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Abstract

When traditional methods for measuring economic welfare are scarce or unreliable, heights and BMIs are now well accepted measurements that represent biological conditions during economic development. Weight, after controlling for height, is an alternative measure to BMI for current net nutrition. Little is known about how weights varied among Mexicans living in the 19th century American West. Between 1870 and 1920, average Mexican weight decreased slightly. Mexican farmers had the heaviest weights, and unskilled worker weights were low. For combined characteristics, weight varied the most with height and age, two uncontrollable characteristics, indicating that 19th century Mexican current net nutrition varied the most with factors over which individuals of Mexican descent had no control.

JEL-Codes: I100, J110, J150, N000, N310.

Keywords: anthropometrics, nineteenth century US weights, net nutrition, health.

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

The Weight of the 19th Century Mexican Net Nutrition in the Western United States

I. Introduction

When traditional welfare measures are scarce or unreliable, stature and the body mass index (BMI) values are now two well accepted measures that reflect health during economic development. When material conditions are difficult to compare, stature and BMIs have the added advantage of comparing conditions within and across populations. Moreover, the effect of economic development and how it relates to health is an important aspect of human nature. Stature represents the cumulative net difference between calories consumed, less calories required for work and to fend off disease. BMIs are weight in kilograms divided by height in meters squared and may represent the current net difference between the same variables (Fogel, 1994; Strauss and Thomas, 1998, p. 773). However, interpreting BMI values is more difficult than interpreting stature because BMI is the ratio of current to cumulative net nutrition. This complication results, in part, from when privation occurs. For example, if a person receives insufficient nutrition in their youth, their statures may be short, their frames small, and their basal metabolic needs will be lower in later life (Mifflin, 1990). If nutrition improves for a short person as they get older, their BMIs are more likely to be high because smaller frames have less area to distribute weight, (Herbert et al., 1993, p. 1438; Carson, 2009; Carson, 2012). Alternatively, if an individual receives sufficient net nutrition during their youth, they are more likely to grow to taller statures, and their BMIs will be lower as they get older because their frames have more area to distribute weight (Sorkin et al. 1999; Sorkin et al. 1999). This inability to isolate the difference between current and cumulative net nutrition using BMI indicates an

alternative is needed, and weight is a viable alternative that isolates changes in current net nutrition.

Modern Mexican populations have a rich history with origins in both Europe and Native Mexico. Like the United States' political separation from Great Britain, much of Mexico's early history was shaped by its transition to independence from Spain. After its political separation in 1821, diverse political interests fought for control over Mexico. Between 1864 and 1867, Austria's Hapsburg family controlled Mexico's early economic and political development. However, in 1867, civil conflict with indigenous groups led Benito Juárez to over throw Hapsburg rule in Mexico, and Juárez went on to serve as president during the 1870s. In 1876, Porfian Díaz led a revolt and was installed as Mexico's president, and Díaz served for nearly three decades as the head of the Porfiriato, which is the political and economic regime that was characterized by stability, modernization, and economic development. In 1911, Madero, a Mexican Revolutionary, led a successful revolt against Díaz but was himself assassinated in 1913. Throughout the 1920s, this revolt against Madero led to considerable political instability, and Mexican statures and BMIs stagnated (Carson, 2005; Carson, 2007).

It is against this backdrop that this study considers three paths of inquiry into late 19th and early 20th century weight variation for Mexicans living in the American West. First, across the distribution, how did weights vary during the late 19th and early 20th centuries? Between 1870 and 1920, Mexican weights decreased slightly and may have been little above subsistence, indicating that working class current net nutrition varied little with economic development. Second, across the distribution, what was the relationship between weight and socioeconomic status? Mexican farmer's proximity to nutrition and distance from urban areas was associated with greater weight and better net nutrition. Third, during this period of Mexican economic and

political development, what were the demographic factors associated with weight variation, and did Mexicans acquire attributes associated with better current net nutrition, or did their weights vary with factors over which they had little control? Among 19th century factors associated with Mexican weight variation, weight had the greatest variation with height and age, indicating that 19th century Mexican current net nutrition was largely beyond their control.

II. Mexican Weight and Historical Body Measurements

There is a well-established literature that addresses late 19th and early 20th century Mexican biological conditions that shows early 20th century Mexican statures followed a north-south stature gradient (Faulhaber, 1970, pp. 94-96). Goldstein (1943, pp. 16-17) finds that early 20th century Mexican children born in the US were taller than their parents who did not migrate, indicating that Mexican net nutrition improved with immigration to the American West. Using Mexican-born prisoners in the US, Carson (2005, pp. 414-415) demonstrates that adult Mexican statures stagnated in the late 19th century. As Porfirian Dìaz's economic policies to favor greater factor mobility, railroads, and economic growth advanced, Mexican male statures declined by nearly one centimeter. Inequality also increased during the Porfiriato (Haber, 1989, pp. 16-18; Bortz and Haber, 2002, p. 16; Carson, 2005), and Diaz's economic policies to rapidly develop foreclosed working class Mexican peasants and campesinos from opportunity. Carson (2015c) demonstrates that Mexican physical activity and calories remained constant throughout the late 19th and early 20th centuries.

Beans and rice were two staples in the 19th century Mexican diet; however, this diet lacked animal proteins and fats (Gamio, 1969, pp. 140-147) and was associated with lower body mass index values. Lower BMIs are associated with lower levels of chronic health conditions,

such as diabetes and heart disease (Carson, 2007). Diets of 19th century Mexicans in Mexico were largely vegetarian, and contained few calories from animal proteins. Dairy was also not an important part of the diet in Mexico. However, the diets of Mexicans in the United States were augmented with pork and dairy products (Gamio, 1969, pp. 140-147). This is in marked contrast with modern obesity trends, where 21st century US citizens of Mexican descent have among the highest rates of obesity and diabetes (Ogden et al. 2012; Ogden et al. 2014, p. 810). The difference is explained, in part, by the modern nutritional transition, and the diets of modern Mexicans in the US have become more calorie-dense with simple sugars and saturated fats (Popkin, 1993; Flegal, et al. 2012, pp. 493-494; Ogden et al. 2012, pp. 486).

Despite its importance relative to other physical measurements, weight has received little attention in historical health studies, which is due to a lack of 19th century weight data. To consider how weights in the US varied with economic development, Komlos (1987) uses West Point cadet weight and height data to show there was a general decrease in 19th century net nutritional status that was geographically widespread and affected blue collar workers and farmers more than workers in other occupations. Students at The Citadel also did not experience a decline in net nutritional status until after the Civil War (Coclanis and Komlos, 1995). Carson (2015b) shows that late 19th and early 20th century black and white weights were in normal weight categories, and for the same height, blacks had heavier weight than whites. Farmers and unskilled workers were heavier than workers in other occupations; weights were greater in the South, and declined throughout the late 19th and early 20th centuries. However, nothing is known about how 19th century weight varied for Mexicans in the western US.

III. Nineteenth Century Mexicans in US Prisons

Data to analyze 19th century weight for Mexicans living in the Western United States is from four Western state prisons that recorded both Mexican weight and height between 1871 and 1925: Arizona, Colorado, New Mexico, and Texas. At the time of incarceration, US prison enumerators recorded occupation, crime, place of birth, age, height, and weight. Since age, occupations, and physical measurements were recorded at the time of incarceration, they reflect pre-incarceration conditions and not conditions within Western prisons. Because most 19th century Western state prisons did not document an inmates' Mexican city of birth, only their state or country of origin, it is not clear whether Mexicans living in the West were born in Mexico and immigrated north or if they were born in the West. However, the New Mexico prison recorded the hometown of each Mexican inmate, and Mexicans claiming birth in Mexico were born within Mexico after the 1848 border settlement with the United States. Moreover, no Mexican-born inmate claimed birth in a Mexican city that later became part of the US.[1] In sum, if Mexican populations in other Western prisons are similar to the New Mexico prison, it is sensible to conclude that Mexican inmates were born within Mexico after the 1848 border settlement with the US.[2]

There are two common sources of historical weight and height data: military and prison records. Historical military records represent conditions in higher socioeconomic groups (Sokoloff and Vilafour, 1982), whereas prison records represent conditions among the working class. While both military and prison samples are valuable, there are concerns when using

[3] Most inmates with identifiable hometowns were from, Matamoras, Chihuahua, Santa Rosolia, Ciudad Juárez, and other Northern provinces. A few inmates appear from Zacatecas and Mexico City, but none were from the Yucatan Peninsula or farther South. No Mexican inmate claimed a hometown in the Yucatan Peninsula or Southern Mexico.

[4] Mexico's Northern Provinces that border the United States are Tamaulipas, Nuevo Leon, Coahuila, Baja California Norte, Sonora, and Chihuahua. Other Northern Provinces include Sinaloa, Durango, Zacatecas and San Luis Potasi.

military data because of minimum stature requirements for service, which means that only taller men with lower BMIs remain in service records. Prison records avoid this constraint and the resulting truncation bias because height requirements did not exist for prison incarceration. However, prison data are not above reproach. For example, it is not clear which segment of society prison records represent, and if prisoners turned to theft for survival, prison records may represent conditions for the materially poorest individuals. Alternatively, law enforcement officers may have incarcerated physically fit individuals who had an advantage in physical assault crimes over shorter physical assault arrestees. Because the majority of Mexican prisoners were incarcerated for theft and physical assault crimes, prison records likely represent conditions among the working class.

Before the use of photographic technology was widespread, prison enumerators recorded characteristics in detail because written descriptions were an important means of identifying inmates if they escaped and were recaptured. Written descriptions were also an important means of identifying individuals within a prison. Enumerators recorded a wide-range of occupations and defined them narrowly, which are classified here into four categories. Laborers and miners are classified as unskilled workers. Unfortunately, enumerators did not always distinguish between farm and common laborers. Since farm laborers typically came to maturity under more favorable biological conditions than common laborers, this probably overestimates the biological benefits of being a common laborer and underestimates the biological benefits of being a farm laborer (Carson, 2013, p. 59; Carson, 2015a). Workers in the agricultural sector are classified as farmers. Light manufacturers, craft workers, and carpenters are classified as skilled workers. Merchants and high skilled workers are classified as white collar workers (Lauderie, 1979; Margo and Steckel, 1992; p. 520).

Table 1, Nineteenth Century US and Mexican-born Demographic, Socioeconomic Characteristics, and Residence

	US Born				*Mexican Born*			
	US Born				Mexican Born			
	N	%	Weight	Height	N	%	Weight	Height
Nativity								
US Born	3,418	37.44	143.01	66.31				
Mexico Born	5,712	62.56	140.40	65.61				
Ages								
Teens	513	15.01	135.74	65.85	577	10.10	132.69	65.09
20s	1,855	54.27	143.61	66.50	2,857	50.02	140.90	65.82
30s	700	20.48	145.85	66.34	1,416	24.79	142.24	65.68
40s	243	7.11	144.75	65.87	581	10.17	141.44	65.25
50s	83	2.43	146.27	66.12	214	3.75	140.49	65.07
60s	24	.70	140.15	64.94	67	1.17	136.87	64.86
Occupations								
White-Collar	64	1.87	141.91	66.70	85	1.49	137.85	65.74
Skilled	296	8.66	142.30	66.12	690	12.08	137.87	65.43
Farmer	310	9.07	145.36	66.70	310	5.43	144.50	65.67
Unskilled	2,663	77.91	142.94	66.27	4,513	79.01	140.63	65.65
No Occupation	85	2.49	139.77	66.30	114	2.00	137.29	65.08
Received								
1870	30	.88	143.67	65.55	165	2.89	141.04	65.51
1880	267	7.81	143.29	66.36	678	11.87	141.24	66.01
1890	803	23.49	143.15	66.24	1,329	23.27	141.61	65.90
1900	967	28.29	143.30	66.25	1,615	28.27	140.94	65.43
1910	1,287	37.65	142.59	66.45	1,847	32.34	138.68	65.45
1920	64	1.87	141.00	65.21	78	1.37	140.54	65.23
Residence								
Arizona	428	12.52	141.55	66.17	1,721	30.13	140.11	65.69
Colorado	84	2.46	141.62	65.39	96	1.68	141.73	65.34
New Mexico	1,349	39.47	143.86	66.25	556	9.73	143.96	65.80
Texas	1,557	45.55	142.74	66.45	3,339	58.46	139.91	65.55

Source: Arizona State History and Archives Division, State Capital, Suite 342, 1700 West Washington, Phoenix, AZ 85007; Colorado State Archives, 1313 Sherman, Room 1B20, Denver, CO 80203; New Mexico State Records Center and Archives, 1205 Camino Carlos Rey, Santa Fe, NM 87507; Texas State Library and Archives Commission, P.O. Box 12927, Austin, TX 78711.

Table 1 summarizes 19th century Mexican population characteristics in Western state prisons and indicates that over one-half of Mexican inmates were incarcerated in Texas. Little more than a third of Mexicans were born in the American West. Like modern populations, younger inmates were more common than older inmates (Hirshi and Gottfredson, 1983; Carson, 2009). US born Mexicans were more likely to be farmers. Mexican nativity was more common early in the 19th century, but US birth became more common over time. Arizona had a high percentage of Mexicans born in Mexico, while New Mexico had more Mexicans that were born in the West. While a few female weights and heights were recorded, their numbers are small, so only Mexican male inmates are considered here.[3]

To determine obesity's prevalence, the World Health Organization (WHO) established obesity status in terms of BMI. Individuals with BMIs greater than 29.9 are obese; BMIs between 29.9 and 24.9 are overweight; individuals with BMIs less than or equal to 24.9 and greater than 18.5 are in the normal category; BMIs less than 18.5 are underweight.

[3] There were 30 Mexican females in American prisons between the ages of 14 and 22 with average BMIs of 21.5. There were 63 females between the ages of 23 and 55, with an average BMI of 23.1.

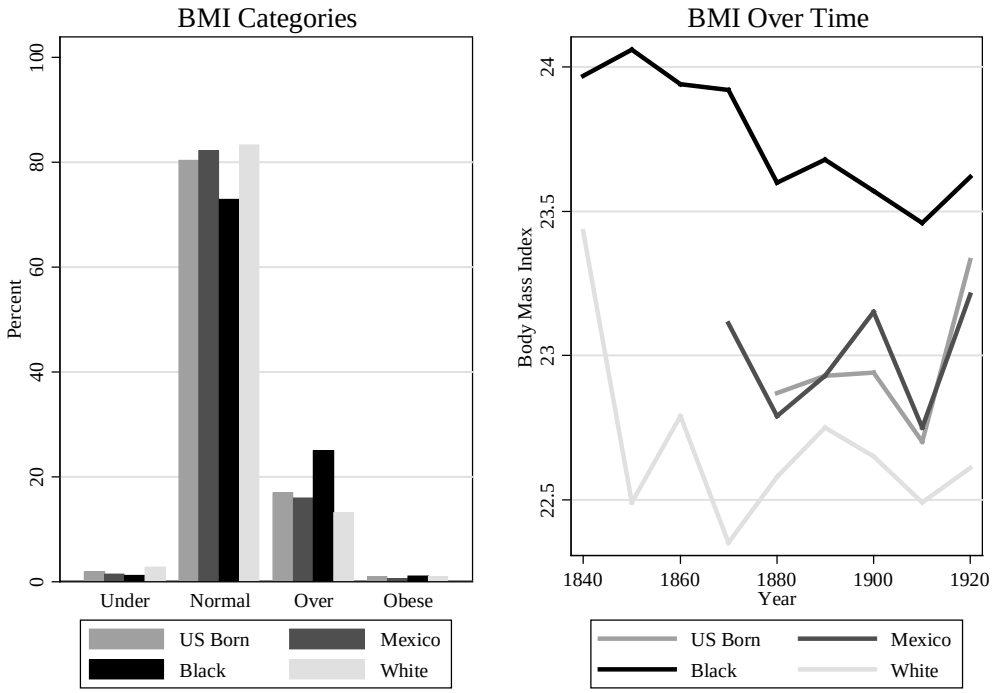

Figure 1, Late 19th and Early 20th century Mexican BMIs by Category and Over Time

Source: See Table 1.

Notes: US Mexican-born represents Mexicans born in the United States. Mexicans born in Mexico are Mexicans born in Mexico but who migrated to the American West. BMI estimates over time are from Carson (2007).

The majority of 19th century Mexicans in the American West were in the normal category (Figure 1); neither starvation nor obesity was common. Average Mexican-born BMIs were 22.93, while average US-born Mexican BMIs were 22.87. There were surprisingly few Mexicans in the underweight category, and few in overweight and obese categories. To the degree that BMIs represent access to current net nutrition, 19th century Mexican BMIs were constant overtime. However, rather than a sign of adequate Mexican diets in the Western US,

low and constant Mexican BMIs probably represents subsistent conditions among Mexicans in the American West (Carson, 2007, pp. 45-46).

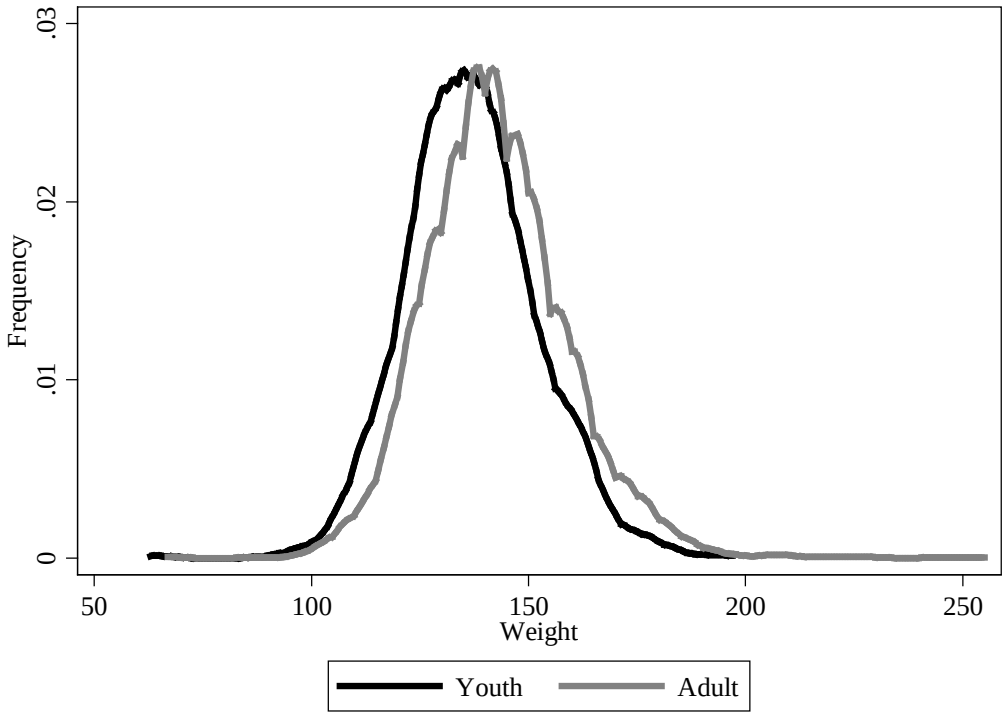

Figure 2, Mexican Youth and Adult Weight Comparison

Source: See Table 1.

To illustrate how 19th century Mexican weights were distributed, weight kernel density estimates are presented in Figure 2 and illustrates that Mexican weights were distributed symmetrically. Average Mexican youth and adult weights were 136.93 and 142.61 pounds, respectively. By comparison, 19th century US black and white youth weights were 144.21 and 140.94 pounds. During the same period, black and white adult weights were 154.09 and 148.00 (Carson, 2015b), indicating that Mexican weights in the American West were lower than both

their black and white counterparts. In sum, the majority of late 19th and early 20th century Mexican BMIs were in normal categories, and Mexican weights were lower than their US-born black and white equivalents.

IV. Combined Demographic, Wealth, Inequality, and Environmental Effects with Weight

Across the distribution, 19th century Mexican weight varied with demographics, observation period, socioeconomic status, and nativity. To better understand Mexican weight variation, a conditional quantile regression function is constructed. Two advantages of quantile regressions in weight studies are greater description of covariate effects across the distribution and more robust estimation in the presence of an unknown height truncation point (Galenson and Conley, 1994). Quantile estimation is also important in white weight and BMI studies because late 19th and early 20th century US BMIs in the 95th quantile increased at the same time that average and median white BMIs decreased (Carson, 2012a), indicating that cross distributional variation is important when comparing weight.

Let w_i be the i^{th} individual's weight, and x_i be the vector of covariates representing demographic characteristics, observation period, and socioeconomic status. The conditional quantile function is

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

which is the p^{th}-weight quantile, given x (Koenker and Bassett, 1978; Koenker and Bassett, 1982). The interpretation of the coefficient θ_i is the relationship for the i^{th} covariate on the weight distribution at the p^{th} quantile. For example, the farmer dummy variable coefficient at the median (.5 quantile) is the average difference in weight that keeps a farmer's weight at the

median relative to workers in other occupations. We now test how Mexican weights were related to demographic, socioeconomic characteristics, and residence.

$$Weight_i^p = \theta_0^p + \theta_H^p Inches_i + \sum_{c=1}^{2} \theta_c^p Complexion_{i+} \sum_{a=15}^{60} \theta_a^p Age_t + \sum_{t=1870}^{1920} \theta_t^p Observation\ Period_t$$

$$+ \sum_{l=1}^{5} \theta_l^p Occupations_i + \sum_{r=1}^{3} \theta_r^p \text{Re}sidence_i + \varepsilon_i^p$$

Height in inches is included to account for the positive relationship between weight and height. Complexion dummy variables are included to account for the relationship between weight variation and Mexican complexion. Youth age dummy variables are included in one year intervals between ages 15 and 22; adult age dummy variables are included in ten year intervals for ages 30 through 60.[4] To account for the relationship with weights over time, observation period dummy variables are included in ten year intervals between 1870 and 1920. Occupation dummy variables are included for white-collar, skilled, farming, and unskilled occupations. Prison dummy variables are included to account for the relationship between weights and residence at the time of measurement.

[4] A continuous age variable was initially used to identify the relationship between height and age. However, stature increases with age during their teen ages. Alternatively, statures remain approximately constant between ages 23 and 40. There is minor, nearly imperceptible shrinkage in the 40s and 50s, and there is perceptible shrinkage with age after 70 years old. Consequently, dummy variables impose more flexibility on the relationship between height and age and have become the norm in several anthropometric studies.

Table 2, Mexican Weight Quantile by Height, Demographics, Socioeconomic Status, and Residence

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
	OLS	25th	50th	75th	90th	95th
Intercept	-73.28***	-71.79***	-76.84***	-77.25***	-69.88***	-57.48***
Height						
Inches	3.26***	3.10***	3.30***	3.50***	3.50***	3.38***
Complexion						
Light	-3.14*	-1.80	-2.95	-2.75	-8.00	-18.21**
Medium	Reference	Reference	Reference	Reference	Reference	Reference
Dark	-2.23	-2.04	-2.37	-1.25	-5.13	-13.91
Ages						
15	-14.18***	-10.33***	-15.18***	-15.50***	-19.00***	-18.00
16	-7.27***	-5.86**	-5.55***	-7.13***	-8.63***	-9.78***
17	-7.44***	-6.71***	-8.75***	-8.38***	-9.38***	-6.88*
18	-6.12***	-4.02***	-5.50***	-6.88***	-7.50***	-8.51***
19	-4.67***	-4.80***	-3.63***	-5.00***	-6.00***	-5.00***
20	-1.43**	-.374	-.902	-1.75**	-3.13**	-4.44***
21	-1.80***	-.870	-1.86**	-1.50	-1.88	-1.31
22	-1.49**	-.844	-1.61**	-1.50**	-2.75***	-3.05*
23-29	Reference	Reference	Reference	Reference	Reference	Reference
30s	1.52***	1.10**	1.35***	1.50***	1.38	3.05**
40s	1.86***	.695	1.25*	3.38***	4.13***	3.75*
50s	1.85**	.085	.554	2.38**	4.75**	3.95
60s	-.917	-4.89*	-2.10	7.15^{-9}	4.75	5.39
Received						
1870	1.96*	2.21**	1.61	.875	1.13	-.039
1880	-1.17**	-.946*	-.946*	-1.63**	-3.13***	-3.31**
1890	-.628	-.374	-.359	-1.00	-1.88**	-2.07*
1900	Reference	Reference	Reference	Reference	Reference	Reference
1910	-1.52***	-1.52***	-1.47***	-2.13***	-1.63**	-1.94***
1920	-.294	2.91	-.424	-3.13	.125	-5.74
Occupations						
White-Collar	-1.81	-3.53	-2.62*	-5.00*	-1.13	7.16
Skilled	-.769	-1.36	-1.71	-3.88**	-.250	1.36
Farmer	2.93***	2.24	2.61*	.250	2.25	5.74
Unskilled	.655	1.01	.804	-2.63*	-1.13	-.377
No Occupation	Reference	Reference	Reference	Reference	Reference	Reference
Residence						
Arizona	1.93	2.10	2.16	.250	2.88	12.55
Colorado	2.16	.442	1.64	4.25**	.375	5.40

New Mexico	1.77***	1.38***	1.46***	1.88***	2.63***	4.49
Texas	Reference	Reference	Reference	Reference	Reference	Reference
N	9,130	9,130	9,130	9,130	9,130	9,130
R^2	.3047	.1715	.1706	.1803	.1820	.1778

Source: See Table 1.

Notes: *** significant at .01.; ** significant at .05; significant. Standard errors are bootstrapped standard errors.

Three paths of inquiry are considered when analyzing late 19th and early 20th century Mexican weight variation. First, Table 2 and Figure 3 demonstrate that between 1870 and 1920, Mexican weight decreased by 1.6 percent, while Mexican height decreased by .10 percent, indicating that stagnating 19th century Mexican BMIs was due to decreasing weight. Mexican weight variation over time also indicates that throughout the late 19th and early 20th centuries that current net nutrition decreased across the distribution (Figure 4). For example at the 25th quantile, between 1870 and 1920, weights increased by .5 percent, and decreased at the median and 95th quantile by 1.4 and 3.2 percent, respectively, indicating that current net nutrition for Mexican workers living in the American West consolidated in the late 19th and early 20th centuries.

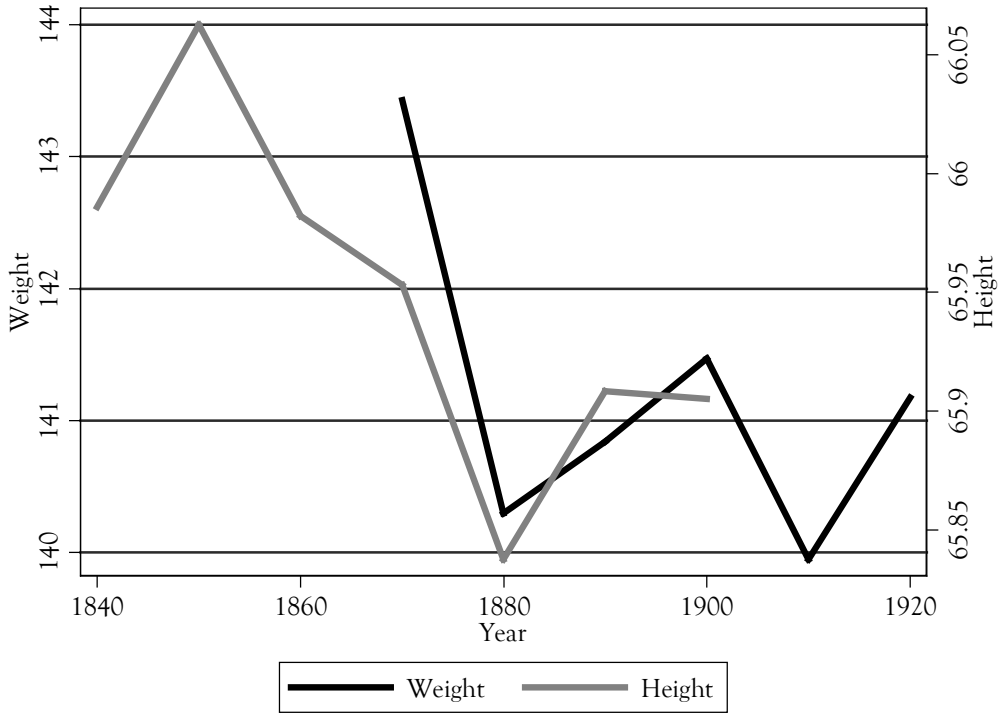

Figure 3, Nineteenth Century Mexican Weight and Height over Time

Source: See Table 1.

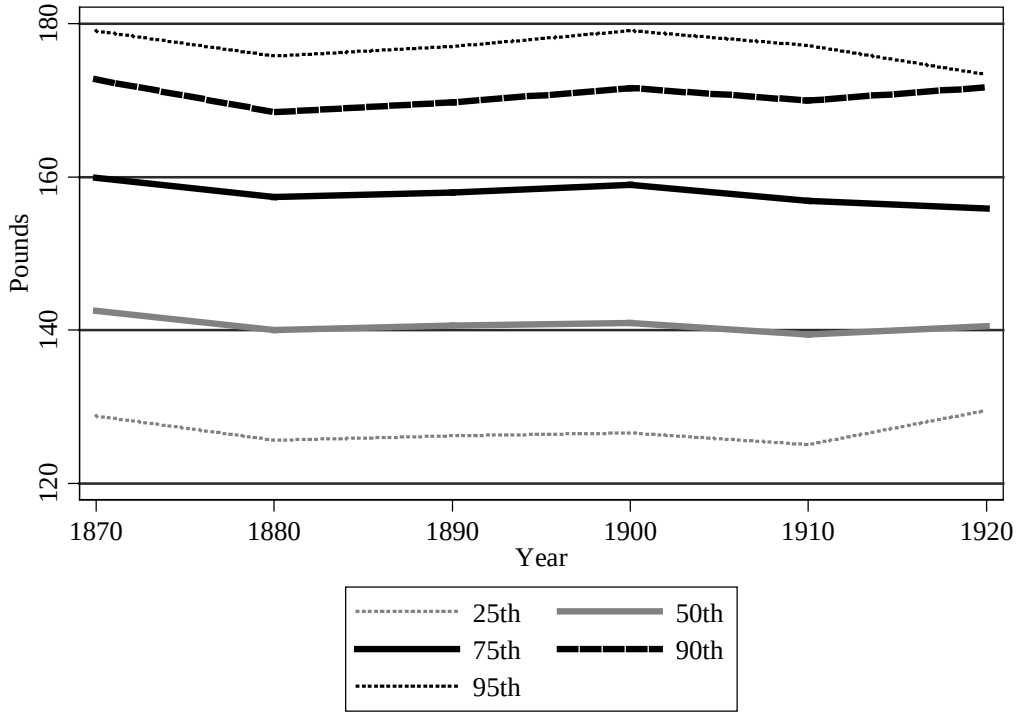

Figure 4, Mexican weight over time

Mexican Weight by Year

Source: See Tables 1.

Notes: Heights used in the weight models are 65 inches for the 25th quantile, 66 inches for the 50th quantile, 67.5 inches for the 75th quantile, 69 inches for the 90th quantile, and 70 inches for the 95th quantile.

Second, like stature, BMI, and nutrition, Mexican weight varied by occupations, and Mexican farmer's proximity to nutrition and removal from urban disease environments was associated with greater weight and better net nutrition (Figure 5). Part of heavier farmer weights was also related to physical activity, and weight represents a person's composition between muscle and fat. Farmers were physically more active and had greater muscle mass,

which is associated with heavier weight per unit of height (Carson, 2015c). There were also various 19th century disease episodes; however, Mexican farmers were removed from densely populated areas where diseases were more easily propagated. Skilled workers had the lowest weights, but like other occupations, skilled worker weights increased across the weight distribution. In sum, Mexican farmers had greater access to nutrition, were more physically active, and were less exposed to the deleterious effects of disease and had greater weight.

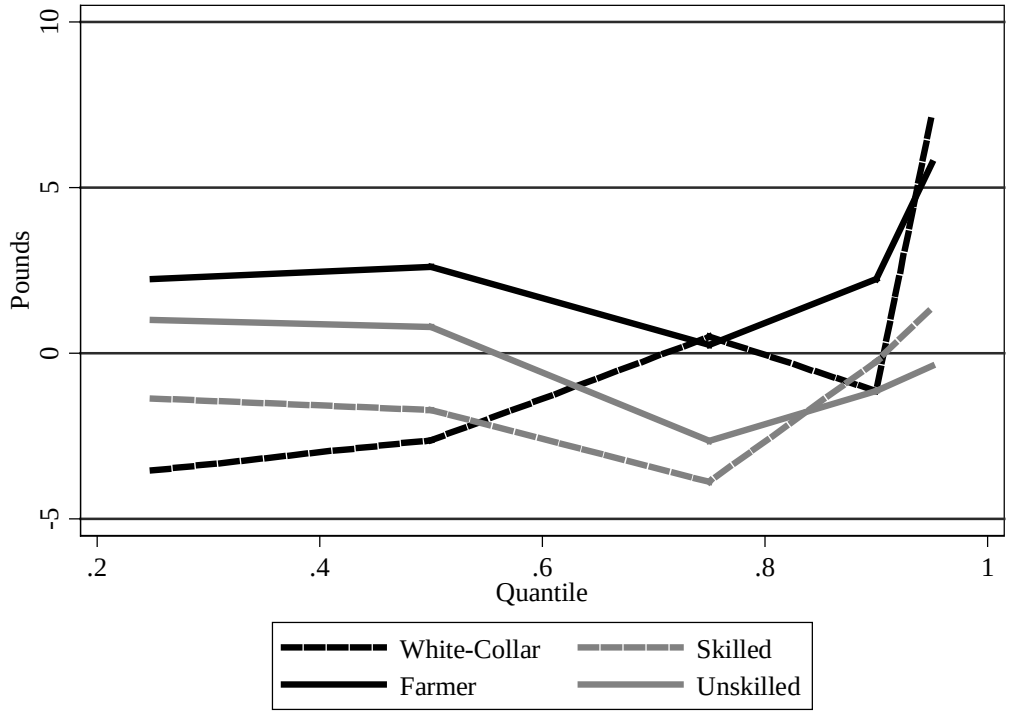

Figure 5, Mexican Weight by Occupations

Source: See Tables 1

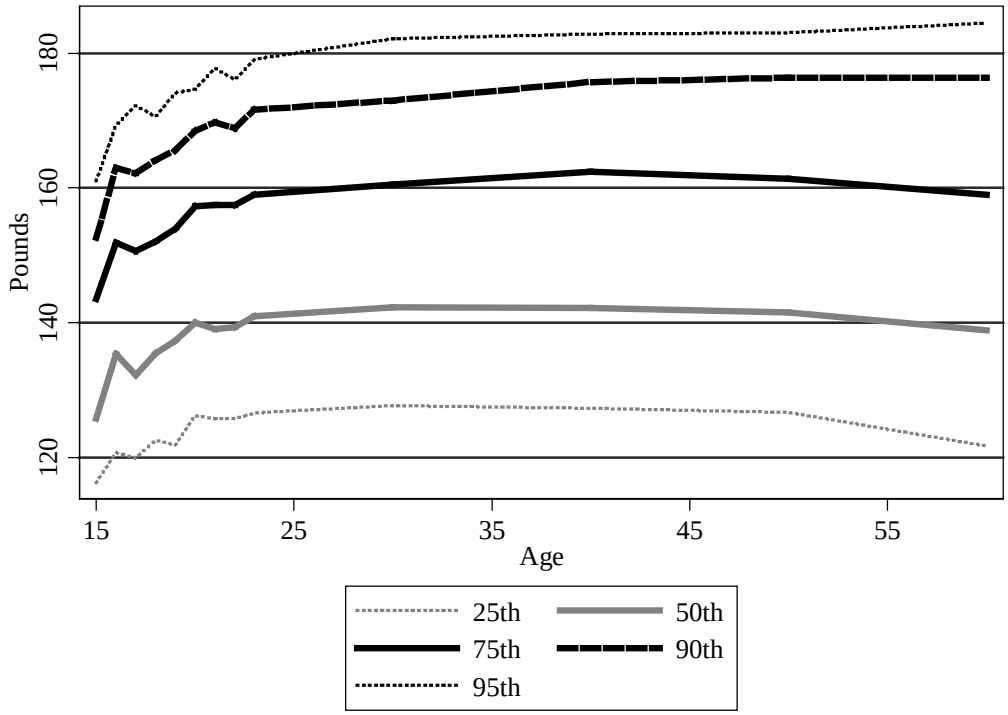

Figure 6, Mexican Weight by Age

Source: See Tables 1 and 2.

Notes: Heights used in the weight models are 65 inches for the 25th quantile, 66 inches for the 50th quantile, 67.5 inches for the 75th quantile, 69 inches for the 90th quantile, and 70 inches for the 95th quantile.

Other patterns are consistent with expectations. Mexicans residing in New Mexico had greater weights than other Mexicans living in the US. However, Mexican complexion was not related to weight, and Mexican weight increases with age were modest (Figure 6); lower Mexican weights at older ages were also similar to weight decreases with age experienced by African-Americans in the 19th century US (Carson, 2015b). These weight-age patterns indicate

that Mexican workers did not receive excess dietary allocations and were at the bottom of the net nutritional distribution.

Estimating the Significance of Collective Effects

Quantile weight regression coefficients account for individual relationships between weight and observable characteristics. They do not, however, account for the combined relationships for how observable characteristic subsets were associated with weight. For example, by itself, the farmer occupation dummy variable offers insight into how weight varied across the distribution for agricultural occupations, but individual effects do not account for how weights varied collectively with occupations. Sensitivity analysis accounts for how a dependent variable differs with an unconstrained model when variable subsets are excluded (Leamer, 1983; Leamer, 2010; Angrist and Pishke, 2010, pp. 3-6). Table 3 presents weight sensitivity models when height, complexion, age, decade received, occupation, and residence are excluded. Model 1 presents the unrestricted Mexican weight model with height, demographic, complexion, and socioeconomic variables. Models 2 through 7 present restricted models when subsequent classes are omitted, which are used to determine how weight varied with cohort subsets.

Table 3, Mexican Weight Sensitivity Analysis by Height, Demographics, Socioeconomic Status, and Residence

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*
	Total	Height Omitted	Complexion Omitted	Age Omitted	Received Omitted	Occupation Omitted	Residence Omitted
Intercept	-73.28***	141.28***	-73.09***	-76.57***	-74.14***	-73.49***	-73.28***
Height							
Inches	3.26***		3.26***	3.30***	3.26***	3.28***	3.26***
Complexion							
Light	-3.14	-1.66		-3.11	-3.41*	-3.07	-3.14
Medium	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Dark	-2.23	-1.98		-1.93	-2.23	-2.11	-2.23
Ages							
15	-14.18***	-20.84***	-14.21***		-14.20***	-14.23***	-14.18***
16	-7.27***	-11.84***	-7.21***		-7.22***	-7.19***	-7.27***
17	-7.44***	-10.36***	7.43***		-7.59***	-7.56***	-7.44***
18	-6.12***	-7.82***	-6.11***		-6.23***	-6.11***	-6.12***
19	-4.67***	-6.25***	-4.49***		-4.77***	-4.67***	-4.68***
20	-1.43**	-2.21***	-1.45**		-1.46**	-1.39**	-1.43***
21	-1.80***	-2.32***	-1.81***		-1.85***	-1.74***	-1.80***
22	-1.49***	-1.85***	-1.50***		-1.52***	-1.47***	-1.49***
23-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30s	1.52***	.727	1.52***		1.53***	1.55***	1.52***
40s	1.86***	-.469	1.88***		1.94***	1.95***	1.86***
50s	1.85***	-.777	1.87*		1.78*	1.96*	1.85*
60s	-.917	-5.06**	-.929		-.953	-.790	-.917
Observation Period							
1870s	1.96**	1.21	1.94**	2.00**		1.87**	1.96**
1880s	-1.17**	-.115	-1.20**	-1.09**		-1.07**	-1.17**
1890s	-.628	.295	-.661*	-.515		-.632	-.628
1900s	Reference	Reference	Reference	Reference	Reference	Reference	Reference
1910s	-1.52***	-1.16***	-1.57***	-1.87***		-1.51***	-1.52***
1920s	-.294	-3.05	-.280	.103		-.457	-.294

Occupations							
White Collar	-1.81	-.097	-1.79	-1.59	-1.33		-1.81
Skilled	-.769	-.895	-.799	.222	-.249		-.769
Farmers	2.93**	4.66***	2.92**	3.71***	3.28***		2.93**
Unskilled	.655	1.30	.644	.898	1.31		.655
No Occupation	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Residence							
Arizona	1.93	1.47	-.423	2.18	1.86	1.72	1.93
Colorado	2.16	2.70	2.16	2.77	1.40	2.52	2.16
New Mexico	1.77***	2.69***	1.77***	2.23***	1.67***	1.80***	1.77***
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference
N	9,130	9,130	9,130	9,130	9,130	9,130	9,130
R^2	.3047	.0467	.3045	.2837	.3028	.3022	.3047

Source: See Table 1.

During the late 19th and early 20th centuries, there were two important collective weight relationships that varied with characteristics among Mexicans living in the American West: height and age. There was a positive relationship between weight and height, and when height is excluded, the relationship between weight, age, observation period, nativity, socioeconomic variables, and residence varies considerably, indicating that weight had a significant independent relationship with height (Carson, 2013). Height omissions also upwardly bias the relationship between weights, occupations, and residence, while downwardly biasing the relationship between weight and age. In addition, an F-test test between unrestricted and restricted height models indicates that height was significant $F(1, 9{,}102)=2{,}526.13$, $p=.0000$.

After accounting for height, there was little Mexican weight variation with age, which indicates that after accounting for height, Mexican youths did not put on significant weight with age (Figure 6); the relationship between Mexican youth ages and current net nutrition was

limited. A joint hypothesis test on Mexican ages demonstrates that weights were significantly related with age, F(12, 9,102)=28.80 p=.000; however, the 19th century collective relationship between weight and age indicates that when age is omitted, there is little variation with other coefficients, indicating that weight was related more with height than age. As adolescents age, height increases, and individuals gain weight with age (Williams and Woods, 2006; Sorkin et al, 1999; Sorkin et al. 1999).

The relationship between weight and socioeconomic status indicates that Mexican farmers consistently had greater weights than workers in other occupations. A joint hypothesis test on occupations indicates that weight was collectively related with occupations, F(1, 9,102)=6.46, p=000. Throughout the late 19th and early 20th centuries, rural Mexican farmers were in closer proximity to more nutritious diets than workers in other occupations and were far removed from urban occupations where disease was easily spread. Part of farmer weights may also be related to greater physical activity, indicating that farmers' had sufficient calories to maintain weight. Remaining model restrictions indicate there is little relationship between 19th century Mexican weight and complexion, period observed, and residence.

Estimating the Magnitude of Choice and non-Choice Characteristics

Weight variation is sensitive to two general characteristics: choice and non-choice characteristics. For example, height and age are two non-choice characteristics that individuals have no control. However, occupations and residence are two characteristics that individuals exercise considerable control. F-statistics test the collective relationship between joint characterisics. They do not, however, provide a magnitude for weight variation that restricted variables had with 19th century Mexican weight variation. To account for restricted variables'

magnitude with weight variation, the percentage change in the restricted model sum of squared regressions (SSR_R) relative to the unrestricted model (SSR_U) are reported for each set of observable characteristics.

Let the relative magnitude of the restricted set of variables be the difference between models explained and unexplained sum of squared errors (Table 3). Unrestricted and restricted model's R^2 are presented in Table 3.

$$\%\Delta SSR = \frac{SSR_r - SSR_u}{SSR_u} = \frac{R_r^2 - R_u^2}{R_u^2} = \%\Delta R^2$$

where SSR_U and SSR_R are the explained variation in the unrestricted and restricted models, respectively. Within the set of non-choice characteristics associated with weight variation, height accounted for an 84.7 percent decrease in weight variation; age accounted for a 6.9 percent decrease in weight variation; complexion only accounted for a .07 percent weight decrease. Within the set of choice variables, occupations account for a .82 percent weight decrease; observation year accounts for .62 percent decrease in weight variation. In sum, height accounts for the greatest weight variation, and non-choice characteristics had the greatest explanatory power in 19th century weight variation. Occupations account for the largest magnitude associated with choice characteristics.

V. Conclusion

When traditional measures for economic welfare are scarce or unreliable, stature and BMI are now well accepted measures that reflect economic well-being during development and are compliments to traditional measures for economic welfare when they are available. However, interpreting BMI variation is difficult because it represents the ratio of net current to

net cumulative nutrition, which indicates that an alternative to net current nutrition is needed. Weight—after controlling for height—is an important alternative to BMI because it only reflects changes in current net biological conditions, and this study analyzes late 19th and early 20th century Mexican weights to assess how net nutrition varied over time, by demographic characteristics, and socioeconomic status.

Nineteenth century Mexican weights were symmetrically distributed, and the weight of Mexicans in the American West was neither underweight nor obese. The weight of Mexicans living in Western United States decreased slightly between 1870 and 1920, and Mexican current net nutrition remained low throughout the period. Between 1870 and 1920, Mexican weight variation consolidated over time, indicating that current net nutrition converged among the working class in the late 19th and early 20th centuries. Rural farmers were in close proximity to agricultural diets, which had greater amounts of proteins and complex carbohydrates. In sum, height and age were the most significant collective effects and had the greatest magnitude variation with Mexican weight, indicating that 19th century current net nutrition was largely beyond the control of Mexicans living in the American West. Therefore, there are complex relationships between height, age, and weight, and Mexican weight differences were influenced the most by factors beyond a person's control.

References

Angrist, Joshua and Jörn-Steffen Pischke. (2010). "The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics." *Journal of Economic Perspectives* 24, 2, pp. 3-30.

Barquera, Simon, Lucia Hernandez-Barrera, Maria Lizbeth and Barry Popkin (2008). "Energy Intake from Beverages Is Increasing Among Mexican Adolescents, and Adults." *Journal of Nutrition* 138(12), pp. 2454-2461.

Bortz, Jeffrey and Stephen Haber (2002). *The Mexican Economy, 1870-1930: Essays on the Economic History of Institutions, Revolution, and Growth*. Stanford: Stanford University Press.

Carson, Scott Alan. (2005) "Chinese Sojourn Labor and the American Transcontinental Railroad: Transaction Costs, Labor Queuing and Demand-Side Learning," *Journal of Institutional and Theoretical Economics*. Volume 161(1), pp. 80-102.

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

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

Carson, Scott Alan. (2012a), "Nineteenth Century Race, Body Mass, and Industrialization: Evidence from American Prisons," *Journal of Interdisciplinary History*. 42, pp. 371-391.

Carson, Scott Alan. (2012b). "Demographic, Residential, and Socioeconomic Effects on the Distribution of Nineteenth Century White Body Mass Index Values." *Mathematical Population Studies* 19. pp. 1-19.

Carson, Scott Alan. (2013). "Biological Conditions and Economic Development:

Westward Expansion and Health in Late 19th and Early 20th Century Montana." *Journal of Historical Society,*13(1), pp. 51-68.

Carson, Scott Alan. (2013). "The Significance and Relative Contributions to Demographics, Residence, and Socioeconomic Status in 19th Century US BMI Variation." *Historical Methods* 46(2). pp. 67-76

Carson, Scott Alan. (2015a). "Biological Conditions and Economic Conditions: Nineteenth-Century Stature on the U. S. Great Plains." *Human Nature* 26, pp. 123-142.

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

Carson, Scott Alan. (2015c) "The Mexican Calorie Allocation Among the Working Class in the American West, 1870-1920." *Essays in Economic & Business History* 33, pp. 26-50.

Coclanis, Peter and John Komlos. (1995). "Nutrition and Economic Development in Post-Reconstruction South Carolina." *Social Science History* 19, pp. 91-115.

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

Faulhaber, J. (1970) The antropometry of living indians. In Wauchope, R. (ed.) Handbook of Middle American Indians, vol. 9x. University of Texas Press, Austin, TX, pp. 82–104.

Flegal, Katherine, Margaret Carroll, Brian Kit, and Cynthia Ogden. (2012). "Prevalence of Obesity and Trends in the Distribution of Body Mass Index among US Adults, 1999-2010." *Journal of the American Medical Association* 307, 5, pp. 491-497.

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

Conley, Timothy G. and David W. Galenson. (1994). **"**Quantile Regression Analysis of

Censored Wealth Data."; *Historical Methods*, *27*(4), pp. 149-65.

Gamio, Manuel. 1969. *Mexican Immigration to the United States.* New York: Arno Press.

Goldstein, M. (1943) Demographic and Bodily Changes in Descendants of Mexican Immigrants. University of Texas Press, Austin.

Haber, Stephen H. (1989). *Industry and Underdevelopment: The Industrialization of Mexico.* Stanford: Stanford University Press.

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

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

Koenker, Roger, "Robust Methods in Econometrics," Econometric Reviews , (1), 213- 215.

Koenker, Roger and G Bassett (1978) "Regression Quantiles," Econometrica, 46: 33-50.

Koenker, Roger (2005) *Quantile Regression*, Cambridge University Press, Cambridge.

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

Ladurie, E. L., 1979. The conscripts of 1968: A study of the correlation between geographical mobility, delinquency and physical stature and other aspects of the situation of the young Frenchman called to do military service that year.

In: Reynolds B, Reynolds S, editors. *The Territory of the Historian*, (Chicago: University of Chicago Press). 33-60.

Leamer, Edward (1983) "Let's Take the Con Out of Econometrics." *American Economic Review* 73(1), 31-43.

Leamer, Edward (2010) "Tantalus on the Road to Asymptopia," *Journal of Economic Perspectives* 24(2), 31-46.

Margo, R., Steckel, R. 1992. The nutrition and health of slaves and antebellum southern whites. In *Without Consent or Contract: Conditions of Slave Life and the Transition to Freedom,* edited by R. W. Fogel and S. L. Engerman, New York: Norton, 508-521.

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

Ogden, Cynthia, Margaret Carroll, Brian Kit, and Katherine Flegal. (2012). "Prevalence of Obesity and Trends in Body Mass Index among US Children and Adolescents, 1999-2010." *Journal of the American Medical Association* 307, 5 pp. 483-490.

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

Rosenberg. Charles. (1962). *The Cholera Years: The United States in 1832, 1849, and 1866.* Chicago: University of Chicago Press.

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

Sorkin, J.D., Muller, D.C., Andres, R., (1999). "Longitudinal Change in Height of Men and

Women: Implications for Interpretation of the Body Mass Index: the Baltimore Longitudinal Study of Aging." *American Journal of Epidemiology,* 150, pp. 969-977.

Sorkin, J.D., Muller, D.C., Andres, R., (1999). "Longitudinal Change in the Heights of Men and Women: Consequential Effects of Body Mass Index." *Epidemiological Reviews* 21, pp. 247-260.

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

Williams, PT and PD Wood. (2006). "The Effects of Changing Exercise Levels on Weight and Age-Related Weight Gain." *International Journal of Obesity* 30, pp. 543-551.

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