to complete manual tasks, and men have more muscle mass per unit of tissue, consequently, are stronger than women (Marques, et al, 2018, p. 151; Robb, 1994, p. 222). As a result, men historically had different labor market standing when occupations required greater physical strength. Because of child birth and rearing, travel in traditional economies is also more difficult for women, and women are less mobile and are further excluded from paid-labor market participation. Furthermore, women during the 19th century were excluded from market opportunities in developing economies because of institutional constraints, such as religion and social stigmas that foreclosed women from skilled positions. Over time, much of these biological and institutional constraints have changed with economic development, technological innovations, and labor market transitions, and women presently have greater economic and nutritional opportunities compared to their female and male historical counterparts.

Not all of the economic changes that women faced were due to technological change and labor market transitions (Burnette, 2013, pp. 309-311). Throughout history, the legal rights of women were tied to their male companions (Becker, 1981, pp. 31-39, 251). By the mid-19th century, pressure increased for women's legal and political rights to vote and have greater economic opportunity. The National American Women Suffrage Association (NAWSA) was organized in the 1890s; however, when women's suffrage was denied by the Supreme Court's 1874 *Minor vs. Happersett* decision, much of women's suffrage was refocused toward individual states. Ironically, the first state victories for women's suffrage were in Wyoming (1869) and Utah (1870), two territories along the western frontier where the relative bargaining power of women—both within society and within the household—were greater than other regions within the United States. States with larger suffrage movements and competitive political systems were another reason women secured the right to vote in the West compared to the East and South (Teele, 2018). In 1920, the United States' Constitution's 19th Amendment later codified women's right to vote, an important progression toward women's equality with the United States.

When monetary measures that reflect economic development are scarce or unreliable, various alternatives are developed to measure the relationship between individual welfare and economic development. A population's average stature reflects the cumulative net nutrition between calories consumed and calories expended for work and to withstand the physical environment (Fogel et al 1978; Fogel et al 1979). A population's average body mass index (BMI) reflects current net nutrition available between the same variables (Fogel, 1994, pp. 375-383), and the body mass index is used here to assess how women's current net nutrition varied relative to men and relative to women born before and after the rise of social feminism.

It is against this backdrop that this study uses United States' historical women and men's BMIs and difference-in-decompositions to illustrate how women's relative current net nutrition varied with the rise of social feminism and women's suffrage. Two paths of inquiry are considered. First, how did women and men's BMIs vary across and within groups with the rise of social feminism and suffrage? Women's BMIs increased relative to men and were higher after the transition. Second, what was the greatest source of BMI variation with the transition? The primary source of across-group variation was height and nativity. The greatest source of within-group variation was nativity and socioeconomic status. Subsequently, women's net nutrition improved relative to men and relative to women observed before the rise of social feminism, and nativity was an important factor explaining variation in current nutrition.

II. Women and Men's Body Mass and Health

Before modern economic measures and medical research developed, BMIs are one measure that reflect health by gender. There has been a modern increase in BMIs, and higher BMIs are associated with deleterious health outcomes. However, late 19th and early 20th century BMIs were in healthy ranges, indicating historically poor health was not related to high BMIs, and historical comparisons are less complicated than modern comparisons because BMIs were in lower, healthy ranges. Mortality risk is associated with body mass, and if historical mortality risk by gender is comparable to modern standards, mortality risk for women and men is minimized for a BMI around 25 (Costa, 1993). However, women's relative mortality risk increases and is higher than men for BMIs lower and higher than 25 (Waaler. 1984; Fogel, 1994, p. 376). There is a relationship between early life conditions and later-life outcomes, and a novel explanation is a pre-natal adaptive response to in-utero nutrition, where a child's metabolism and growth trajectory are programmed early to match conditions in later life (Barker, 1992;

Schnieder, 2017, pp. 4-7; Carson, 2016). Carson (2018) shows that women and men's BMIs stagnated throughout the late 19th and early 20th centuries (Carson, 2016), and individuals of African-descent had greater BMIs than individual of European descent (Carson, 2009; Carson, 2012; Carson 2018). Women and men from the Southwest were taller and had lower BMIs compared to their counterparts from elsewhere within the US (Carson, 2019a, pp. 32-33). Women's BMIs did not vary by socioeconomic status, while male farmer and unskilled workers' BMIs were higher than workers in other occupations (Carson, 2012; Carson, 2018).

Women are shorter than men and measuring obesity with BMIs is difficult because women are shorter, which upwardly bias their BMIs and obesity classification (Himes, 2011, p. 40). There are other disadvantages of using BMI to measure obesity and health. However, because they have less protein in muscle tissue, women's BMIs and obesity may be lower than men for the same tissue mass (McLannahan and Clifton, 2008, p. 42). There are other drawbacks of using BMIs as a measure for health. Burkhauser and Cawley (2008) demonstrate that BMIs are misleading because they do not distinguish between fat and fat-free mass. In general, BMI is less accurate among men than women at classifying obesity and when available, more accurate measures for classifying obesity should be used. However, none of the advanced BMI measuring techniques were available during the late 19th and early 20th centuries.

III. Late 19th and Early 20th Century Female and Male BMI Data

Evaluating late 19th century women and men's BMI variation is difficult because institutions that randomly collected weight and height were yet to develop. Military and prison records are two common sources that collected late 19th and early 20th century male weight and height data. All historical data reflect the purposes for which they are collected, and because the purpose of military records did not include women, prison records are the only late 19th and early

20th century sources that exist to compare women and men's BMI values. Moreover, because prison records reflect conditions among lower socioeconomic groups, prison records measure lower socioeconomic status female and male biological conditions (Sokoloff and Vilaflour, 1982; Ellis, 2004; Bereczki et al, 2018, p. 190). Given the limited number of institutions that recorded women's historical weight and height, it is unlikely that a comparable data set will emerge, making prison records a valuable source to compare women and men's historical net nutrition during economic development.

Data to evaluate BMIs is part of an extensive collection project to collate and organize the weight and height of 19th century women and men (Carson, 2011; Carson, 2013; Carson, 2018). At the time of incarceration, prison enumerators recorded weight, height, gender, complexion, observation year, nativity, occupations, age, and residence. Because weight and height measures had legal implications in case an inmate escaped and was recaptured, during this pre-photographic period, prison enumerators were careful when recording physical descriptions. Physical descriptions were also used to identify individuals within prisons. There are 4,592 women and 172,277 men used in this study, and women made up about 2.6 percent of the prison sample.

There are various measurement concerns that began early in stature and BMI studies. Among the first was whether individuals were measured with or without shoes, which may have influenced their terminal statures, therefore, BMIs. Fogel at al (1978, p. 456) address this concern by using a sample of Union Army recruits known to have been measured without shoes. These observations are then compared to an adult black recruit's sample, and there is little difference between the two samples. There are no 19th century data that exist that measures women's height without shoes, so a similar female comparison is not available. There is a parallel concern for weight that influenced weight measures because inmates may have been measured with or without clothes. Because females and males were incarcerated at the same time and because of gender social roles at the time, inmates were probably measured with clothes. Prison enumerators did not systematically record whether a women was pregnant, so no information was recorded for pregnancy status.

There is a recent challenge to the established pattern known as the antebellum paradox, the result that average statures decreased with industrialization and urbanization during the 19th century's second and third quarters (Bodenhorn et al 2017). However, vigorous rebuttal calls these criticisms into question (Komlos, 2019; Carson, 2019a, pp. 32-33). The recent criticism also does not account for shorter urban compared to rural statures, and urban statures decreased when food consumption was separated from food production (Komlos, 1987; Carson, 2008, p. 368). The 19th century's second quarter stature decrease is also observed across interdisciplinary studies. For example, Davidson et al (2002, p. 268), and Steckel and Rose (2002, p. 575) show that statures were shorter in geographic areas with higher disease rates, and the disease explanation is an important part of the antebellum paradox (Haines et al. 2003, p. 406).

Occupations are among the best measures for historical socioeconomic status, and occupation classifications used here are skilled, unskilled, and workers without listed occupations. For women, the prison records include skilled occupations, such as nurses and dressmakers. For men, there is greater skilled occupational diversity because male workers included bankers but also included occupations that restricted women from participation, such as the clergy. Examples of unskilled women include waitresses and cooks, while male unskilled workers also include day laborers and miners. Because women were not listed as farmers, male farmers are excluded from the analysis. A final occupational category is for women and men who did not report an occupation at the time of incarceration, who are classified here as ‘no listed occupations.’

Race was an important means to identify individuals within prisons and is inferred from a complexion variable. The complexion category is less gender-specific than occupations, and across prisons, women and men were recorded with the same complexion categories. For both women and men, individuals of African descent were classified as black, light black, and various shades of mulatto. European inmates were recorded as white, light, medium, and dark. This white European classification is also supported by foreign-born individuals from primarily white European populations who were recorded with the same white, light, medium, and dark complexions. In census and prison records, until the 1930s, it was common to designate individuals of mixed African and European ancestry as ‘mulattos’. However individuals recorded as mulattoes are referred to as ‘mixed-race’ in the results that follow.

Birth regions are classified into seven broad geographic regions. Individuals from Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont are classified as from the Northeast. Birth in Delaware, Washington DC, Maryland, New Jersey, New York, and Pennsylvania are classified as from the Middle Atlantic. Individuals from Illinois, Indiana, Michigan, Ohio, and Wisconsin are classified as from the Great Lakes. Individuals from Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota are classified as from the Plains. Individuals from Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia are classified as from the Southeast. Individuals from Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming are classified as from the Far West (Carlino and Sill, 2000).

[Insert Table 1 here]

Birth cohorts for late 19th and early 20th century women and men are classified into four groups: women and men born before and after 1900. Table 1 indicates that males were a larger portion of the prison population compared to females. Women were also more likely to be black and mixed race than men (Carson, 2009; Carson, 2018). Women were more likely to be incarcerated at younger ages, and older men were incarcerated before and after the transition to social feminism. Before and after the transition, international nativity is mixed for women; however, foreign-born males were likely to be incarcerated after 1900. Native-born results are mixed before and after the transition, as are women and men's residence. Reflecting labor market, biological, and institutional constraints, women were more likely to be listed without occupation before and after the rise of social feminism. Nevertheless, men were more likely to be listed as unskilled workers before 1900, and women were more likely to be enumerated as unskilled after the transition. Before and after the transition to social feminism, men were more likely than women to be listed as skilled workers. Women residing in the 19th century Northeast were more likely to be from the Northeast than 19th century men, a pattern that persistent into the 20th century.

IV. Econometric Model

In the quasi-experimental literature, difference-in-difference estimators measure treatment effects with only cross-sectional data by creating designs 'as if treatment' is randomly assigned (Card and Kruegar, 1993). A Oaxaca decomposition separates response variable differences into structural and compositional components (Blinder, 1973; Oaxaca, 1973; Oaxaca and Ransom, 1999).[1] A difference-in-decompositions estimator combines difference-in-difference estimators with Oaxaca decompositions to approximate differences between response variables around the time of an event. Rather than identifying sources of variation, difference-in-decompositions partition group variations into structural and compositional returns. If there is a measureable effect at the time of the event associated with returns to characteristics and only small composition differences, the event effects are more likely due to structural effects associated with the event. However, if there are small structural and large compositional differences, response variable differences are associated with compositional differences.

A Oaxaca decomposition is used to assess the before and after difference in response variables around the time of treatment. Let y_c and y_t be control and treatment response variables.

$$y_c = \alpha_c + \beta_c X_c \qquad (1)$$

and

$$y_t = \alpha_t + \beta_t X_t \qquad (2)$$

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

where α_c and α_t are control and treatment group autonomous components. β_t and β_c are structural returns to treatment and control characteristics. X_t and X_c are treatment and control characteristic matrices.

A decomposition partitions the response variable differences into structural and compositional effects around the time of the event. In the case of female and male BMI differences, the event is the 1900 rise of social feminism. To summarize the effect of the transition, BMIs are partitioned into female and male vectors before and after the rise of social feminism.

$$BMI_f^n = \alpha_f^n + \beta_f^n X_f^n \qquad (3)$$

$$BMI_f^t = \alpha_f^t + \beta_f^t X_f^t \qquad (4)$$

$$BMI_m^n = \alpha_m^n + \beta_m^n X_m^n \qquad (5)$$

$$BMI_m^t = \alpha_m^t + \beta_m^t X_m^t \qquad (6)$$

where α_f^n and α_m^n are the 19th century female and male autonomous BMI components. α_f^t and α_m^t are the 20th century female and male autonomous components. β_f^n and β_m^n are the 19th century female and male returns associated with characteristics, and β_f^t and β_m^t are the 20th century female and male BMI returns associated with characteristics. X_f^n and X_m^n are 19th century average female and male characteristic matrices, while X_f^t and X_m^t are defined similarly for 20th century females and males.

4.1 Across-Group Difference-in-Decompositions

There are two ways to decompose an event's effect: across and within-groups. The across group difference-in-decompositions isolates the across-group effects before and after social feminism by partitioning the differences between women and men into structural and compositional effects. Because women have higher BMIs than men, they are assigned as the base category (Carson, 2009; Carson, 2018). Twentieth century female-male decompositions are calculated by taking the difference between 20th century female and male models, Equations 4 minus 6.

$$BMI_f^t - BMI_m^t = \alpha_f^t + \beta_f^t \overline{X}_f^t - \alpha_m^t - \beta_m^t X_m^t \tag{7}$$

The across-group difference-in-decompositions are constructed by first taking the female-male post and pre-transition decompositions by adding appropriate counterfactuals (Carson, 2018; Carson, 2019b). Equation 8 is the 20th century counterfactual for average male characteristics observed at 20th century female returns to characteristics. Equation 9 is the 20th century male BMI returns to characteristics observed at 20th century female average characteristics.

$$\beta_f^t X_m^t - \beta_f^t X_m^t = 0 \tag{8}$$

and

$$\beta_m^t X_f^t - \beta_m^t X_f^t = 0 \tag{9}$$

Equation 10 is the 20th century female-male decomposition for males observed at female coefficients and is obtained by adding Equation 8 to Equation 7 (Table 3, Panel A). Equation 11 is the 20th century female-male decomposition for females observed at male characteristics and is obtained by adding equations 9 to 7 (Table 3, Panel A).

$$BMI_f^t - BMI_m^t = \left(\alpha_f^t - \alpha_m^t\right) + \left(\beta_f^t - \beta_m^t\right)\bar{X}_m^t + \left(\bar{X}_f^t - \bar{X}_m^t\right)\beta_f^t \qquad (10)$$

$$BMI_f^t - BMI_m^t = \left(\alpha_f^t - \alpha_m^t\right) + \left(\beta_f^t - \beta_m^t\right)\bar{X}_f^t + \left(\bar{X}_f^t - \bar{X}_m^t\right)\beta_m^t \qquad (11)$$

Equation 12 is the 19th century female-male decomposition, calculated by taking the difference between 19th century female and male BMI models, Equation 3 minus 5.

$$BMI_f^n - BMI_m^n = \alpha_f^n + \beta_f^n \bar{X}_f^n - \alpha_m^n - \beta_m^n X_m^n \qquad (12)$$

Equation 13 is the counterfactual for 19th century female returns to characteristics observed at 19th century male characteristics. Equation 14 is the counterfactual for 19th century male return to characteristics observed at 19th female characteristics.

$$\beta_f^n X_m^n - \beta_f^n X_m^n = 0 \qquad (13)$$

and

$$\beta_m^n X_f^n - \beta_m^n X_f^n = 0 \qquad (14)$$

Equation 15 is the 19th century female-male decomposition for males observed at female coefficients and is obtained by adding Equation 13 to Equation 12 (Table 3, Panel B). Equation 16 is the 19th century female-male decomposition for females observed at male characteristics and is obtained by adding Equation 14 to Equation 12 (Table 3, Panel B).

$$BMI_f^n - BMI_m^n = \left(\alpha_f^n - \alpha_m^n\right) + \left(\beta_f^n - \beta_m^n\right)\bar{X}_m^n + \left(\bar{X}_f^n - \bar{X}_m^n\right)\beta_f^n \qquad (15)$$

$$BMI_f^n - BMI_m^n = \left(\alpha_f^n - \alpha_m^n\right) + \left(\beta_f^n - \beta_m^n\right)\bar{X}_f^n + \left(\bar{X}_f^n - \bar{X}_m^n\right)\beta_m^n \qquad (16)$$

To derive the female-male across-group difference-in-decompositions, the second step is to take the female-male difference before and after the transition. Equation 17 is the female-male BMI difference-in-decompositions for female returns observed at male characteristics is Equation 10 minus 15 (Table 3, Model C).

$$\left(BMI_f^t - BMI_m^t\right) - \left(BMI_f^n - BMI_m^n\right) = \left(\alpha_f^t - \alpha_m^t\right) - \left(\alpha_f^n - \alpha_m^n\right) + \left[\left(\beta_f^t - \beta_m^t\right)\bar{X}_m^t - \left(\beta_f^n - \beta_m^n\right)\bar{X}_m^n\right]$$

$$+\left[\left(\bar{X}_f^t - \bar{X}_m^t\right)\beta_f^t - \left(\bar{X}_f^n - \bar{X}_m^n\right)\beta_f^n\right] \qquad (17)$$

Equation 18 is the female–male difference-in-decompositions for male returns observed at female characteristics is Equation 11 minus 16 (Table 3, Panel C).

$$\left(BMI_f^t - BMI_m^t\right) - \left(BMI_f^n - BMI_m^n\right) = \left(\alpha_f^t - \alpha_m^t\right) - \left(\alpha_f^n - \alpha_m^n\right) + \left[\left(\beta_f^t - \beta_m^t\right)\bar{X}_f^t - \left(\beta_f^n - \beta_m^n\right)\bar{X}_f^n\right]$$

$$+\left[\left(\bar{X}_f^t - \bar{X}_m^t\right)\beta_m^t - \left(\bar{X}_f^n - \bar{X}_m^n\right)\beta_m^n\right] \qquad (18)$$

4.2 Within-Group Difference-in-Decompositions

The within-group difference-in-decompositions isolates structural and compositional differences within female and male groups after and before the transition to social feminism. Women are assigned as the base structure (Carson, 2019b; Carson, 2018b). The within-group difference-in-decompositions are constructed by first taking the difference between 20th and 19th century female and male BMIs and adding appropriate counterfactuals. Equation 19 is Equation 4 minus 3. Equation 20 is Equation 6 minus 5.

$$BMI_f^t - BMI_f^n = \alpha_f^t + \beta_f^t \bar{X}_f^t - \alpha_f^n - \beta_f^n X_f^n \qquad (19)$$

$$BMI_m^t - BMI_m^n = \alpha_m^t + \beta_m^t \bar{X}_m^t - \alpha_m^n - \beta_m^n X_m^n \qquad (20)$$

Equation 21 is the counterfactual for 19th century female returns to BMI at average 20th century female average characteristics. Equation 22 is the counterfactual for 19th century female returns counterfactual observed at 20th century female average characteristics.

$$\beta_f^n X_f^t - \beta_f^n X_f^t = 0 \qquad (21)$$

$$\beta_f^t X_f^n - \beta_f^t X_f^n = 0 \qquad (22)$$

Equation 23 is women's within-group decomposition for 20th century women's characteristics observed at 19th century average characteristics and is obtained by adding Equation 19 to Equation 21 (Table 4, Panel A). Equation 24 is women's within-group decomposition for 19th century characteristics observed at 20th century returns to characteristics and is obtained by adding Equation 20 to Equation 22 (Table 4, Panel A).

$$BMI_f^t - BMI_f^n = \left(\alpha_f^t - \alpha_f^n\right) + \left(\beta_f^t - \beta_f^n\right)\bar{X}_f^t + \left(\bar{X}_f^t - \bar{X}_f^n\right)\beta_f^n \qquad (23)$$

$$BMI_f^t - BMI_f^n = \left(\alpha_f^t - \alpha_f^n\right) + \left(\beta_f^t - \beta_f^n\right)\bar{X}_f^n + \left(\bar{X}_f^t - \bar{X}_f^n\right)\beta_f^t \qquad (24)$$

Equation 25 is the counterfactual for observing 19th century male BMI returns at 20th century average male characteristics. Equation 26 is the counterfactual for observing 20th century male BMI returns at 19th century average male characteristics.

$$\beta_m^n X_m^t - \beta_m^n X_m^t = 0 \qquad (25)$$

$$\beta_m^t X_m^n - \beta_m^t X_m^n = 0 \qquad (26)$$

Equation 27 is the difference between 20th and 19th century male returns to characteristics observed at 20th century average male characteristics, Equation 20 plus 25 (Table 4, Panel B).

Equation 28 is the difference between 20th century male returns to characteristics observed at 19th century average male characteristics, Equation 20 plus 26 (Table 4, Panel B).

$$BMI_m^t - BMI_m^n = \left(\alpha_m^t - \alpha_m^n\right) + \left(\beta_m^t - \beta_m^n\right)\bar{X}_m^t + \left(\bar{X}_m^t - \bar{X}_m^n\right)\beta_m^n \tag{27}$$

$$BMI_m^t - BMI_m^n = \left(\alpha_m^t - \alpha_m^n\right) + \left(\beta_m^t - \beta_m^n\right)\bar{X}_m^n + \left(\bar{X}_m^t - \bar{X}_m^n\right)\beta_m^t \tag{28}$$

To derive the female-male within-group difference-in-decompositions, the second step is to take the difference between the female after-before decomposition measured at 19th century BMI returns to characteristics observed at 20th century female characteristics. Equation 29 is the within-group difference-in-decompositions observed at 20th century females at 19th century male characteristics, Equations 23 minus 27 (Table 4, Panel C).

$$\left(BMI_f^t - BMI_f^n\right) - \left(BMI_m^t - BMI_m^n\right) = \left(\alpha_f^t - \alpha_f^n\right) - \left(\alpha_m^t - \alpha_m^n\right) + \left[\left(\beta_f^t - \beta_f^n\right)\bar{X}_f^t - \left(\beta_m^t - \beta_m^n\right)\bar{X}_m^n\right]$$
$$+\left[\left(\bar{X}_f^t - \bar{X}_f^n\right)\beta_f^n - \left(\bar{X}_m^t - \bar{X}_m^n\right)\beta_m^n\right] \tag{29}$$

Equation 30 is the within-group difference-in-decomposition for 20th century returns to characteristics measured at 19th century characteristics is Equation 24 minus 28 (Table 4, Panel C).

$$\left(BMI_f^t - BMI_f^n\right) - \left(BMI_m^t - BMI_m^n\right) = \left(\alpha_f^t - \alpha_f^n\right) - \left(\alpha_m^t - \alpha_m^n\right) + \left[\left(\beta_f^t - \beta_f^n\right)\bar{X}_f^n - \left(\beta_m^t - \beta_m^n\right)\bar{X}_m^n\right]$$
$$+\left[\left(\bar{X}_f^t - \bar{X}_f^n\right)\beta_f^t - \left(\bar{X}_m^t - \bar{X}_m^n\right)\beta_m^t\right] \tag{30}$$

V. Female and Male BMI Returns: A Difference in Decompositions Approach

5.1.1 Regression Results

[Insert Table 2 here]

Isolating female and male BMI changes across and within genders demonstrates how relative net-nutrition was related to the rise of social feminism. A common result when comparing women and men's height is that men are biologically taller than women associated with sexual dimorphism (Marques et al, 2018, p. 151; Williams et al 2018, p. 288), and men were taller than women before and after the rise of social feminism. Moreover, the inverse female relationship between BMI and height was nearly twice the magnitude for men, indicating women's BMIs were particularly sensitive to height (Komlos and Carson, 2017; Carson, 2018c). As was common throughout the 19th and 20th centuries, individuals with darker complexions had greater BMIs and weight than individuals with fairer complexions (Carson, 2009; Carson, 2012; Carson, 2015a; Carson, 2015b). Before and after the transition, BMI returns to age were similar for women and men, and the female regional BMI returns associated with northeastern nativity was largest in the 19th century. During the 19th century, the Far West was only in the early stages of economic development, and occupations were segregated along gender lines, where physical strength was required in agricultural occupations along the Far Western frontier (Marques et al 2018, p. 142; Williams et al. 2018, p. 293). However, women in the northeast before and after the transition had higher BMIs than women elsewhere in the US.

5.2 Across-Group Difference-in-Decompositions

Isolating female and male BMI differences across and within groups illustrates how current net nutrition was related to the transition to social feminism. Across-group decompositions are calculated first. Table 3's Panel A (Equations 10 and 11) are the post-1900 female-male BMI compositions. Panel B (Equations 15 and 16) are the pre-1900 female-male BMI decomposition. Panel C (Equations 17 and 18) are the female-male across-group difference-in-decompositions with the transition to social feminism, and the sign and magnitude indicate how women and men's across-group BMI variation changed with the transition to social feminism. For example, a positive intercept difference between 20th century women and men indicates that women's autonomous BMI returns were greater than men, whereas their 19th century autonomous BMI returns were lower than men.

[Insert Table 3 here]

5.2.1 Across-Group, Post Transition Decomposition

Table 3's, Panel A's positive level intercept, .597 BMI units, indicates that women's BMIs were greater than men after social feminism. However, sources of the across-group post-transition were important. In proportions, Panel A's positive intercept indicates that the greatest source of differences was associated with autonomous, unobserved factors in the intercept, and women's net nutrition after the transition was greater than men. The greatest source of observable characteristics was height, and after the transition, men had higher returns to height than women. Men's advantage between BMI and height was greater with the transition to social feminism; however, the difference in average height favored women. Nevertheless, the male BMI returns to height offset women's returns to average characteristics. Although not as large, male returns to nativity and returns to average nativity were greater after the transition to social feminism. Alternatively, women's returns to occupations were greater after social feminism, when social and economic forces aligned to compensate women more than men in socioeconomic status. Returns to age and residence also favored women, however, were offset slightly by greater returns to average age and residence characteristics. Although the differences vary, the majority of women's post transition BMIs advantage was associated with average characteristics and not returns to characteristics

5.2.2 Across-Group Pre-Transition Decomposition

Before the transition, men had greater BMIs compared to women associated with level differences, and this difference is supported by high-autonomous proportional BMI returns. From proportions, Table 3's Panel B's pre-transition decomposition indicates that men before the transition to social feminism had an advantage in both the levels and proportional intercept, indicating biological disparity between men and women favored men. Before the transition women had greater BMI returns associated with height, complexions, residence, and nativity. Men had greater BMI returns associated with age and occupations. Before the transition to social feminism, characteristic returns to women's height favored women; however, cumulative net nutrition offset a small part of the returns to women's height. Before the transition to social feminism, women also had greater returns to residence and nativity that were reinforced by returns to average characteristics. Nevertheless men had greater BMI returns associated with occupations and age. Before the transition, male BMI return advantages were supported by returns to socioeconomic status, and occupation returns and returns to age reinforced the male pre-transition advantage to current net nutrition. The majority of women's pre-transition advantage was due to returns to height, and women had considerable return advantages from greater returns to average characteristics, such as age, nativity, residence, and occupations.

5.2.3 Across-Group Difference-in-Decompositions

Table 3's, Panel C, is the female-male across group difference-in-decompositions. If a component is positive, women did better than men with the transition to social feminism and negative if women did worse. From levels, women did better than men with the rise of social feminism, and from proportions, women did better than men due to non-identifiable sources in the intercept. These differences were attributable to nutrition, disease, and urbanization.

However, the increase in the intercept also includes changes in the social, legal, and political position of women, which were unique to the rise of social feminism. Furthermore, women's change in BMI associated with unidentifiable sources in the intercept were offset by men's return to stature and cumulative net nutrition. Among observable characteristics, women did better than men due to age and occupation BMI returns, while male BMI returns were associated with nativity, complexions, and residence. Women's returns to average characteristics were greatest for height and complexions, whereas men's returns to average characteristics were greatest for ages, nativity, residence, and occupation. While women's overall BMIs and current net nutrition were greater with the transition, the positive autonomous intercept indicates that women's BMIs increased with social feminism. However, women's BMI returns associated with height, complexion, nativity, and residence were greater with relative to men before social feminism and women's suffrage.

5.3 Within-Group Difference-in Decompositions

Isolating female and male within-group differences before and after the rise of social feminism isolates how women after the transition compared to women before, relative to how men after the transition compared to men before with the transition. Table 4's Panel A (Equations 23 and 24) are the female within-group decompositions. Panel B (Equations 27 and 28) are the male within-group decompositions. Panel C (Equations 29 and 30) are the female-male within-group difference-in-decompositions with the transition to social feminism.

5.3.1 Women's Within-Group Decomposition

Women's within-group's autonomous intercept difference indicates their BMIs observed after 1900 were greater than women observed before 1900 transition. By proportions, women were better off after the transition to social-feminism; however, the relationship between women's

BMI and stature was greater prior to the rise of social feminism. In addition to stature, women's BMI returns associated with nativity were greater prior to the transition, and compositional differences were small. The largest contribution to the female-male within-group BMI difference were age and complexions, and the complexion average difference was small, indicating a greater causal explanation with complexion was attributable to the rise of social feminism. Alternatively, women's BMIs after the transition associated with age and residence were attributed to compositions, therefore, less of a causal explanation with age and residence. Alternatively, the structural difference between occupations was small, while the occupational difference was large, indicating much of the within-group female difference associated with occupations were compositional. The overall results for the within-group female decomposition are mixed.

5.3.2 Men's Within-Group Decompositions

The male within-group intercept difference indicates that men's BMIs observed prior to the rise of social-feminism were greater than men observed after. By proportions, men were considerably better off prior to social feminism. Independent of characteristics, men's BMIs were higher after 1900, as illustrated by the positive autonomous intercept difference. Nevertheless, like women, men's relationship between BMI and stature was larger prior to the rise of social feminism, and there was little difference between average statures, indicating the preponderance of the BMI return associated with male stature was attributable to structural differences. In addition to stature, male age-related BMI returns were greatest prior to the transition, with comparable compositional differences, indicating that age was less causal after accounting for compositional differences. It was male occupations after the transition to social feminism that had the greatest structural returns, with little differences in the composition component. While the difference was small, male BMI structural returns associated with residence, nativity, and complexion were greater after the transition to social feminism, and there were small compositional differences associated with nativity, indicating more of a causal relationship. Nonetheless, compositional effects associated with age and residence distorted the male BMI relationship. Overall, male BMI results indicate the male within-group BMI results were associated with structural returns to characteristics rather than compositional differences.

5.3.3 Within-Group Difference-in-Decompositions

The within-group difference-in-decompositions indicate the female BMI advantage with the rise of social feminism was greater than the male difference. Much of the increase in women's BMIs after the rise of social feminism was attributable to non-identifiable characteristics after the rise of social feminism relative to before the transition. Moreover, the proportional within-group difference-in-decompositions intercept indicates the transition increased women's BMIs relative to males independent from the changed in structural and compositional differences. Women after the transition were better-off than women before compared to the male difference associated with complexion and ages. However, differences in female returns to characteristics were offset by returns to average characteristics, indicating the difference was due to compositional changes. Male BMI returns after 1900 were larger due to height, nativity, residence, and socioeconomic status. Furthermore, the within-group male structural returns differences associated with height were greatest prior to the transition. Within-group differences-in-decompositions associated with complexions and age for women were greatest with the transition; however, complexion and age were similar, off-setting the structural and compositional difference.

VI. Conclusion

Throughout economic development, the role of women and men's relative living standards changed with the rise of social feminism. In developing economies, greater emphasis is attributable to occupations where physical strength is required (Marques et el 2018, p. 158); however, this emphasis on physical strength decreased as labor markets develop and less importance placed on physical strength and more emphasis on cognitive ability. Late 19th and early 20th century US economic development improved the relative status of women relative to both men before and after the transition, and 20th century women did better relative to 19th century women. The main source of across-group variation were non-identifiable characteristics, height, and nativity, indicating relative net improvement in women's net nutrition was related to non-observable factors, such as improved social standing and better conditions after passage os the 19th Amendment. Nativity and socioeconomic status were the primary sources of female-male within-group variation, yet both of these favored men relative prior to the rise of social feminism. Subsequently, women's net nutrition improved relative to men and relative to women in the 19th century with women's suffrage and the rise of social feminism.

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Table 1, Women and Men's 19th and 20th Century Characteristic Distributions

	Female, 19th Century		*Female, 20th Century*		*Male, 19th Century*		*Male, 20th Century*	
	N	Percent	N	Percent	N	Percent	N	Percent
Ethnic								
Black	874	44.19	869	33.24	17,337	22.77	22,219	23.11
Mexican	44	2.22	41	1.57	2,779	3.65	3,846	4.00
Mixed-Race	387	19.57	737	28.19	15,833	20.80	10,298	10.71
White	673	34.02	967	36.99	40,178	52.78	59,787	62.18
Ages								
Teens	609	30.79	433	16.56	12,674	16.65	11,725	12.19
20s	836	42.26	1,330	50.88	39,880	62.39	47,469	49.37
30s	311	15.72	568	21.73	14,495	19.04	22,299	23.19
40s	140	7.08	201	7.69	5,898	7.75	9,548	9.93
50s	61	3.08	62	2.37	2,449	3.22	3,831	3.98
60s	21	1.06	20	.77	731	.96	1,278	1.33
Native								
International								
Canada	7	.35	25	.96	588	.77	990	1.03
Europe	59	2.98	82	3.14	3,308	4.35	6,039	6.28
Great Britain	141	7.13	31	1.19	3,126	4.11	1,891	1.97
Latin America	28	1.42	56	2.14	2,385	3.13	4,265	4.44
National								
Far West	1	.05	74	2.83	838	1.10	3,002	3.12
Great Lakes	88	4.45	310	11.86	3,845	5.05	11,454	11.91
Middle Atlantic	422	21.33	132	5.05	14,901	19.57	9,036	9.40
Northeast	6	.30	12	.46	819	1.08	1,125	1.17
Plains	44	2.22	488	18.67	2,616	3.44	17,585	18.29
Southeast	797	40.29	879	33.63	30,749	40.39	25,553	26.58
Southwest	385	19.46	525	20.08	12,952	17.01	15,210	15.82
Residence								
Arizona	5	.25	19	.73	782	1.03	3,250	3.38
Colorado			301	11.51			5,720	5.95
Idaho			12	.46	50	.07	629	.65
Illinois	96	4.85	408	15.61	1,453	1.91	9,861	10.26
Kentucky	101	5.11	19	.73	8,197	10.77	3,323	3.46
Missouri	19	.96	469	17.94	2,086	2.74	17,114	17.80
Mississippi			34	1.30	24	.03	1,674	1.74
Montana	2	.10	83	3.18	1,211	1.59	7,822	8.14

Nebraska			112	4.28			7,364	7.66
New Mexico	31	1.57	22	.84	973	1.28	2,031	2.11
Oregon	3	.15			2,189	2.88		
PA, East	129	6.52	88	3.37	4,866	6.39	4,095	4.26
PA, West	155	7.84	28	1.07	6,675	8.77	1,009	1.05
Philadelphia	377	19.06			6,671	8.76	2,025	2.11
Tennessee	576	29.12	453	17.33	16,493	21.67	11,746	12.22
Texas	484	24.47	566	21.65	24,457	32.13	18,487	19.23
Occupations								
No Occupations	783	39.59	433	16.56	16,253	21.35	9,104	9.47
Skilled	181	9.15	228	8.72	17,531	23.03	33,307	34.64
Unskilled	1,014	51.26	1,953	74.71	42,343	55.62	53,739	55.89
Residence								
Northeast	661	33.42	116	4.44	18,212	23.92	7,129	7.41
Plains	216	10.92	896	34.28	11,736	15.42	30,298	31.51
South	1,060	53.59	1,053	40.28	40,974	53.82	31,907	33.18
West	41	2.07	549	21.00	5,205	6.84	26,816	27.89
Total	1,978		2,614		76,127		96,150	

Source: Arizona State Library, Archives and Public Records, 1700 W. Washington, Phoenix, AZ 85007; Colorado State Archives, 1313 Sherman Street, Room 120, Denver, CO 80203; California State Archives, 1020 O Street, Sacramento, CA 954814; Idaho State Archives, 2205 Old Penitentiary Road, Boise, Idaho 83712; Illinois State Archives, Margaret Cross Norton Building, Capital Complex, Springfield, IL 62756; Kentucky Department for Libraries and Archives, 300 Coffee Tree Road, Frankfort, KY 40602; Maryland State Archives, 350 Rowe Building, Annapolis, MD 21401; Missouri State Archives, 600 West Main Street, Jefferson City, MO 65102; William F. Winter Archives and History Building, 200 North St., Jackson, MS 39201; Montana State Archives, 225 North Roberts, Helena, MT, 59620; Nebraska State Historical Society, 1500 R Street, Lincoln, Nebraska, 68501; New Mexico State Records and Archives, 1205 Camino Carlos Rey, Santa Fe, NM 87507; Ohio Archives Library, 800 E. 17th Avenue, Columbus, OH43211; Oregon State Archives, 800 Summer Street, Salem, OR 97310; Pennsylvania Historical and Museum Commission, 350 North Street, Harrisburg, PA 17120; Philadelphia City Archives, 3101 Market Street, Philadelphia, PA 19104; Tennessee State Library and Archives, 403 7th Avenue North, Nashville, TN 37243 and Texas State Library and Archives Commission, 1201 Brazos St., Austin TX 78701; Utah State Archives, 346 South Rio Grande Street, Salt Lake City, UT 84101; Washington State Archives, 1129 Washington Street Southeast, Olympia, WA 98504.

Table 2, Women and Men's 19th and 20th Century Social Feminism BMI Regression Models by Demographic and Socioeconomic Status

	Female, 19th Century	*Female, 20th Century*	*Male, 19th Century*	*Male, 20th Century*
Intercept	39.76***	47.65***	34.05***	32.23***
Height				
Centimeters	-.104***	-.136***	-.066***	-.053***
Complexion				
White	Reference	Reference	Reference	Reference
Black	.131	.684***	1.21***	.968***
Mixed Race	.156	.382*	1.01***	.726***
Mexican	-.490	-.383	.140**	.051
Ages				
14	-3.35***	-3.07***	-3.46***	-3.05***
15	-2.98***	-2.31***	-2.92***	-2.33***
16	-1.80***	-.614**	-2.19***	-1.84***
17	-1.39***	-1.31***	-1.50***	-1.28***
18	-.700**	-.850**	-1.14***	-.964***
19	-.594*	-.556**	-.705***	-.567***
20-29	Reference	Reference	Reference	Reference
30s	1.03***	1.52***	.264***	.361***
40s	.783**	2.27***	.416***	.655***
50s	1.36***	1.99***	.523***	.696***
60s	.249	2.86***	.280***	.662***
Nativity				
National				
Northeast	Reference	Reference	Reference	Reference
Middle Atlantic	.626	-4.39***	-.064	-.151*
Great Lakes	-.487	-2.95***	.057	-.014
Plains	.318	-3.32***	-.059	-.333***
Southeast	-.346	-3.57***	.076	-.355***
Southwest	-.935	-3.65***	-.285***	-.374***
Far West	3.49	-3.45***	.051	-.207**
International				
Canada	.681	-3.17**	.222*	-.023
Europe	.768	-2.12*	.712***	.795***
Britain	.530	-4.83***	.149*	-.126
Latin America	-1.39	-3.58***	-.657***	-.451***
Residence				
Northeast	-1.10***	1.09**	-.322***	-.486***
Plains	-.252	-.030	-.343***	-.726***
South	Reference	Reference	Reference	Reference
West	-.466	-.111	.472***	-.027

Occupation				
Skilled	.344	.931***	.013	-.266***
Unskilled	.674***	.487**	.208***	-.196***
No Occupation	Reference	Reference	Reference	Reference
N	1,978	2,614	76,127	96,150
R^2	.1210	.1288	.1334	.0943

Source: See Table 1.

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

Table 3, Women and Men's Across-Group 19th and 20th Century BMI Difference-in-Decompositions with the Rise of Social Feminism

Panel A	Equation 10		Equation 11	
Post 1900	$\left(\beta_F^{Post}-\beta_M^{Post}\right)\overline{X}_M$	$\left(\overline{X}_F^{Post}-\overline{X}_M^{Post}\right)\beta_F^{Post}$	$\left(\beta_F^{Post}-\beta_M^{Post}\right)\overline{X}_F$	$\left(\overline{X}_F^{Post}-\overline{X}_M^{Post}\right)\beta_M^{Post}$
	Structure	*Composition*	*Structure*	*Composition*
Levels				
Sums	-.442	1.04	-.003	.600
Total		.597		.597
Proportions				
Intercept	25.84		25.84	
Height	-23.73	2.12	-22.44	.827
Complexions	-.201	.244	-.332	.375
Ages	.884	-.282	.764	-.162
Nativity	-5.39	-.048	-5.36	-.082
Residence	.524	-.043	.487	-.006
Occupations	1.34	-.251	1.03	.054
Sum	-.741	1.74	-.006	1.01
Total		1		1
Panel B	Equation 15		Equation 16	
Pre 1900	$\left(\beta_F^{\text{Pre}}-\beta_M^{\text{Pre}}\right)\overline{X}_M^{\text{Pre}}$	$\left(\overline{X}_F^{\text{Pre}}-\overline{X}_M^{\text{Pre}}\right)\beta_F^{\text{Pre}}$	$\left(\beta_F^{\text{Pre}}-\beta_M^{\text{Pre}}\right)\overline{X}_F^{\text{Pre}}$	$\left(\overline{X}_F^{\text{Pre}}-\overline{X}_M^{\text{Pre}}\right)\beta_M^{\text{Pre}}$
Levels				
Sums	-.998	.680	-.934	.615
Total		-.318		-.318
Proportions				
Intercept	-17.93		-17.93	
Height	20.34	-3.33	19.13	-2.12
Complexions	1.40	-.104	2.07	-.768
Ages	-.754	.766	-.777	.788
Nativity	.390	.070	.450	.010
Residence	.742	.223	.846	.118
Occupations	-.105	.242	-.845	.034
Sum	3.14	-2.14	2.93	-.1.93
Total		1		1
Panel C	Equation 17		Equation 18	
Difference in Decompositions				
Levels				
Sums	.556	.359	.930	-.015

Total		.915		.915
Proportions				
Intercept	43.77		43.77	
Height	-44.08	5.45	-41.57	2.94
Complexions	-1.60	.348	-2.40	1.14
Ages	1.64	-1.05	1.54	-.950
Nativity	-5.78	-.119	-5.80	-.092
Residence	-.218	-.266	-.359	-.125
Occupations	2.39	-.049	1.88	.195
Sum	-3.88	3.88	-2.94	2.94

Source: See Tables 1 and 2.

Table 4, Women and Men's Within-Group 19th and 20th Century BMI Difference-in-Decompositions with the Rise of Social Feminism

Panel A	Equation 23		Equation 24	
Females	$\left(\beta_f^{Post}-\beta_f^{\text{Pre}}\right)\bar{X}_f^{Post}$	$\left(\bar{X}_f^{Post}-\bar{X}_f^{\text{Pre}}\right)\beta_f^{\text{Pre}}$	$\left(\beta_f^{Post}-\beta_f^{\text{Pre}}\right)\bar{X}_f^{\text{Pre}}$	$\left(\bar{X}_f^{Post}-\bar{X}_f^{\text{Pre}}\right)\beta_f^{Post}$
	Structure	*Composition*	*Structure*	*Composition*
Levels				
Sums	.133	.474	.472	.135
Total		.607		.607
Proportions				
Intercept	13.01		13.01	
Height	-8.51	-.187	-8.45	-.245
Complexions	.411	.004	.480	-.065
Ages	.471	.436	.498	.409
Nativity	-5.42	-.013	-5.94	.508
Residence	.409	.283	1.26	-.567
Occupations	-.146	.258	-.070	.182
Sum	.219	.781	.778	.222
Total		1		1
Panel B				
Males	$\left(\beta_m^{Post}-\beta_m^{\text{Pre}}\right)\bar{X}_m^{Post}$	$\left(\bar{X}_m^{Post}-\bar{X}_m^{\text{Pre}}\right)\beta_m^{\text{Pre}}$	$\left(\beta_m^{Post}-\beta_m^{\text{Pre}}\right)\bar{X}_m^{\text{Pre}}$	$\left(\bar{X}_m^{Post}-\bar{X}_m^{\text{Pre}}\right)\beta_m^{Post}$
	Equation 27		Equation 28	
Levels	-.400	.092	-.285	-.024
Sums		-.309		-.309
Total				
Proportions				
Intercept	5.90		5.90	
Height	-7.19	.042	-7.18	.034
Complexions	.291	.316	.381	.226
Ages	-.268	-.339	-.271	.336
Nativity	.639	.006	.730	-.086
Residence	.882	-.315	.429	.137
Occupations	1.05	-.007	.937	.102
Sum	1.30	-.297	.923	.077
Total		1		1
Panel C				
Difference in Decompositions				
Levels	Equation 29		Equation 30	

Sums	.533	.382	.757	.159
Total		.915		.915
Proportions				
Intercept	7.11		7.11	
Height	-1.32	-.229	-1.27	-.278
Complexions	.120	-.312	.099	-.292
Ages	.739	.774	.768	.745
Nativity	-6.06	-.019	-.667	.594
Residence	-.473	.599	.829	-.704
Occupations	-1.19	.265	-1.01	.080
Sum	-1.08	1.08	-.145	.145

Source: See Tables 1 and 2.