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## International Migration and Net Nutrition in the Late 19th and Early 20th Centuries: Evidence from Prison Records

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# International Migration and Net Nutrition in the Late 19<sup>th</sup> and Early 20<sup>th</sup> Centuries: Evidence from Prison Records

## Abstract

In migration studies, immigrant health is a concern before, during, and after migration. This study uses a large late 19th and early 20th century data set of over 20 US prisons to assess migrant net nutrition. Native-born individuals were taller and had the lowest BMIs. International immigrants had lower BMIs and shorter statures. After controlling for other characteristics, native-born females had lower BMIs than men; however, foreign-born women's BMIs were higher than domestic-born women. Females and males with darker complexions had greater BMIs than their counterparts with fairer complexions.

JEL-Codes: I120, I310, J310, J700, N310.

Keywords: nineteenth century US health, immigrant health, BMI, malnourishment.

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I appreciate comments from Lee Carson and Paul Hodges.

## I. Introduction

Eighteenth and 19<sup>th</sup> century European migration to the developing United States was among the leading economic and historical events of the time. With an abundance of land, early colonial economies faced labor shortages, while European immigrants who lacked land found opportunity in the developing United States (Atack and Bateman, 1987). With the Louisiana Purchase and later Mexican Cession, early US land acquisitions created opportunity for land-starved European immigrants (Rosenbloom, 2002). Primary European source countries were Great Britain, Ireland, and Germany, and before colonial markets developed, early immigrants found credit to migrate with claims against their future labor after arriving in the colonies (Galenson, 1981; Cohen, 2009; Carson, 2001, Carson, 2002). Except for specific periods of political and religious change, the primary factor motivating migration is that individuals choose to migrate when the discounted net benefits of migration exceed realized costs (Sjaastad, 1962). After transportation costs fell, immigrants independently bore the costs of migration, and 19<sup>th</sup> century European immigration increased (Grubb and Stitt, 1994; Cohen, 2009). Subsequently, US immigration increased when the difference between destination and host regions net discounted income and wealth exceeded the costs of migration, and the opening of the American West increased the discounted net benefits to migration.

In migration studies, immigrant health is a concern before, during, and after migration (Rechel et al. 2013). Because of migration stress, health disparities across populations include cardiovascular disease, stroke, hypertension, and diabetes (Rechel et al., 2013, pp. 1238).

Nevertheless, compared to non-migrant health in host countries, migrants may not have higher all-case mortality. Data are limited in development studies to surviving health records, and when other measures for material conditions are scarce or unreliable, the body mass index (BMI), height, and weight are three biological measures for 19<sup>th</sup> century health (Fogel et al, 1978; Fogel, et al 1979; Fogel, 1986; Margo and Steckel, 1983). BMI is weight in kilograms divided by height in meters squared. Roughly defined, BMIs are kilograms weighted per square meter and is an important measure for current net nutrition (Case and Deaton, 2020, p. 80). Nonetheless, BMIs must be interpreted with caution because they do not account for bone, sinew, and muscle-to-fat composition (Burkhauser and Cawley, 2008). Late 19<sup>th</sup> and early 20<sup>th</sup> century body mass varied by race, and 19<sup>th</sup> century African and European Americans were in healthy, normal and overweight BMI ranges (Carson, 2009; Carson, 2016). Moreover, there is a modern obesity epidemic, and evaluating historical black and white BMIs before the modern epidemic began sheds light on how net nutrition and health varied with the modern diet and lifestyle. As a result, health associated with migration is an important concern in economic studies, and when traditional measures for material conditions are unavailable, body mass, height, and weight are important measures to evaluate migrant health.

There are various explanations offered for the relationship between BMI variation and health (Cawley, 2011; Cawley, 2015). The traditional view is that BMIs increase when there is an excess of calories consumed over calories required for work and to withstand the physical environment (Cawley, 2011; Rashad and Komlos, 2016). However, this explanation does not account for obesity across individuals or time. For example, individuals who consume the same number of calories, but different dietary carbohydrates, proteins, and fats compositions may be more prone to obesity because simple sugars and saturated fats are associated with metabolic

disorders (Popkin, 1993; Popkin, 2009; Taubes, 2010; Riera-Crichton and Tefft, 2014).

Nevertheless, BMI variation may also be explained by stress triggered with hormonal responses related to obesity (Rosemuend and Björntorp, 1998; Rudman et al 1990 pp. 1 and 5). For example, the steroid cortisol is released during stressful periods and associated with the fight or flight response. Adiponectin is a protein that regulates glucose and fatty acid breakdown and is inversely related to adult percent body fat. Adiponectin is a protein that modulates multiple metabolic processes, including fatty acid oxidation and glucose regulation. Adiponectin is secreted into the bloodstream from adipose tissue and is inversely related to BMIs.<sup>1</sup> Leptin is a protein that signals to adipose tissue and regulates hunger, appetite, energy intake, and metabolism. The amino acid, ghrelin, lines the stomach and is the counterpart to the hormone leptin. Ghrelin levels increase before consumption and decrease after, and ghrelin is a fast-acting hormone that plays a role in meal initiation, while leptin regulates long-term energy balances by suppressing food intake and weight loss. Imbalances between ghrelin and leptin may contribute to obesity. In sum, there are multiple explanations for BMI variation; however, it is not clear how dietary explanations for obesity interacts with various hormones and proteins to explain historical migrant BMI, height, and weight variation.

There are various transitions throughout economic development, and the nutrition transition is the process by which traditional diets high in animal proteins and complex carbohydrates transition into modern diets high in saturated fats and simple sugars. Migration also influenced females and males differently. Female and male migration interrupted the nutritional transition at different rates, and women's net nutrition may be more affected by

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<sup>1</sup> Ukkola. O., Santaniemi, M. (2002). "Adiponectin: A Link between Excess Adiposity and Associated Co-Morbidities?" *Journal of Molecular Medicine*, 80(11), pp. 696-702.

migration than men. The dynamics of household change affecting women's material and net nutrition were related to the nutritional transition, which was also related to migration. Household resources are also shared resources, which masks net nutrition and material well-being that accrues to women (Carson, 2021a).

It is against this backdrop that this study considers three questions regarding late 19<sup>th</sup> and early 20<sup>th</sup> century BMIs compared by nativity. First, how did female and male BMIs compare by nativity and race? Native-born individuals were taller and had some of the lowest BMIs. International migrants had lower BMIs and shorter statures. Second, how did female and male domestic and foreign BMIs compare? After controlling for other characteristics, native-born females had lower BMIs than men; however, foreign-born women's BMIs were higher than domestic born women. Third, how did female and male BMIs compare by complexion? Females and males with darker complexions had greater BMIs than their counterparts with fairer complexions.

## **II. Late 19<sup>th</sup> and Early 20<sup>th</sup> Century US External Immigration**

During the 19<sup>th</sup> and early 20<sup>th</sup> centuries, individuals migrated to the US for a myriad of reasons, and a principal reason is the relative discounted net benefits between sending and receiving areas (Hicks, 1932, p. 76; Sjaastad, 1962, pp. 80-93). Hatton and Williamson (1998) consider migration to the US between 1860 and 1914 and find that immigrants were motivated by differences in expected real wages between host countries and the US, population growth between countries, the degree of industrialization and urbanization in source countries combined with previous chain migration from source countries, and pull factors within the US (Cohn, 2009). Much of early 19<sup>th</sup> century migration was associated with the prevailing transportation revolution (Atack and Passel, 1994). There are three periods of high in-migration to the US



distinct by sending regions. The first large-scale immigration between 1845 and 1852 was from Ireland, the United Kingdom, and Northern Europe, and the primary factor motivating migration was the Irish potato famines. Ireland's potato famine boosted migration during the 1840s and 1850s. During the famine's peak, around one million Irish died, while another million emigrated. The second large-scale immigration wave was from 1890 through 1915 from Southern and Eastern Europe. Migration slowed during the US Civil War but increased during the 1870s and 1880s as US economic opportunity increased. The third and on-going large-scale migration is from Asia and Latin America for 1965 through the present. Subsequently, various migration waves to the US reflect the flow of individuals to the United States.

From its inception, the issue of slavery divided the United States, and stress between North and South increased as the country developed. The 1857 economic contraction decreased employment opportunities and ignited a round of nativism that limited opportunity by ethnic status and foreign birth. These turbulent economic and political events may have influenced early US economic welfare and net nutrition by ethnicity, nativity, and urban residence. As migrants made their way West, ready access to fertile farmlands and lower transportation costs made the US a primary destination for international migrants (Atack and Passel, 1994; Cohn, 2009). Subsequently, because of its increase in population, urbanization, and industrialization, the late 19<sup>th</sup> and early 20<sup>th</sup> century US reflects US economic development and demographic change that was associated with net nutrition by nativity, ethnicity, and race.

### **III. Nineteenth and 20<sup>th</sup> Century Height, Body Mass, and Weight Data**

Military and prison records are the two primary data sources to evaluate 19<sup>th</sup> and early 20<sup>th</sup> century African and European immigrations combined with biological measures to the United States. During economic development, US military records were the first large-scale

source to evaluate height and cumulative net nutrition (Fogel et al. 1978; Fogel et al. 1979). However, while abundant, military records do not collect valuable information for stature and migration studies to the US. For example, 19<sup>th</sup> century military unit records disproportionately include individuals of European descent. Furthermore, 19<sup>th</sup> century military records reflect violence and conflict, and women—who took little role in 19<sup>th</sup> century military affairs—are absent from US military records. Fortunately, US prison records collected a greater portion of individuals of African descent and women (Haines, 2000; Steckel, 2000). However, prison records are not above scrutiny. For example, prison records are more likely from lower socioeconomic groups, that segment of society more vulnerable to economic change (citations). Prison records provide a reasonable alternative for military records and provide reasonable estimates for women and African-Americans.

Physical characteristics contain valuable information for identification in case an individual escaped and was recaptured. At the time of incarceration, individual height, weight, occupation, gender, complexion, age, and residence were collected across prisons, and inmate characteristics were recorded in detail at the time individuals were incarcerated. There are 16 prisons used in this study.<sup>2</sup> There were 4,572 women incarcerated and 172,277 men incarcerated in US prisons, indicating women were approximately 2.5 percent of the prison population.

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<sup>2</sup> Arizona State Library, Archives and Public Records, 1700 W. Washington, Phoenix, AZ 85007; Colorado State Archives, 1313 Sherman Street, Room 120, Denver, CO 80203; Idaho State Archives, 2205 Old Penitentiary Road, Boise, Idaho 83712; Illinois State Archives, Margaret Cross Norton Building, Capital Complex, Springfield, IL 62756; Kentucky Department for Libraries and Archives, 300 Coffee Tree Road, Frankfort, KY 40602; Missouri State Archives, 600 West Main Street, Jefferson City, MO 65102; William F. Winter Archives and History Building, 200 North St., Jackson, MS 39201; Montana State Archives, 225 North Roberts, Helena, MT, 59620; Nebraska State Historical Society, 1500 R Street, Lincoln, Nebraska, 68501; New Mexico State Records and Archives, 1205

The physical treatment of women in 19<sup>th</sup> century US prisons is a concern, and social prejudice at the time maintained that female criminals were threats to social cohesion and moral integrity. During the earliest years of female incarceration, there were seldom female guards or matrons, and in early prisons, sexual and physical assaults were common (Rafter, 1985; Irwin, 1987). In 1837, the Ohio State prison was the first to construct an annex exclusively for women. In 1839, New York State prison also constructed a facility to house women separate from men.

At the time individuals were admitted into prison, there were a variety of racial categories inferred from a complexion variable. Individuals of African descent were recorded as various shades of light, medium, and dark black. Individuals of European descent were recorded as light, medium, and dark. This European complexion is further supported by individuals claiming European birth incarcerated in US prisons, who were recorded with the same light, medium, and dark complexions. There were also individuals of combined African and European ancestry recorded as various shades of ‘mulatto.’ However, in the results that follow, individuals recorded as mulattos are classified as mixed-race. The Arizona and Montana prisons are the two prisons that—at least for a time—recorded both qualitative complexion classifications with a photograph, and it is clear from these photographs that individuals classified as white, black, and mixed race are consistent with modern complexion classifications.

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Camino Carlos Rey, Santa Fe, NM 87507 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 7<sup>th</sup> Avenue North, Nashville, TN 37243; Texas State Library and Archives Commission, 1201 Brazos St., Austin TX 78701; Utah State Archives, 346 South Rio Grande Street, Salt Lake City, UT 84101; Washington State Archives, 1129 Washington Street Southeast, Olympia, WA 98504.

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

**Table 1, Total, Foreign-Born, Native, Female, and Male Descriptive Statistics**

	<i>Total</i>	<i>Foreign-Born</i>	<i>Native</i>	<i>Females</i>	<i>Males</i>
<b>Intercept</b>					
Height					
Centimeters	170.31	168.02	170.65	160.87	170.56
Foreign-Born	21.87			14.83	22.057
Centimeters					
<b>Gender</b>					
Male	Reference	Reference	Reference		
Female	0.026	0.019	0.027		
Foreign-Born	0.002				
Female					
<b>Nativity</b>					
National					
Northeast	0.011		0.012	0.004	0.011
Middle-	0.139		0.159	0.121	0.140
Atlantic					
Great Lakes	Reference		Reference	Reference	Reference
Plains	0.117		0.135	0.116	0.117
Southeast	0.328		0.377	0.365	0.327
Southwest	0.164		0.189	0.198	0.164
Far West	0.022		0.026	0.016	0.022
International					
Great Britain	0.029	0.225		0.038	0.029
Europe	0.054	0.412		0.031	0.054
Canada	0.009	0.070		0.007	0.009
Latin	0.038	0.295		0.018	0.038
America					
<b>Total Ages</b>					
14	0.003	6.08 <sup>-4</sup>	0.004	0.006	0.003
15	0.007	0.002	0.007	0.012	0.006
16	0.016	0.004	0.017	0.036	0.015
17	0.026	0.008	0.028	0.045	0.025
18	0.045	0.020	0.019	0.065	0.044
19	0.049	0.027	0.052	0.061	0.048
20	0.052	0.032	0.055	0.061	0.051
21	0.058	0.038	0.062	0.058	0.059
22	0.067	0.047	0.070	0.071	0.067
23-29	Reference	Reference	Reference	Reference	Reference
30s	0.213	0.275	0.204	0.191	0.214
40s	0.089	0.150	0.080	0.074	0.090
50s	0.036	0.065	0.032	0.027	0.037
60s	0.116	0.022	0.010	0.009	0.012

<b>Foreign-Born</b>					
<b>Ages</b>					
14	7.92 <sup>-5</sup>				8.13 <sup>-5</sup>
15	2.32 <sup>-4</sup>			2.18 <sup>-4</sup>	2.32 <sup>-4</sup>
16	4.64 <sup>-4</sup>			8.71 <sup>-4</sup>	4.53 <sup>-4</sup>
17	0.001			0.001	0.001
18	0.003			0.003	0.003
19	0.004			0.003	0.004
20	0.004			0.002	0.004
21	0.005			0.002	0.005
22	0.006			0.002	0.006
23-29	Reference	Reference	Reference	Reference	Reference
30s	0.036			0.029	0.036
40s	0.019			0.019	0.020
50s	0.008			0.006	0.009
60s	0.003			0.004	0.003
<b>Occupations</b>					
Total					
Skilled	0.290	0.368	0.278	0.089	0.295
Unskilled	0.560	0.576	0.558	0.646	0.558
No	Reference	Reference	Reference	Reference	Reference
Occupation					
Foreign-Born					
Occupations					
Skilled	0.048			0.013	0.049
Unskilled	0.075			0.054	0.076
No	Reference	Reference	Reference	Reference	Reference
Occupation					
<b>Decade</b>					
<b>Received</b>					
Total					
1860s	0.015	0.014	0.015	0.004	0.015
1870s	0.084	0.063	0.087	0.067	0.085
1880s	0.148	0.146	0.148	0.185	0.147
1890s	0.195	0.196	0.194	0.176	0.195
1900s	Reference	Reference	Reference	Reference	Reference
1910s	0.240	0.267	0.236	0.228	0.241
1920s	0.037	0.034	0.037	0.053	0.036
1930s	0.016	0.008	0.017	0.005	0.016
International					
1860s	0.002				0.002
1870s	0.008			0.012	0.008

1880s	0.019			0.031	0.019
1890s	0.026			0.009	0.026
1900s	Reference	Reference	Reference	Reference	Reference
1910s	0.035			0.017	0.035
1920s	0.004			0.007	0.004
1930s	9.95 <sup>-4</sup>			2.18 <sup>-4</sup>	0.001
<b>Residence</b>					
Total					
Arizona	0.023	0.085	0.014	0.005	0.023
Colorado	0.034	0.059	0.030	0.066	0.033
Idaho	0.004	0.006	0.004	0.003	0.004
Illinois	0.067	0.127	0.058	0.110	0.066
Kentucky	0.066	0.021	0.073	0.026	0.067
Missouri	0.111	0.050	0.121	0.106	0.112
Mississippi	0.010	6.70 <sup>-4</sup>	0.011	0.007	0.010
Montana	0.052	0.104	0.044	0.019	0.052
Nebraska	0.042	0.032	0.044	0.024	0.043
New Mexico	0.017	0.031	0.015	0.012	0.017
Oregon	0.012	0.025	0.011	6.65 <sup>-4</sup>	0.013
PA, East	0.052	0.080	0.048	0.047	0.052
PA, West	0.050	0.065	0.041	0.040 <sup>-4</sup>	0.045
Philadelphia	0.051	0.079	0.047	0.082	0.051
Tennessee	0.166	0.023	0.187	0.022	0.164
Texas	Reference	Reference	Reference	Reference	Reference
Foreign-Born					
Arizona	0.011			0.001	0.011
Colorado	0.008			0.014	0.008
Idaho	0.001				7.66 <sup>-4</sup>
Illinois	0.017			0.014	0.017
Kentucky	0.003			2.18 <sup>-4</sup>	0.003
Missouri	0.007			0.003	0.007
Mississippi	9.05 <sup>-5</sup>				9.29 <sup>-5</sup>
Montana	0.014			0.004	0.014
Nebraska	0.004			0.002	0.004
New Mexico	0.004			0.001	0.004
Oregon	0.003				0.003
PA, East	0.010			0.010	0.010
PA, West	0.009			0.009	0.009
Philadelphia	0.010			0.027	0.010
Tennessee	0.003			0.001	0.003
Texas	Reference	Reference	Reference	Reference	Reference

Source: Arizona State Library, Archives and Public Records, 1700 W. Washington, Phoenix, AZ 85007; Colorado

State Archives, 1313 Sherman Street, Room 120, Denver, CO 80203; Idaho State Archives, 2205 Old Penitentiary

Road, Boise, Idaho 83712; Illinois State Archives, Margaret Cross Norton Building, Capital Complex, Springfield, IL 62756; Kentucky Department for Libraries and Archives, 300 Coffee Tree Road, Frankfort, KY 40602; Missouri State Archives, 600 West Main Street, Jefferson City, MO 65102; William F. Winter Archives and History Building, 200 North St., Jackson, MS 39201; Montana State Archives, 225 North Roberts, Helena, MT, 59620; Nebraska State Historical Society, 1500 R Street, Lincoln, Nebraska, 68501; New Mexico State Records and Archives, 1205 Camino Carlos Rey, Santa Fe, NM 87507; 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 7<sup>th</sup> Avenue North, Nashville, TN 37243; Texas State Library and Archives Commission, 1201 Brazos St., Austin TX 78701; Utah State Archives, 346 South Rio Grande Street, Salt Lake City, UT 84101; Washington State Archives, 1129 Washington Street Southeast, Olympia, WA 98504.

Table 1 illustrates that males were predictably more likely to be incarcerated than females. Whites were the largest racial category, and European immigrants were the largest part of foreign-born inmates, followed by individuals from Latin America and Britain. Domestic nativity and residence within US prison records are mostly and resided in the Southwest and Southeast. Crime and incarceration occur among the young, and most inmates were in their 20s; however, there were considerable cohorts incarcerated in their 30s and 40s (Carson, 2008; Carson, 2009b). Older foreign-born individuals were more common than native-born individuals, indicating that prisons may have been used to incarcerate older, foreign-born males who were unsuccessful in US labor markets, faced rigid hiring practices, and broke US laws, and did not conform to US laws. During the 19<sup>th</sup> century, various states enacted vagrancy laws, which targeted unemployed males who were not attached to US labor markets (Brands, 2010, p. 156). Foreign-born workers were more likely to be skilled, indicating a higher proportion of skilled workers among immigrants. Female unskilled workers were the most likely occupations



to be incarcerated, and males were over three times more likely than females to be skilled workers. Between 1900 and 1910, both immigrants and natives were most likely to be incarcerated. Residence at the time of incarceration indicates a geographic trajectory, and the foreign-born were more likely to be incarcerated in Northern latitudes and avoided the South (Atack and Bateman, 1987). Women were also more likely to be incarcerated in Illinois, indicating the Illinois prison at Joliet was used to house women and immigrants.

During the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, prison enumerators recorded a broad set of occupations and defined them narrowly. Three classifications are used here to combine occupations into similar groups: white collar and skilled, unskilled, and without listed occupations. Among males, government administrators, physicians, and the Clergy are white-collar workers. Carpenters, blacksmiths, and crafts workers are skilled workers. Unskilled workers are cooks, laborers, and miners. A final category is included for workers without defined occupations or occupations that were recorded with illegible titles. Among female, reflecting their low socioeconomic status, women's occupations were skilled, unskilled, and women with no listed occupation. Women had limited access to skilled positions, and skilled female workers were mostly to serve other women, such as dressmakers and nurses. Unskilled female occupations include cooks, housekeepers, and servants. Because there are too few female agricultural records, female and male agricultural workers are excluded from the analysis. Male inmates were more likely than the general public to be unskilled and without occupations (Table 2; Rosenblum, 2002, p. 88, Church et al, 2011). However, domestic male white-collar and skilled inmates were more likely than the general domestic-born male population to be white collar and skilled workers, while foreign-born white-collar and skilled inmates were nearly twice as likely than the general population to be white collar and skilled workers. Inmates were more

likely than the general public to be unskilled and workers without occupations (Rosenblum, 2002, p. 88).

From the beginning, selection concerns in height studies were common (Fogel, 1978; Fogel, 1979, Sokoloff and Vilaflor; Steckel 1979), however, has become more common in recent research. An early means of assessing selection is to consider characteristics by comparing prison to census records and distributions by occupational and residential distributions over time. Contrasting census to prison record occupation distributions over time by nativity provides insight into selection of socioeconomic status. Because census records disproportionately recorded male household heads, the primary comparison is between male prisoners and census male headed households. An early period of urbanization was between 1860 and 1900. In 1860, 22.50 percent of US white males were urbanized. By 1900, 46.11 percent of US white males were urbanized (IPUMs, 1860, 1870, 1880, and 1900; Ruggles et al., 2004; Cuff, 2005; Carson, 2010, pp. 470-471).

**Table 2, National US Census and Prison Records by Occupations and Decade**

	<i>Males Census</i>		<i>Male Prison Natives</i>		<i>Male Prison Foreign Born</i>	
Census	WC, Skill	Unskill, None	WC, Skill	Unskill, None	WC, Skill	Unskill, None
1870s	13.6	69.1	15.2	84.8	35.6	64.4
1880s	19.1	56.0	21.9	78.1	39.4	60.6
1890s			23.8	76.2	36.0	64.0
1900s	23.6	58.1	29.6	70.4	38.0	62.0
1910	31.2	50.4	35.8	64.2	36.5	63.5
			Female Prison Natives		Female Prison Foreign Born	
			WC, Skill	Unskill, None	WC, Skill	Unskill, None
1870s			4.7	95.3	7.6	92.5
1880s			13.0	87.0	10.7	89.3
1890s			6.9	93.1	9.8	90.2
1900s			6.1	93.9	19.5	80.5
1910			9.0	91.0	19.7	80.3

Source: See Table 1 and IPUMs. Steven Ruggles, Catherine A. Fitch, Ronald Goeken, J. David Hacker, Matt A.

Nelson, Evan Roberts, Megan Schouweiler, and Matthew Sobek. IPUMS Ancestry Full Count Data: Version 3.0

[dataset]. Minneapolis, MN

**Table 3, International Nativity to Residence within Each State**

<i>Canada</i>	27 .67	92 1.53	17 2.46	244 2.06	44 .38	139 .71	2 .12	434 4.76	78 1.04	28 .92	78 3.56	57 .62	98 1.25	43 .47	75 .26	154 .35
Europe	143 3.53	600 9.97	67 9.70	2,218 18.77	204 1.75	645 3.28	8 .46	1,190 13.05	391 5.23	102 3.34	246 11.22	1,145 12.48	818 10.40	727 8.01	186 .64	798 1.81
Great Britain	96 2.37	206 3.42	27 3.91	383 3.24	236 2.03	287 1.46	4 .23	670 7.35	111 1.48	49 1.60	235 10.72	608 6.62	571 7.26	1,022 11.26	234 .80	450 1.02
Latin America	1,692 41.72	457 7.59	21 3.04	79 .67	4 .03	83 .42	2 .12	99 1.09	158 2.11	542 17.73	9 .41	33 .36	9 .11	35 .39	22 .08	3,489 7.93
<b>Domestic</b>																
Far West	233 5.74	788 13.09	154 22.29	123 1.04	15 .13	297 1.51	3 .17	999 10.96	300 4.01	143 4.68	450 20.53	29 .32	30 .38	22 .24	66 .23	263 .60
Great Lakes	272 6.71	946 15.71	107 15.48	5,092 43.09	705 6.06	2,555 12.98	16 .092	1,735 19.03	1,025 13.71	139 4.55	330 15.05	186 2.03	468 5.95	80 .88	780 2.67	1,261 2.87
Middle Atlantic	201 4.96	609 10.11	57 8.25	1,046 8.85	349 3.00	1,004 5.10	5 .29	1,137 12.47	493 6.59	218 7.13	408 18.61	6,285 68.48	4,979 63.29	6,206 68.40	474 1.62	1,020 2.32
Northeast	69 1.70	141 2.34	25 3.62	199 1.68	30 .26	196 1.00	1 .06	333 3.65	102 1.36	27 .88	104 4.74	180 1.96	149 1.89	146 1.61	58 .20	202 .46
Plains	211 5.20	1,051 17.46	120 17.37	895 7.57	180 1.55	10,792 54.82	5 .29	1,448 15.88	3,742 50.05	156 5.10	199 9.08	40 .44	56 .71	39 .43	383 1.31	1,416 3.22
Southeast	233 5.74	665 11.04	61 8.83	1,433 12.13	9,850 84.62	3,126 15.88	1,671 96.48	741 8.13	698 9.34	254 8.31	114 5.20	602 6.56	679 8.63	739 8.15	26,819 91.63	10,293 23.40
Southwest	879 21.67	466 7.74	35 5.07	106 .90	23 .20	564 2.86	15 .87	332 3.64	378 5.06	1,399 45.76	19 .87	13 .14	10 .13	14 .15	171 .58	24,648 56.03
Total	4,056	6,021	691	11,818	11,640	19,688	1,732	9,118	7,476	3,057	2,192	9,178	7,867	9,073	29,268	43,994

Note: Prison population by US and International nativity. Each column represents the state prison's distribution of International nativity.

**Table 3, International Nativity to Residence within Each State**

<i>Nativity</i>	<i>AZ</i>	<i>CO</i>	<i>ID</i>	<i>IL</i>	<i>KY</i>	<i>MO</i>	<i>MS</i>	<i>MT</i>	<i>NE</i>	<i>NM</i>	<i>OR</i>	<i>PA</i> <i>EAST</i>	<i>PA</i> <i>WEST</i>	<i>PHILLY</i>	<i>TN</i>	<i>TX</i>
<b>International</b>																
Canada	27	92	17	244	44	139	2	434	78	28	78	57	98	43	75	154
	.67	1.53	2.46	2.06	.38	.71	.12	4.76	1.04	.92	3.56	.62	1.25	.47	.26	.35
Europe	143	600	67	2,218	204	645	8	1,190	391	102	246	1,145	818	727	186	798
	3.53	9.97	9.70	18.77	1.75	3.28	.46	13.05	5.23	3.34	11.22	12.48	10.40	8.01	.64	1.81
Great Britain	96	206	27	383	236	287	4	670	111	49	235	608	571	1,022	234	450
	2.37	3.42	3.91	3.24	2.03	1.46	.23	7.35	1.48	1.60	10.72	6.62	7.26	11.26	.80	1.02
Latin America	1,692	457	21	79	4	83	2	99	158	542	9	33	9	35	22	3,489
	41.72	7.59	3.04	.67	.03	.42	.12	1.09	2.11	17.73	.41	.36	.11	.39	.08	7.93
<b>Domestic</b>																
Far West	233	788	154	123	15	297	3	999	300	143	450	29	30	22	66	263
	5.74	13.09	22.29	1.04	.13	1.51	.17	10.96	4.01	4.68	20.53	.32	.38	.24	.23	.60
Great Lakes	272	946	107	5,092	705	2,555	16	1,735	1,025	139	330	186	468	80	780	1,261
	6.71	15.71	15.48	43.09	6.06	12.98	.092	19.03	13.71	4.55	15.05	2.03	5.95	.88	2.67	2.87
Middle Atlantic	201	609	57	1,046	349	1,004	5	1,137	493	218	408	6,285	4,979	6,206	474	1,020
	4.96	10.11	8.25	8.85	3.00	5.10	.29	12.47	6.59	7.13	18.61	68.48	63.29	68.40	1.62	2.32
Northeast	69	141	25	199	30	196	1	333	102	27	104	180	149	146	58	202
	1.70	2.34	3.62	1.68	.26	1.00	.06	3.65	1.36	.88	4.74	1.96	1.89	1.61	.20	.46
Plains	211	1,051	120	895	180	10,792	5	1,448	3,742	156	199	40	56	39	383	1,416
	5.20	17.46	17.37	7.57	1.55	54.82	.29	15.88	50.05	5.10	9.08	.44	.71	.43	1.31	3.22
Southeast	233	665	61	1,433	9,850	3,126	1,671	741	698	254	114	602	679	739	26,819	10,293
	5.74	11.04	8.83	12.13	84.62	15.88	96.48	8.13	9.34	8.31	5.20	6.56	8.63	8.15	91.63	23.40
Southwest	879	466	35	106	23	564	15	332	378	1,399	19	13	10	14	171	24,648
	21.67	7.74	5.07	.90	.20	2.86	.87	3.64	5.06	45.76	.87	.14	.13	.15	.58	56.03
Total	4,056	6,021	691	11,818	11,640	19,688	1,732	9,118	7,476	3,057	2,192	9,178	7,867	9,073	29,268	43,994

Note: Prison population by US and International nativity. Each column represents the state prison's distribution of International nativity.

Table 2 compares 1870, 1880, 1900, and 1920 occupation distributions over time by male headed census and prison records. Female prisoner occupations are provided for reference. Internal migration within the United States was different between domestic and foreign born. Internal migration is considered in two ways. First, each state prison's nativity distribution indicates where inmates migrated to the US (Table 3). Second, each nativity can be traced to their destination within the US (Table 3; Carson, 2004). Table 3 indicates that immigrants of Latin descent were more likely to be incarcerated in Western prisons. Canadian immigrants were in Northern prisons in states bordering Canada. However, Canadians were also more likely to take advantage of low-priced land in Texas (Table 3). The British and Europeans were likely to remain along similar latitudes in the US (Steckel, 1983) and were the largest compositions in northern prisons. Alternatively, Latin Americans were likely to remain in the West in states that bordered Mexico.

[Insert Table 4]

#### IV. Immigrant Demographics and Socioeconomic Status

Migration among the prison population was also related to characteristics and the decision to migrate. International migration status among the late 19<sup>th</sup> and early 20<sup>th</sup> prison sample is now regressed on demographic characteristics and socioeconomic status. After controlling for characteristics, there were also regional and spatial differences (Steckel, 1989).

$$\begin{aligned}
 Migrant_i = & \theta_0 + \theta_1 Centimeters_i + \sum_{g=1}^2 \theta_2 Gender_i + \sum_{r=1}^3 \theta_3 Race_i + \sum_{n=1}^{10} \theta_n Nativity_i + \sum_{a=1}^{13} \theta_a Age_i \\
 & + \sum_{fa=1}^{10} \theta_{fa} Nativity_i * Age_i + \sum_{j=1}^2 \theta_j Occupation_i + \sum_{nj=1}^2 \theta_{nj} Nativity_i * Occupation_i
 \end{aligned}$$

$$\sum_{t=1}^7 \theta_t \text{Observation Year}_i + \sum_{ft=1}^7 \theta_{ft} \text{Nativity}_i * \text{Observation Year}_i + \sum_{j=1}^{17} \theta_j \text{Residence}_i + \sum_{ff=1}^{17} \theta_{ff} \text{Nativity}_i * \text{Residence}_i + \varepsilon_i$$

A gender dummy variable is included to control for how migration varied between females and males. Race dummy variables are included for black, mixed-race, and Mexicans. International nativity dummy variables are included for Great Britain, Europe, Canada, and Latin America. Domestic-birth dummy variables are included for nativity in the Northeast, Middle Atlantic, Plains, Southeast, Southwest, and Far West. Youth age dummy variables are included for ages 14 through 22. Decade dummy variables are included for the 30s through 60s. Occupation dummy variables are included for skilled and unskilled workers. Women in US prisons were unlikely to migrate and be found among the prison population. African Americans—many whom were at one time enslaved—were unlikely to migrate within the US and be incarcerated in US prisons. Southern prisons and nativity are overrepresented in the sample, and incarcerating slaves prevented slave owners from recovering costs against their slave holdings. Nonetheless, Southern law evolved to allow slave masters to punish slaves who broke the law on plantations as they paid the social costs of their crimes (Wahl, 1996; Wahl, 1997).

**Table 5, Immigrant Characteristics in United States' Prisons**

	<i>Total</i>	<i>Males</i>	<i>Females</i>
Intercept	4263.40***	4568.60***	25.90***
<i>Height</i>			
Centimeters	.938***	.937***	.961***
<i>Gender</i>			
Male	Reference		
Female	.577***		
<i>Race</i>			
White	Reference	Reference	Reference
Black	.082***	.083***	.069***
Mixed-Race	.132***	.133***	.184***
Mexican	13.67***	13.57***	29.14***
<i>Ages</i>			
14	.321***	.334***	
15	.392***	.388***	.778
16	.298***	.295***	.441
17	.391***	.387***	.601
18	.512***	.509***	.583
19	.631***	.633***	.612
20	.736***	.747***	.389**
21	.750***	.755***	.500
22	.755***	.760***	.365**
23-29	Reference	Reference	Reference
30s	1.33***	1.33***	1.44**
40s	1.81***	1.79***	2.42***
50s	2.08***	2.08***	1.92**
60s	2.28***	2.24***	3.47***
<i>Occupation</i>			
Skilled	1.40***	1.46***	.970
Unskilled	1.52***	1.58***	1.15
No Occupation	Reference	Reference	Reference
<i>Received</i>			
1860s	6.07***	6.02***	47.17***
1870s	1.85***	1.83***	3.91***
1880s	1.51***	1.48***	2.96***
1890s	1.14***	1.14***	1.04
1900s	Reference	Reference	Reference
1910s	.992	.992	.837
1920s	.668***	.669***	.505**
1930s	.358***	.361***	.151*
<i>Residence</i>			
Arizona	8.14***	8.08***	8.60***
Colorado	2.49***	2.45***	7.90***



Idaho	2.07***	2.10***	
Illinois	3.27***	3.27***	5.33***
Kentucky	.345***	.344***	.256**
Missouri	.753***	.748***	1.64
Mississippi	.404***	.405***	
Montana	3.54***	3.51***	6.87***
Nebraska	1.58***	1.56***	5.41***
New Mexico	.323***	.330***	.070***
Oregon	2.25***	2.26***	
PA East	1.89***	1.87***	5.66***
PA West	1.60***	1.59***	3.51***
Philadelphia	2.26***	2.19***	4.89***
Tennessee	.397***	.406***	.277**
Texas	Reference	Reference	Reference
N	176,869	172,277	4,501
R <sup>2</sup>	.2759	.2743	.3786

Source: See Table 2.

Table 5 presents a binary logit migration model for the likelihood an individual was an international migrant to US prisons. Younger individuals are more likely than older individuals to be incarcerated in US prisons, and young foreign-born inmates were less likely to be incarcerated in US prisons compared to older individuals (Hicks, 1932, p. 76; Sjaastad, 1962, pp. 80-93) (Table 5). Alternatively, older foreign-born individuals were more likely to be incarcerated than younger US-born individuals, and the likelihood older foreign-born individuals were incarcerated increased with age; however, because explicit and psychic-costs are high, individuals in advanced years are less likely to migrate (Steckel, 1989; Ferrie, 1999; Carson, 2001; Carson, 2005a). Compared to natives, foreign-born skilled and unskilled workers were fifty percent more likely than natives to be incarcerated. Skilled and unskilled workers were more likely than workers without occupations to be incarcerated in US prisoners. The degree of occupation mobility—in large part—is determined by the similarity between sending and receiving areas (Steckel, 1989; Ferrie, 1999, p. 72). Because foreign-born skilled and unskilled

migrants were not as likely to match with US employers, there were more foreign-born individuals incarcerated for theft and property crimes and were more likely than skilled natives to be incarcerated in US prisons. Predictably, as the US population increased over time, the population of native-born individuals became more prominent. Foreign-born individuals were in urbanized Philadelphia and Chicago; they were also more likely to be incarcerated in the Far West. However, like general migration patterns, criminal immigrants mostly avoided the South and were less likely to be incarcerated in Southern prisons.

## V. Body Mass by Demographic and Socioeconomic Characteristics

The timing and extent of BMI variation reflects stature, demographics, socioeconomic status, and nativity. BMI classification accounts for under, normal, over, and obese classification.<sup>3</sup> BMIs are first partitioned by nativity and gender. Least squares models are used first on BMI levels for the nativity and gender partitions (Table 6) and combined in a multinomial model with the total sample (Table 7).

$$\begin{aligned}
 BMI_i = & \theta_0 + \theta_1 Centimeters_i + \sum_{g=1}^2 \theta_2 Gender_i + \sum_{r=1}^3 \theta_3 Race_i + \sum_{n=1}^{10} \theta_n Nativity_i + \sum_{a=1}^{13} \theta_a Age_i \\
 & + \sum_{fa=1}^{10} \theta_{fa} Nativity_i * Age_i + \sum_{j=1}^2 \theta_j Occupation_i + \sum_{nj=1}^2 \theta_{nj} Nativity_i * Occupation_i \\
 & + \sum_{t=1}^7 \theta_t Observation Year_i + \sum_{ft=1}^7 \theta_{ft} Nativity_i * Observation Year_i + \sum_{j=1}^{17} \theta_j Residence_i
 \end{aligned}$$

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<sup>3</sup> BMIs less than 18.5 are classified as underweight; BMIs between 18.5 and 24.9 are classified as normal; BMIs between 25 and 29.9 are classified as overweight. BMIs over 30 are obese.

$$+ \sum_{fj=1}^{17} \theta_{fj} \text{Nativity}_i * \text{Residence}_i + \varepsilon_i$$

Stature in centimeters is included to account for the inverse relationship between BMI and height (Carson, 2009; Carson, 2012; Komlos and Carson, 2017). Other variables are as defined in Table 5.

**Table 6, Foreign-Born, Native Body Mass by Gender**

	<i>Total Stature</i>	<i>Total BMI</i>	<i>Foreign- Born</i>	<i>Native</i>	<i>Females</i>	<i>Males</i>
<b>Intercept</b>	Model 1 172.94***	Model 2 33.15***	Model 3 33.03***	Model 4 33.07***	Model 5 42.87***	Model 6 32.81***
<b>Height</b>						
Centimeters		-.061***	-.0611***	-.0613***	-.125***	-.059***
Foreign-Born Centimeters		.002			.037	3.29 <sup>-4</sup>
<b>Gender</b>						
Male	Reference	Reference	Reference	Reference		
Female	-8.99***	-.505***	.136	-.510***		
Foreign-Born Female	-.429	.704***				
<b>Race</b>						
White	Reference	Reference	Reference	Reference	Reference	Reference
Black	-2.23***	1.10***	.198*	1.09***	.559***	1.12***
Mulatto	-1.71***	.851***	-.080	.845***	.471***	.855***
Mexico	-4.47***	.110**	-.411***	-.021		.114
<b>Nativity</b>						
<i>National</i>						
Northeast	-.769***	.011			1.60	.005
Middle-Atlantic	-1.08***	-.073**			-.197	-.065**
Great Lakes Plains	Reference	Reference			Reference	Reference
Southeast	.410***	.007			-.086	.007
Southwest	.983***	-.149***			-.498*	-.145***
Far West	1.15***	-.151***			-.376	-.142***
	.363***	-.154***			-.387	-.148***

<i>International</i>						
Great Britain						
Europe						
Canada						
Latin America						
<b>Total Ages</b>						
14	-11.75***	-3.40***	-3.81***	-3.41***	-3.57***	-3.36***
15	-8.07***	-2.81***	-2.98***	-2.82***	-2.84***	-2.78***
16	-5.26***	-2.11***	-1.65***	-2.12***	-1.59***	-2.12***
17	-3.20***	-1.49***	-1.45***	-1.49***	-1.45***	-1.47***
18	-2.02***	-1.13***	-1.13***	-1.13***	-.831***	-1.13***
19	-1.29***	-.718***	-.789***	-.718***	-.807***	-.707***
20	-.556***	-.449***	-.309***	-.449***	-.358	-.445***
21	-.189***	-.292***	-.322***	-.291***	-.505**	-.283***
22	-.165***	-.173***	-.281***	-.173***	-.442**	-.161***
23-29	Reference	Reference	Reference	Reference	Reference	Reference
30s	.077*	.248***	.278***	.248***	1.18***	.225***
40s	-.315***	.513***	.512***	.514***	1.61***	.490***
50s	-.807***	.615***	.471***	.613***	1.83***	.592***
60s	-1.51***	.435***	.602***	.432***	1.88**	.412***
<i>Foreign-Born Ages</i>						
14	6.01***	-.479				-.549
15	2.98***	-.122			-3.71***	-.062
16	.975	.474**			.606	.471**
17	.679	.051			.248	.036
18	.116	-.003			-1.17*	.038
19	.621**	-.090			1.10	-.128
20	.181	.131			1.95	.106
21	-.422*	-.048			.551	-.059
22	.027	-.104			-.778	-.114*
23-29	Reference	Reference			Reference	Reference
30s	-.383***	.039			-.292	.050
40s	-.691***	.004			-.346	.009
50s	-.465**	-.122			-1.63	-.095
60s	-.153	.206			-1.98	.219
<b>Occupations</b>						
<i>Total</i>						
Skilled	-.153**	.054**	.298***	.060**	.332	.056**
Unskilled	.135**	.169***	.525***	.168***	.170	.157***

No Occupation <i>Foreign-Born</i> Occupations	Reference	Reference	Reference	Reference	Reference	Reference
Skilled	-.190	.148*			-.181	.106
Unskilled	-.492**	.292***			.565	.256***
No Occupation	Reference	Reference			Reference	Reference
<b>Decade Received</b>						
Total						
1860s	.744***	.697***	.350*	.704***	2.32**	.679***
1870s	.541***	.416***	-.141*	.419***	.521**	.410***
1880s	.661***	.100***	-.141**	.101***	.182	.099***
1890s	.268***	.119***	-.035	.120***	-.320*	.129***
1900s	Reference	Reference	Reference	Reference	Reference	Reference
1910s	.008	-.034*	.042	-.035*	.524***	-.052***
1920s	.435***	.098***	.243**	.098**	.377	.077*
1930s	1.60***	.150**	.027	.154**	-.254	.147**
International						
1860s	.240	-.178				-.176
1870s	-.222	-.466***			.676	-.480***
1880s	.076	-.152**			.139	-.140**
1890s	.020	-.120**			-.293	-.125**
1900s	Reference	Reference	Reference	Reference	Reference	Reference
1910s	-.215	.067			1.84**	.060
1920s	-.101	.087			1.19	.112
1930s	-.419	-.182			1.92***	-.236
<b>Residence</b>						
Total						
Arizona	-1.85***	.031	-.419***	.055	1.02	.027
Colorado	-1.77***	.392***	.476***	.450***	.168	.398***
Idaho	-.163	.214*	.069	.267**	1.11	.191*
Illinois	-1.57***	-.166***	.292***	-.075**	.337	-.187***
Kentucky	-2.04***	-.459***	.015	-.463***	.272	-.458***
Missouri	-1.58***	-.744***	-.597***	-.648***	.237	-.761***
Mississippi	.374**	-.200***	-.378	-.210***	.451	-.208***
Montana	1.27***	.643***	.870***	.712***	.222	.652***
Nebraska	-.806***	-.620***	-.782***	-.528***	-.039	-.619***
New Mexico	-1.07***	.119**	.320***	.189***	-.522	.135**

Oregon	-2.21***	.792***	1.17***	.845***	-.335	.793***
PA, East	-3.11***	-.503***	-.085	-.453***	.374	-.525***
PA, West	-2.12***	.382***	.803***	.433***	1.26**	.358***
Philadelphia	-2.39***	-.725***	.002	-.677***	-1.24**	-.720***
Tennessee	-2.16***	.355***	.550***	.344***	.178	.370***
Texas	Reference	Reference	Reference	Reference	Reference	Reference
<i>Foreign-Born</i>						
Arizona	-1.21***	.038			1.04	.046
Colorado	-.292	.179*			-1.11	.230**
Idaho	-.554	-.106				-.060
Illinois	-.372*	.312***			.522	.332***
Kentucky	-.988**	.421***			-1.65	.438***
Missouri	-.325	.109			1.14	.101
Mississippi	1.74	-.219				-.213
Montana	-.205	.260***			-.690	.272***
Nebraska	-.626*	-.146			-1.23	-.143
New Mexico	1.25***	.253**			-.192	.250**
Oregon	-.679*	.388***				.375***
PA, East	-1.25***	.337***			1.63	.320***
PA, West	-1.34***	.375***			.254	.393***
Philadelphia	-.239	.741***			.959	.767***
Tennessee	-.470	.191			.557	.160
Texas	Reference	Reference	Reference	Reference	Reference	Reference
N	176,869	176,869	23,021	153,848	4,592	172,277
R <sup>2</sup>	.1547	.1241	.0946	.1242	.1436	.1275

Source: See Table 2.

Three patterns emerge when evaluated 19<sup>th</sup> and early 20<sup>th</sup> century BMI variation. First, body mass is related to nativity, and statures are related to geography because different geographic regions have different access to nutrition (Hilliard, 1972; Carson, 2020; Carson, 2021a; Carson, 2021b; Carson 2015a), and different exposures to insolation independent individuals, and areas exposed to greater insolation receive greater vitamin D production and have taller statures (Carson, 2009a; Carson, 2020). Individuals from the Northeast and Middle Atlantic had shorter statures and had among the highest BMIs (Table 6). International nativity patterns are also noteworthy, and after controlling for other characteristics, international migrants had shorter statures and lower BMIs than natives. Furthermore, BMI is a measure for current net nutrition, and international migrants from Latin America were both shorter and had lower BMIs than Americans from the mid-west (Carson, 2005b; Carson, 2007; Carson, 2019). Individuals with taller regional statures had lower BMIs, which holds for both females and males (Table 5, Models 5 and 6).

Second, sexual dimorphism is the genetic explanation, where males are systemically taller than females because they have longer stature growth periods than females (Table 5; Gray and Wolfe, 1980; Frayer and Wolpoff, 1985). Males in the US are currently around 9 percent taller than females and have 16.5 percent greater weight (NHANES, 2004; National Health Statistics, 2008). After controlling for demographics and other characteristics, domestic born females had lower BMIs than men; however, foreign-born women had greater BMIs than native-born women (Table 6). Foreign-born women are also shorter than domestic-born women, and BMIs are inversely related to stature (Table 6, Column 1; Carson, 2018a, pp. 319-322).

Third, individuals with fairer complexions are taller than individuals with darker complexions (Steckel, 1979; Steckel. 2016, p. 40; Carson, 2015b), and Bodenhorn (1999) and

Bodenhorn (2002), attribute shorter statures to 19<sup>th</sup> century social preferences that disproportionately favored individuals with fairer complexions. However, because individuals with fairer complexions produce more vitamin D in their epidermis, individuals with fairer complexions had taller statures than darker complexion individuals, which was related to vitamin D synthesis and skin pigmentation (Carson, 2008; Carson, 2009). From construction, BMI and stature are inversely related, and individuals with shorter statures have higher BMIs than taller individuals (Carson, 2009, Carson, 2012; Komlos and Carson, 2017). Since individuals with darker complexions are shorter, they have higher BMIs, in part, because BMIs and stature are inversely related (Table 5, Model 1). However, stature by itself is unable to explain why individuals with shorter statures have higher BMIs. Body mass is also related to the amount of protein in muscle tissue, and muscle is heavier than fat (Schutte, et al. 1984; Wagner and Hayward, 2000). Individuals with darker complexion also have greater protein in muscle tissue, leading to greater BMIs for individuals with darker complexion in addition to their shorter stature (Table 5, Model 2). Subsequently, BMIs are related to both race and nativity.

Other patterns are consistent with expectations. Male white-collar and skilled workers had greater BMIs than workers without listed occupations. While not as large, the male foreign-born unskilled BMI advantage is over three times that of unskilled domestic unskilled workers, indicating that skilled, unskilled, and potentially agricultural BMIs for foreign-born workers were greater than domestic. Women listed as white-collar and skilled workers had greater weight; however, female BMI variation by occupation was not significant (Tables 5 and 6).

## **VI. Sensitivity Analysis**

Inferences from empirical results are sensitive to model specification, and sensitivity analysis is presented in Table 8 to assess the collective effects of BMI variation by international



nativity. BMIs are sensitive to two general characteristics: choice and non-choice characteristics. Choice characteristics are those over which individuals have some control, while non-choice characteristics are predetermined variables over which individuals have no control, such as age and race. F-statistics test the collective significance on a restricted set of covariates and illustrate that collective foreign-born characteristics were significant in determining late 19<sup>th</sup> and early 20<sup>th</sup> century BMI variation (Table 8). F-statistics do not, however, address the magnitude and relative importance that restricted variables have on BMI variation. The collective magnitude that a set of variables has on BMI is the percentage change in the sum of squared regression (SSR) are accessed relative to the unrestricted model for each set of restricted variables. The percent change in SSR is

$$\% \Delta SSR = \frac{SSR_R - SSR_U}{SSR_U} = \frac{R_R^2 - R_U^2}{R_U^2} = \% \Delta R^2$$

where  $SSR_U$  and  $SSR_R$  are the unrestricted and restricted sum of squares regressions.  $R_U^2$  and  $R_R^2$  are the unrestricted and restricted  $R^2$ .

The unrestricted Model 1 includes height, gender, race, nativity, age, occupation, and observation period variables (Table 7). Collective restricted variables are omitted to determine combined magnitudes and effects on BMI variation (Leamer, 1983; Leamer, 2010; Angrist and Pishke, 2010). Individuals have some degree of control over socio-economic status, residence, and even observation period. Alternatively, individuals have less control over age, gender, and race. Collective height, gender, race, nativity, age, socioeconomic status, and observation period are collectively significant in BMI variation. However, the magnitude of BMI variation by choice and non-choice characteristics varies considerably. The magnitude of BMI variation by age, race, and height were -.386, -.197, and -.194. The magnitude of BMI variation by nativity,

occupations, and observation period are -.002, -.006, and -.018. In comparison, it is characteristics themselves rather than characteristics by nativity that account for the greatest magnitude of the effects and not the effect of characteristics by nativity (Carson, 2018b; Carson, 2013; Carson, 2021b). In Subsequently, while BMI variation is significantly related to choice and non-choice characteristics, the magnitude of BMI variation is determined by factors beyond an individual's control.

**Table 8, Nineteenth and Early Twentieth Century International BMI Sensitivity by Height, Demographics, Socioeconomics****Status, and Residence**

	<i>Total</i>	<i>Centimeter s</i>	<i>Gender</i>	<i>Race</i>	<i>Age</i>	<i>Occupatio ns</i>	<i>Observatio n</i>	<i>Residence</i>
<b>Intercept</b>	33.15***	33.09***	33.09***	33.15***	33.15***	33.13***	33.15***	33.07***
<i>Height</i>								
Centimeter	-.061***	-.061***	-.061***	-.061***	-.061***	-.061***	-.061***	-.061***
s								
Foreign- Born	.003		-2.70 <sup>-4</sup>	.002	.003	.003	.003	.001
Centimeter s								
<b>Gender</b>								
Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Residence
Female	-.508***	-.505***	-.344***	-.505***	-.508***	-.510***	-.508***	-.511***
Foreign- Born	.733***	.708***		.704***	.742***	.725***	.733***	.783***
Female								
<b>Race</b>								
White	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Residence
Black	1.11***	1.11***	1.11***	1.10***	1.11***	1.11***	1.11***	1.11***
Mulatto	.865***	.865***	.864***	.851***	.865***	.862***	.865***	.867***
Mexico	.014	.016	.017	.110**	.015	.011	.014	-.002
<b>Foreign Born</b>								
<b>Race</b>								
Black	-.573***	-.572***	-.561***		-.572***	-.564***	-.573***	-.573***
Mulatto	-.648***	-.650***	-.632***		-.651***	-.643***	-.648***	-.708***





Skilled	.153*	.152*	.101	.148*	.152*	.061**	.153*	-.014
Unskilled	.297***	.297***	.257***	.292***	.295***	.197***	.297***	.119
No Occupatio n	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Residence
<b>Decade Received Total</b>								
1860s	.699***	.699***	.699***	.697***	.699***	.700***	.699***	.700***
1870s	.416***	.412***	.417***	.416***	.416***	.417***	.416***	.416***
1880s	.099***	.099***	.099***	.100***	.099***	.098***	.099***	.096***
1890s	.119***	.119***	.120***	.119***	.119***	.119***	.119***	.116***
1900s	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Residence
1910s	-.034*	-.034*	-.034*	-.034*	-.034*	-.032*	-.034*	-.027
1920s	.100**	.100**	.099**	.098**	.100**	.099**	.100**	.110***
1930s	.152**	.151**	.151**	.150**	.151**	.152**	.152**	.190***
<i>Foreign- Born</i>								
1860s	-.173	-.170	-.170	-.178	-.177	-.212	-.173	-.046
1870s	-.423***	-.422***	-.413***	-.466***	-.423***	-.446***	-.423***	-.394***
1880s	-.148**	-.146**	-.132**	-.152**	-.149**	-.167***	-.148**	-.104*
1890s	-.114**	-.114**	-.115**	-.120***	-.114**	-.115**	-.114**	-.085*
1900s	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Residence
1910s	.076	.076	.075	.067	.076	.063	.076	.034
1920s	.090	.090	.098	.087	.094	.083	.090	.023
1930s	-.202	-.198	-.202	-.182	-.197	-.213	-.202	-.530**
<b>Residence Total</b>								
Arizona	.034	.035	.035	.031	.034	.035	.034	.009
Colorado	.396***	.397***	.394***	.392***	.396***	.398***	.396***	.425***
Idaho	.218**	.218**	.217**	.214*	.218**	.217**	.218**	.184*

Illinois	-.164***	-.164***	-.166***	-.166***	-.164***	-.163***	-.164***	-.112***
Kentucky	-.468***	-.457***	-.456***	-.459***	-.457***	-.460***	-.458***	-.430***
Missouri	-.743***	-.743***	-.743***	-.744***	-.743***	-.744***	-.743***	-.727***
Mississippi	-.201***	-.202***	-.201***	-.200***	-.202***	-.203***	-.201***	-.183***
Montana	.647***	.646***	.646***	.643***	.647***	.646***	.647***	.684***
Nebraska	-.618***	-.618***	-.618***	-.620***	-.618***	-.615***	-.618***	-.633***
New Mexico	.169***	.169***	.168***	.119**	.169***	.169***	.169***	.211***
Oregon	.797***	.797***	.798***	.792***	.796***	.802***	-.797***	.854***
PA, East	-.501***	-.500***	-.501***	-.503***	-.501***	-.500***	-.501***	-.423***
PA, West	.385***	.385***	.384***	.382***	.385***	.385***	.385***	.463***
Philadelphia	-.724***	-.723***	-.724***	-.725***	-.724***	-.715***	-.724***	-.574***
Tennessee	.354***	.354***	.354***	.355***	.354***	.372***	.354***	.384***
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Residence
<i>Foreign-Born</i>								
Arizona	.029	.026	.026	.038	.024	.036	.029	
Colorado	.186*	.183*	.215**	.179*	.181*	.192*	.186*	
Idaho	-.111	-.111	-.108	-.106	-.122	-.085	-.111	
Illinois	.322***	.319***	.340***	.312***	.316***	.320***	.322***	
Kentucky	.434***	.427***	.425***	.421***	.437***	.478***	.434***	
Missouri	.134	.131	.142	.109	.128	.130	.134	
Mississippi	-.148	-.142	-.140	-.219	-.159	-.153	-.148	
Montana	.256***	.261***	.267***	.260***	.252***	.275***	.256***	
Nebraska	-.124	-.125	-.116	-.146	-.132	-.119	-.124	
New Mexico	.170	.170	.173	.253**	.166	.176	.170	
Oregon	.386***	.381***	.366***	.388***	.385***	.359***	.386***	
PA, East	.353***	.344***	.358***	.337***	.350***	.356***	.353***	

PA, West	.380***	.373***	.387***	.375***	.377***	.393***	.380***	
Philadelph ia	.759***	.753***	.778***	.741***	.753***	.671***	.759***	
Tennessee	.236*	.230*	.216*	.191	.235*	.119	.236*	
Texas	Reference	Reference	Reference	Reference	Reference	Reference	Reference	
Restricted		.6873	15.24***	17.36***	1.40	6.19***	5.66***	6.10***
F								
N	176,869	176,869	176,869	176,869	176,869	176,869	176,869	176,869
R <sup>2</sup>	.1244	.1244	.1233	.1241	.1243	.1242	.1244	.1239
RMSE	2.382	2.415	2.384	2.416	2.447	2.384	2.386	2.383

Source: See Table 2.



## **VII. Conclusion**

Eighteenth and 19<sup>th</sup> century European migration to developing countries was a leading economic and historical event of its time, and in migration studies, health is a concern before, during, and after migration. BMIs and height are related to nativity within the US, and for individuals born within the US, individuals native to regions with taller statures had lower BMIs. International migrants had lower BMIs and shorter statures than native-born individuals. After controlling for other characteristics, domestic born females had lower BMIs than men; however, foreign-born women had greater BMIs than native-born women. Foreign-born women were also shorter than native-born women, and BMIs are inversely related to height. Foreign and domestic-born females and males with darker complexions have greater BMIs than their fairer complexioned counterparts. In sum, migrants had lower current and cumulative net nutrition, and diets and health also effected migrant decisions.

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