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## Nineteenth century biological conditions on the high central plains

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Nineteenth Century Biological Conditions  
on the High Central Plains

Scott Alan Carson

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# Nineteenth Century Biological Conditions on the High Central Plains

## Abstract

Little work has been done on the biological conditions for the US Central Plains. Throughout the late 19th and early 20th centuries, black and white statures in Nebraska increased with economic development, indicating that biological conditions improved as Nebraska's output market and agricultural sectors embedded. Illustrating the importance of rural environments with stature growth, farm laborers were taller than common laborers. Urbanization and industrialization were significant in stature variation, and closer proximity to trade routes and waterways were inversely related with statures in Nebraska.

JEL-Code: J150, J700, I200, I310, N310.

Keywords: agricultural development, black and white biological conditions.

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## Biological Conditions and Economic Development: 19<sup>th</sup> Century US Stature on the High Central Plains

### I. Introduction

Nineteenth century US economic development coincided with change in its agricultural sector, and those geographic areas that went on to become leading 20<sup>th</sup> century agricultural centers were not the same as those in the 19<sup>th</sup> century. For example, the 19<sup>th</sup> century American South was among the leading US agricultural regions (Ransom and Sutch, 1977; Conrad and Meyer, 1971, p. 342; Cochrane, 1979, p. 337-343). However, as the US frontier pressed westward, agricultural production followed, and by the mid-20<sup>th</sup> century, many of the most productive agricultural farmlands moved from Southern to Midwestern states, particularly Illinois, Indiana, and later Nebraska, Kansas, and the Dakotas. This transformation occurred as the Homestead Act changed US immigrants' access to land, and throughout the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, agricultural productivity increased on the Central Plains. Access to land, in turn, was related to wealth, economic opportunity, and biological living conditions. Nebraska is one agricultural state that developed during the late 19<sup>th</sup> century and received a considerable share of European and eastern state immigrants (Stewart, 2006, p. 549). Therefore, this study uses 19<sup>th</sup> century stature records from the Nebraska state prison to assess how biological conditions varied during a period of considerable economic change

and sheds new light on the nature of late 19<sup>th</sup> and early 20<sup>th</sup> century economic development on the US Central Plains.

The use of height data to measure living standards is now a well-established method in economics and development studies (Fogel, 1994; Case and Paxson, 2008; Deaton, 2008). A population's average stature measures the net cumulative difference between nutrition consumed for growth, work, disease, and the physical environment. By measuring average versus individual statures, individual differences are mitigated, leaving only the net cumulative difference between calories consumed for growth and physical activity. There is a complex relationship between heights and genetics, and in developed economies, nearly 90 percent of height is determined by genetics, while genetics only determine 60 percent of heights in developing economies (Luke et al. 2001). The 19<sup>th</sup> century Nebraska population is particularly interesting because Nebraska was a beef and agricultural producing state in the earliest stages of economic development, and Nebraska was in close proximity to the Missouri River, a major waterway that connected its agricultural output with eastern urban markets (Atack, Bateman, and Parker, 2000, p. 257). Hence, stature provides significant insights into understanding economic development and augments other measures for 19<sup>th</sup> century black and white health during development.

It is against this backdrop that this paper considers three paths of inquiry into 19<sup>th</sup> century Nebraska stature variation. First, what was the relationship between 19<sup>th</sup> century stature and occupations in a highly agricultural state as it transformed from an unsettled frontier community to a productive agricultural region? Farmers were predictably taller than non-farmers, and farm laborers were taller than common laborers. Second, as

multiple nationalities streamed onto America's high Central Plains, how did black and white statures vary throughout the late 19<sup>th</sup> and early 20<sup>th</sup> centuries? Black and white statures increased considerably after 1860, indicating that mid-western statures increased during the earliest stages of economic development. Third, how did statures in Nebraska vary with proximity to major waterways and trade routes? Statures in Nebraska conform to established 19<sup>th</sup> century urban-rural patterns, and individuals in the rural western US near the Missouri River were shorter than in western Nebraska.

## II. Nineteenth Century Nebraska

Nebraska's most distinctive late 19<sup>th</sup> and early 20<sup>th</sup> century characteristics were its central location within the US, military expeditions, land distributions, rise of its agricultural sector, and construction of transcontinental railroads. There were three economically distinct regions within Nebraska: east, central, and west (Figure 1), and grain production was geographically specialized. The eastern third of the state's production was mostly devoted to corn and cropland; the western two thirds of the state were devoted to grain farming and beef production. The eastern side of the state is in close proximity to the Missouri River and receives about 40 percent more annual precipitation than the western third of the state.

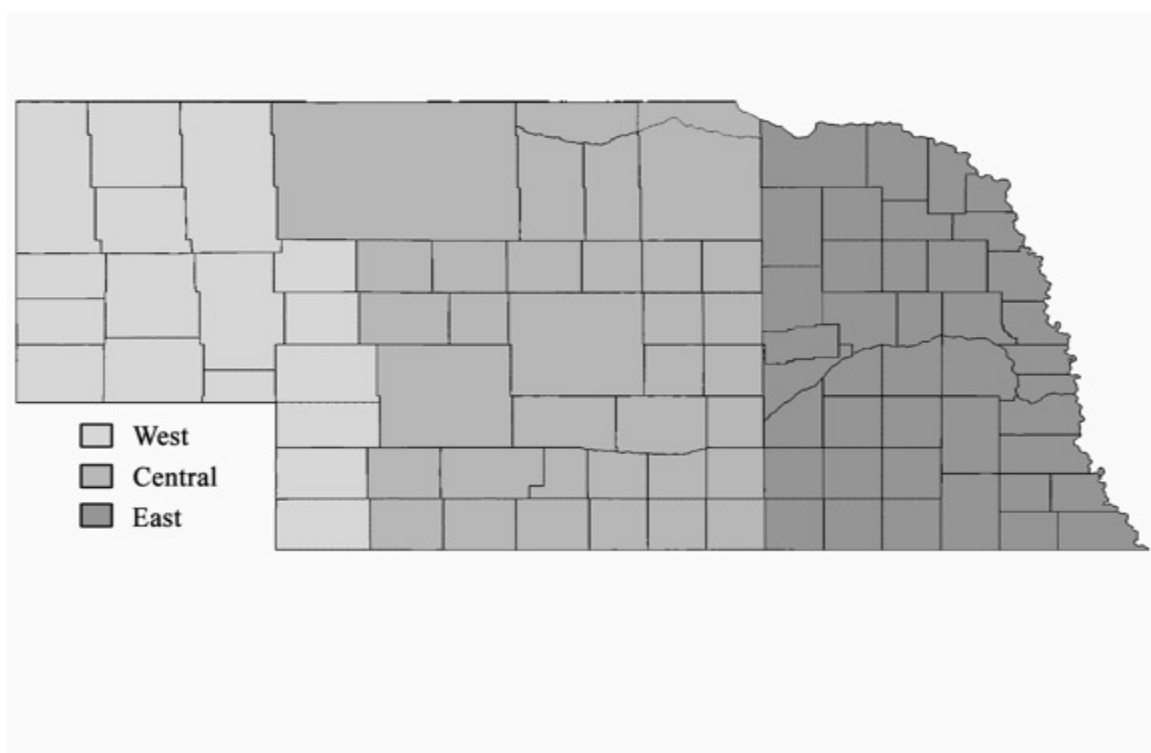


Figure 1, Nineteenth Century Nebraska Regions

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

Given its central location within the US, Nebraska was an important location for the early fur trade, and from its beginning, French-Canadian trappers used the Missouri River as a low-cost water transportation route to ship their furs to eastern US and European markets. Moreover, the Missouri River was an early means by which the US government explored its newly acquired Louisiana Purchase. Between 1804 and 1806, Thomas Jefferson sent explorers Meriwether Lewis and William Clark to navigate the Missouri River as part of their voyage to explore the American West and find a short commercial route to the Pacific. During this expedition, Lewis and Clark explored the Missouri River's eastern border within Nebraska. Therefore, due to its proximity to the Missouri River, Nebraska became an early commercial trade route.

The 1862 Homestead Act made Nebraska and other parts of the Midwest accessible to immigrants from the eastern US and Europe, and as Nebraska's lands were transferred from the public domain to the private sector, wealth and agricultural productivity increased (Cochrane, 1979, pp. 81-85). With increased population from US and European immigration, Nebraska's agricultural sector expanded, and previously unoccupied prairies were, for the first time, brought under cultivation (Atack, Bateman and Parker, 2000, pp. 254-258; Cochrane, 1979). The reaper, steel plow, barbed wire, and refrigeration simultaneously came into use (Cummings, 1940, p. 36-40; Craig, Goodwin, and Grennes, 2004). However, this agricultural boom was short-lived, and between 1874 and 1877, large insect infestations devoured much of Nebraska's agricultural output (Cochrane, 1979, p. 93). Many jubilant eastern settlers abandoned their Nebraska homesteads and returned east to more stable, familiar surroundings (Cochrane, 1979, pp. 85-86; Stewart, 2009, p. 238-239). Nevertheless, by the 1880s,



Nebraska's agricultural sector rebounded and began a series of boom and bust economic cycles that lasted throughout the late 19<sup>th</sup> and early 20<sup>th</sup> centuries.

After the Civil War, Nebraska's central proximity within the US also made it a vital link in the 19<sup>th</sup> century's transportation revolution. In 1865, the Union Pacific Railroad started west from Omaha to conjoin with the Central Pacific Railroad, and construction brought Irish immigrants and Confederate veterans to Nebraska by way of the transcontinental railway. To increase profits, the railroads actively recruited passengers to the Midwest from the northern US and Europe by selling them railroad land grants for between \$2 and \$10 per acre (Cochrane, 1979, pp. 84-85). Therefore, Nebraska's 19<sup>th</sup> century economic development was related to early US exploration, land distribution, rise of its agricultural sector, and the development of the US transcontinental rail system, which were, in turn, related with health and biological conditions.

### III. Nineteenth Century Nebraska Prison Data

The Nebraska Territory's first legislated act was the 1856 statute to name a prison board commissioner and establish a state penitentiary. However, it was not until 1869 that the Nebraska state penitentiary became operational. Meanwhile, Nebraska prisoners were contracted to surrounding state prisons, and the Nebraska state government paid 50 cents per day to room and board each prisoner. During this 15 year interregnum, Nebraska territorial representatives lobbied the US congress to construct a permanent correctional facility in Nebraska. However, with strained Federal resources after the Civil War, it was not until 1869 that inmates were housed in a permanent Nebraska correctional facility.

Throughout the 19<sup>th</sup> century, there were two penal reform systems used in the US: the Pennsylvania and New York systems. The Pennsylvania system maintained that prisoner rehabilitation was most effectively accomplished through solitary confinement, and prisoners were given time to reflect on their offenses. On the other side of the prison debate was the New York system, which held that prisoners were most effectively rehabilitated when they were set to hard manual labor. The 19<sup>th</sup> century Nebraska prison followed the New York system, and early prison inmates were set to hard manual labor and constructed much of the Nebraska prison. After prison ward blocks were completed, Nebraska prisoners were put to work in tailor and shoe shops, and broom and furniture factories.

All historical height data have various selection biases, and the prison data likely selected many of the materially poorest individuals, although there were white-collar and skilled workers in the sample. For the most part, there are two sources of 19<sup>th</sup> century stature data: military and prison data. While the prison data are not random, the type of selectivity prison records have contain their own advantages, such as being drawn from lower socioeconomic groups, that segment of society most vulnerable to economic change. For stature as a measurement of biological change, this type of selection is preferable to that which frequents military data: minimum stature requirements for service (Fogel et al. 1978, p. 85).

To assess how 19<sup>th</sup> and 20<sup>th</sup> century black and white statures varied in a developing US prairie community, over 14,000 male Nebraska state prison records were collected from between 1869 through 1944. Stature measurements were recorded at the time prisoners were admitted into the penitentiary, therefore, reflect pre-incarceration

conditions. Prison enumerators recorded the date inmates were received, complexion, county of incarceration, occupation, and crime. Fortunately, there were a small number of females incarcerated in the Nebraska prison; however, their numbers are insufficient to analyze separately here so are analyzed elsewhere with other 19<sup>th</sup> century US women (Carson, 2011). During the late 19<sup>th</sup> century, there was a considerable contingent of international immigrants in the Nebraska prison, and these records are retained in this study for a comparison with US statures. However, since the focus of this study is on black and white male statures on the high Central Plains, immigrants are later excluded from the analysis. By having the same prison official record characteristics over much of the period, the consistency of the Nebraska sample creates reliable comparison by race over time.

Fortunately, prison officials were quite thorough when recording inmate complexion and occupations. For example, African-Americans in the Nebraska prison were recorded as blacks, copper, ginger, and various shades of mulattos. Prison enumerators recorded white inmates as dark, fair, light, and white. The white complexion is supported further by European inmates, who were also recorded as dark, fair, light, and white. While mulattos share genetic traits with both Africans and Europeans, they were treated as blacks throughout the 19<sup>th</sup> century, and when comparing blacks and whites, mulattos are grouped here with darker complexioned blacks.

Prison officials recorded a broad continuum of occupations, and defined them narrowly, recording over 100 different occupations in this developing frontier community. These occupations are classified here into six categories. High-skilled workers and merchants are classified as white-collar workers. Carpenters, cabinet

makers, and various other craftsmen are classified as skilled workers. Workers in agricultural occupations are classified as farmers. Because Nebraska was a rural western frontier community, there were both general farmers and ranchers. Farmers produced a diverse array of agricultural outputs, which may have been associated with taller statures and superior biological conditions. Ranchers were more specialized in beef production. General day laborers are classified as unskilled workers, while ranch and farm laborers are classified as agricultural workers.

Table 1, Nineteenth Century Nebraska Prison Population by Demographics, Birth  
Period, Nativity, and Occupation

Ages	<i>Whites</i>				<i>Blacks</i>			
	N	Percent	$\bar{X}$	SD	N	Percent	$\bar{X}$	SD
Teens	1,044	7.99	171.39	6.60	108	7.94	169.62	7.36
20s	6,003	45.94	172.67	6.47	670	49.26	170.82	7.07
30s	3,481	26.64	172.83	6.67	379	27.87	171.65	6.20
40s	1,646	12.60	172.25	6.70	147	10.81	170.21	6.28
50s	647	4.95	171.19	6.75	41	3.01	168.95	6.29
60s	246	1.88	170.61	7.52	15	1.10	170.98	7.22
Birth								
Decade								
1820s	49	.37	171.32	5.49	3	.22	172.72	11.07
1830s	149	1.14	169.81	6.79	2	.15	178.75	4.94
1840s	391	2.99	170.87	7.09	31	2.28	170.06	5.65
1850s	923	7.06	170.74	6.45	56	4.12	169.74	6.21
1860s	1,541	11.79	171.12	6.79	116	8.53	168.21	6.48
1870s	1,847	14.13	171.50	6.29	189	13.90	169.54	6.66
1880s	2,124	16.25	171.92	6.37	304	22.35	170.10	6.84
1890s	2,486	19.03	172.64	6.37	311	22.87	171.18	6.83
1900s	2,323	17.78	173.88	6.56	245	18.01	172.66	6.49
1910s	1,087	8.32	175.28	6.30	96	7.06	173.49	6.25
1920s	147	1.12	176.60	6.82	7	.51	173.99	5.68
Nativity								
Northeast	206	1.58	170.26	6.41	19	1.40	171.12	5.99
Middle Atlantic	1,133	8.67	170.97	6.61	53	3.90	168.59	5.28
Great Lakes	2,208	16.90	171.86	6.60	130	9.56	170.81	6.90
Plains	6,257	47.88	173.54	6.32	508	37.35	170.80	6.89
Southeast	614	4.70	172.67	6.76	314	23.09	171.31	6.53
Southwest	439	3.36	173.72	6.51	236	17.35	171.86	6.79
Far West	418	3.20	173.20	6.48	31	2.28	170.19	7.31
Canadian	151	1.16	170.32	7.11				
British	267	2.04	169.35	6.78				
European	846	6.47	169.25	6.56				
Other	528	4.04	171.34	6.77	69	5.07	168.90	6.80
International								
Occupation								
White-Collar	996	7.62	172.83	6.53	27	1.99	172.11	4.98
Skilled	3,054	23.37	172.42	6.69	218	16.03	171.19	6.17
Farmers	3,100	23.72	172.97	6.35	63	4.63	171.90	6.43
Ranchers	134	1.03	174.06	6.96	1	.07	175.26	.
Farm	147	1.12	172.45	5.53	8	.59	169.15	7.66

Laborers								
Unskilled	5,636	43.13	172.07	6.73	1,043	76.69	170.67	6.95

Source: Nebraska State Historical Society; 1500 R Street; P.O. Box 82554; Lincoln, NE 68501-2554.

Notes: Other nativities include Australia, South America, China, Korea, Japan, Jerusalem, Jordan, Egypt, and Mexico.

Table 1 presents black and white percentages incarcerated by age, birth decade, nativity, and occupation. Although average statures are reported, they are not reliable because of compositional effects, which are accounted for in the regression models that follow. Given its recent settlement and distance from the US South, the Nebraska state penitentiary's population was predominantly white. There were predictably more whites than blacks incarcerated in the early 19<sup>th</sup> century, and the share of blacks incarcerated in the Nebraska prison increased after passage of the 13<sup>th</sup> amendment. However, a disproportionate amount of blacks later in the 19<sup>th</sup> century is not necessarily a sign of Nebraska law enforcement targeting blacks but rather blacks lacking legal representation at trial (Walker, 1988). Most whites were born in Plains states, which includes Nebraska, while blacks were born in both Plains and Southern states. Reflecting the state of 19<sup>th</sup> century labor markets, whites were overwhelmingly more likely than blacks to work in white-collar, skilled, and agricultural occupations; blacks were more likely to work in unskilled occupations.

#### IV. The Comparative Effects of Race, Age, Birth Periods, Nativity, and Socioeconomic Status on Height

The timing and extent of stature variation reflects the relationship between nutrition, work effort, and disease; it also reflects relationships between health, wealth, inequality, and economic development (Carson, 2009a). We now test how statures were related with observable characteristics. To start, the  $i^{\text{th}}$  individual's height is assumed to be related with race, age, birth period, nativity, occupation, and residence within Nebraska.

$$Cent_i = \alpha + \sum_{r=1}^2 \beta_r Race_i + \sum_{a=1}^{11} \beta_a Age_{i,t} + \sum_{t=1}^{10} \beta_t Birth Decade_t + \sum_{j=1}^{10} \beta_j Nativity_j \\ + \sum_{l=1}^5 \beta_l Occupations_i + \sum_{p=1}^2 \beta_p Residence + \varepsilon_i$$

To account for the relationship between race and height, a black race dummy variable is included. Because few blacks were from Canada, Britain, and Europe, foreign-born blacks are excluded from the analysis. Youth age dummy variables are included for ages 15 through 22; adult age dummies are included for ages 40 through 60 in 10 year age intervals. Birth decade dummy variables are included in 10 year observation periods for birth between 1840 and 1920. US nativity dummy variables are included for birth in the Northeast, Middle Atlantic, Great Lakes, Southeast, Southwest, and Far West; international dummy variables are included for birth in Canada, the British Isle's, Europe, and other international nativities. Occupation dummy variables are added for white-collar, skilled, agricultural, and unskilled workers, and residence within Nebraska dummy variables are included to account for proximity to the Missouri River, which was an important transportation and trade route.

Table 2 presents four models to account for 19<sup>th</sup> century stature variation by race and US nativity,. Model 1 combines both black and white Nebraska samples. Model 2

presents estimates for whites only, while Model 3 does the same for blacks. To isolate how US material and biological conditions were related with stature variation, model 4 restricts the sample to only blacks and whites born in the US.

Table 2, Nineteenth Century Nebraska Black and White Statures by Demographic, Nativity, Occupation, and Residence

	Model 1		Model 2		Model 3		Model 4	
	<i>Total</i>	<i>S.E.</i>	<i>White</i>	<i>S.E.</i>	<i>Black</i>	<i>S.E.</i>	<i>US Natives</i>	<i>S.E.</i>
Intercept	171.79***	.205	171.94***	.212	169.03***	.877	171.65***	.221
<i>Race</i>								
White	Reference						Reference	
Black	-1.72***	.207			-.851	.727	-1.73***	.212
Mulatto	-1.41*	.660			Reference		-1.18*	.697
<i>Ages</i>								
15	-9.04***	1.51	-7.57***	1.41	-17.56***	2.64	-8.59***	1.96
16	-5.17***	.810	-5.67***	.881	-2.55	1.67	-5.36***	.869
17	-1.99***	.447	-1.87***	.482	-3.21**	1.26	-1.90***	.473
18	-1.24***	.321	-1.19***	.338	-1.76*	1.00	-1.40***	.338
19	-1.05***	.296	-1.11***	.302	-.287	1.31	-1.11***	.322
20	-.622**	.243	-.518**	.256	-1.65**	.794	-.717**	.262
21	-.481**	.240	-.565**	.249	.327	.891	-.508**	.252
22	-.592**	.237	-.518**	.246	-1.41	.892	-.690***	.237
23-39	Reference		Reference		Reference		Reference	
40s	.069	.174	.141	.183	-.321	.599	.100	.187
50s	-.567**	.265	-.495*	.277	-1.15	1.03	-.345	.291
60s	-1.05**	.504	-1.13**	.528	.618	1.83	-.903	.555
<i>Birth Year</i>								
Pre 1850s	.004	.328	-.187	.341	2.50**	1.03	.182	.419
1850s	-.198	.262	-.317	.271	1.26	1.03	.030	.297
1860s	Reference		Reference		Reference		Reference	
1870s	.247	.216	.186	.226	.948	.785	.265	.235
1880s	.411**	.212	.307	.223	1.72**	.730	.639***	.232
1890s	.926***	.212	.767***	.221	2.58***	.756	1.14***	.230
1900s	2.04***	.220	1.84***	.229	4.39***	.788	2.33***	.236
1910s	3.42***	.257	3.27***	.268	5.26***	.879	3.64***	.270
1920s	5.36***	.564	5.24***	.582	6.46***	2.21	5.72***	.575
<i>Nativity</i>								
Northeast	-2.14***	.436	-2.40***	.457	.561	1.27	-2.12***	.437



Middle Atlantic	-1.57***	.214	-1.60***	.221	-1.13	.807	-1.53***	.217
Great Lakes	-.804***	.163	-.859***	.167	-.297	.699	-.753***	.164
Plains	Reference		Reference		Reference		Reference	
Southeast	-.052	.236	-.266	.281	.766*	.466	-.057	.237
Southwest	.272	.264	.147	.310	.784	.529	.242	.264
Far West	-.210	.310	-.185	.320	-.195	1.16	-.220	.310
Canada	-2.25***	.428	-2.29***	.579				
British	-2.88***	.427	-2.97***	.428				
Europe	-3.36***	.243	-3.40***	.244				
Other	-1.16***	.303	-1.12***	.321				
Nativity								
Occupation								
White-Collar	.955***	.213	.951***	.218	1.42	.971	.930***	.226
Skilled	.468***	.138	.464***	.145	.430	.462	.359**	.148
Farmers	1.03***	.141	.989***	.144	1.96	.863	.948***	.151
Rancher	1.49***	.582	1.45***	.585	4.52	.847	1.41**	.595
Unskilled	Reference		Reference		Reference		Reference	
Farm Laborer	.894**	.440	.967**	.442	.197	2.64	.870*	.469
Residence								
West	.512***	.178	.459**	.183	1.48**	.749	.870*	.469
Central	.361***	.137	.393***	.140	-.316	.637	.287**	.144
East	Reference		Reference		Reference		Reference	
N	14,427		13,067		1,360		12,566	
R <sup>2</sup>	.0820		.0793		.0864		.0697	

Source: See Table 1.

Notes: Stature is in centimeters. The occupation classification scheme is consistent with Ferrie (1997); The following geographic classification scheme is: New England= CT, ME, MA, NH, RI and VT; Middle Atlantic= DE, DC, MD, NJ, NY, and PA; Great Lakes= IL, IN, MI, OH, and WI; Plains= IA, KS, MN, MO, NE, ND, and SD; South East= AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, and WV; South West= AZ, NM, OK, and TX; Far West= CA, CO, ID, MT, NV, OR, UT, WA, and WY. Stature difference is average white stature less average black stature.

Three general patterns emerge when comparing 19<sup>th</sup> century black and white statures. First, statures within Nebraska varied by occupations, and ranchers—who were in close proximity to animal proteins, dairy production, and calcium—were taller than general farmers, who were taller than white-collar and skilled workers (Table 2). Nineteenth century farmers also accumulated more wealth than non-farmers, and greater wealth was associated with taller statures (Fogel, 1978; Kearsal et al. 1980; Kearsal et al. 1986; Pope 1989; Ferrie, 1994; Ferrie, 1995; Ferrie, 1997; Stewart, 2006, pp. 250-251; Stewart, 2009, pp. 564-572; Komlos, 1987; Carson, 2009a). Moreover, farm and ranch laborers were taller than common laborers, presenting strong evidence that farmers, ranchers, and farm laborers lived in rural areas with superior biological conditions and were taller than workers in other occupations (Carson, 2009b). The common and agricultural unskilled worker comparison is important because it highlights that unskilled farm laborers were taller than common laborers since farm laborers were closer to nutritious diets and lived in rural environments where disease was less easily propagated (Fogel, 1978). Access to rural agricultural diets abundant in animal proteins is consistent with taller statures in beef producing regions, and individuals in close proximity to beef production were consistently taller than workers in other locations (Carson, 2008, pp. 602-603).

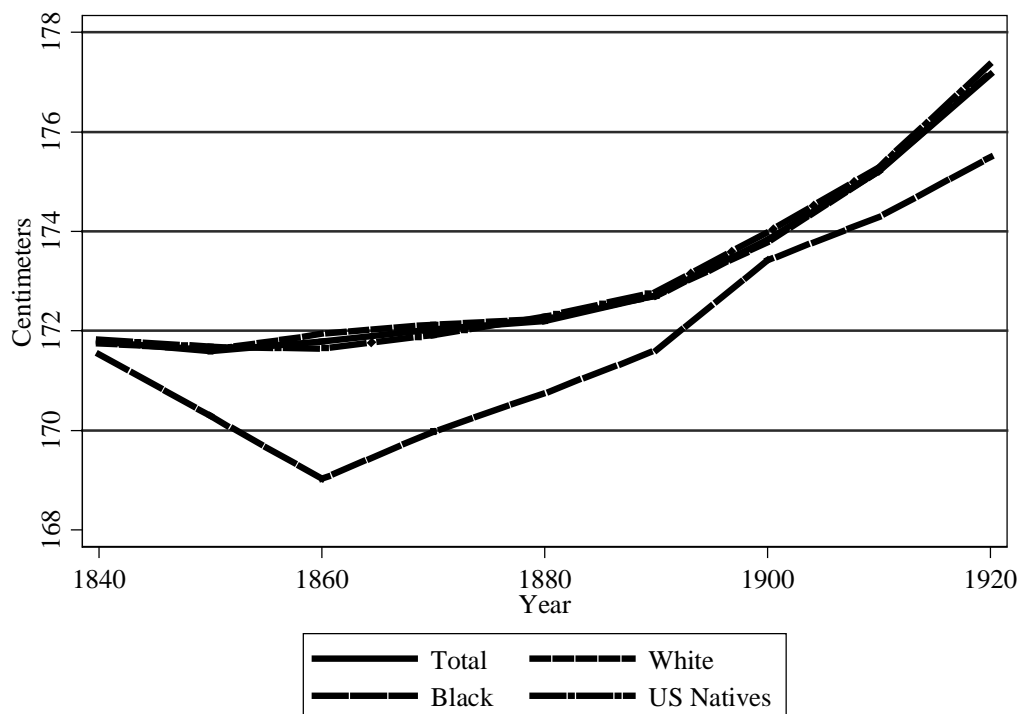


Figure 2, Nineteenth Century Nebraska Black and White Male Statures

Source: See Table 2.

Note: Observation is for birth year.

Second, because the western frontier may have served as a safety valve when 19<sup>th</sup> century social and economic conditions crystallized against upward economic mobility in eastern states and European economies, it is frequently asserted that the west reduced socioeconomic rigidity because settlers migrated west in search of opportunity (Turner, 1893). However, there is considerable debate regarding the nature of late 19<sup>th</sup> and early 20<sup>th</sup> century mid-western opportunity, and there are two views regarding migration onto the Central Plains. On the one hand, between 1870 and 1880, migrants were pushed out of mid-western agricultural Plains because of widespread draughts and economic disruptions (Cochrane, 1979; Libecap and Hansen, 2002). On the other, migrants

voluntarily relocated within the US in search of land and economic opportunity (Stewart 2006; Stewart, 2009). Statures contribute to this dispute, and between 1870 and 1920, both black and white statures increased by over five cms. (Figure, 2). These large and dramatic stature increases in Nebraska indicate that biological conditions improved after 1900, and rather than a region of privation, the mid-west offered biological opportunity (Stewart, 2009, pp. 261-264). Therefore, late 19<sup>th</sup> and early 20<sup>th</sup> century biological conditions improved considerably over time as agricultural markets imbedded and rural agricultural lifestyles became more beneficial to health and economic development.

Third, proximity to late 19<sup>th</sup> and early 20<sup>th</sup> century water ways may have been related with statures in multiple ways, and a complex pattern has emerged where US statures in western states near rivers were shorter, while statures in Eastern states near rivers were taller (Craig and Weiss, 1998, pp. 206-207; Carson, 2011, p. 465; Haines et al. 2003). This pattern is important for the majority of history because coastal dwellers probably received greater nutrition from diets abundant in fish and aquatic animals (Popkin, 2011, p. 290). However, because surplus calories in western states were more easily exported to eastern urban centers through nearby trade networks, proximity to western transportation systems increased the relative price of food. On the other hand, although Nebraska's far western frontier was dry and largely uninhabited, its distance from the Missouri River allowed surplus calories to remain local. Food prices, therefore, remained low, and rural Nebraska statures were taller than statures in counties along the Missouri River.

Other patterns are consistent with expectations. It is striking the degree to which white statures exceeded black statures, which is significant because modern black and

white statures are comparable when brought to maturity under ideal biological conditions (Komlos and Lauderdale, 2005; Carson, 2009b). Moreover, compositional effects can not explain the black-white stature differential, which was partially due to white's access to meat and better nutrition. Black and white statures also varied by nativity, and Northeastern and Middle Atlantic inmates reached shorter terminal statures than elsewhere within the US, and individuals from Southern states were the tallest (Carson, 2009b). Black and white males who persisted on the Central Plains had comparable statures to individuals from elsewhere within the US. Therefore, 19<sup>th</sup> century statures in Nebraska were the result of a complex set of economic, social, and biological interactions, and Nebraska statures were taller for rural farmers, improved over time, and for individuals who were far removed from large western trade routes.

#### V. Accounting for Nebraska's White-Black Stature Differential

To more fully account for the Nebraska white-black stature differential, a Blinder-Oaxaca decomposition is constructed for white and black statures (Oaxaca, 1973). Let  $S_w$  and  $S_b$  represent the statures of whites and blacks, respectively;  $\alpha_w$  and  $\alpha_b$  are the autonomous stature components that accrue to whites and blacks;  $\beta_w$  and  $\beta_b$  are the white and black stature returns associated with specific stature enhancing characteristics, such as age and occupation.  $X_w$  and  $X_b$  are black and white characteristic matrices, and whites are assumed to be the base structure.

$$\Delta S = S_w - S_b = (\alpha_w - \alpha_b) + (\beta_w - \beta_b)\bar{X}_w + \beta_b(\bar{X}_w - \bar{X}_b)$$

The second right hand-side element is the component of the stature differential due to characteristic returns. The third right-hand side element is the part of the stature differential due to differences in average characteristics. Using coefficients from the

stature regressions (Table 2, Models 2 and 3), the white-black stature Oaxaca decomposition indicates taller white statures were due to unobservable characteristics, such as better nutrition and greater socioeconomic status that favored whites.

Table 3, Nineteenth Century Nebraska Black and White Stature Differential

Sum	.847	.292	.886	.254
Total		1		1
Proportion				
Intercept	2.39		2.39	
Ages	.116	.001	.121	-.004
Birth	-1.37	.090	-1.35	.004
Nativity	-.155	-.268	-.032	-.102
Occupations	-.259	.476	-.042	.259
Residence	.260	.017	-.022	.065
Sum	.744	.267	.777	.223
Total		1		1

Source: See Table 2, Models 2 and 3.

Notes: Black and white sample averages from Table 1.

However, black stature returns were greater than whites for birth period and socioeconomic status. Figure 2 illustrates that after 1860, black stature increases were greater than for whites, and the net cumulative rate of biological returns increased more for blacks than for whites on the Central Plains. Moreover, Table 3 indicates that black farmer and rancher stature gains with occupations were larger than for whites, and whites had greater stature returns associated with age and residence within Nebraska. On the high Central Plains, black stature gains overtime and by socioeconomic status were greater than for whites; however, the majority of the white-black stature differential is

explained by non-identifiable characteristics, such as differences in access to nutrition biological differences between blacks and whites.

## VI. Conclusion

The Nebraska prison sample confirms established patterns for 19<sup>th</sup> century stature studies and offers new insights into existing questions in regard to US economic development. First, the Nebraska sample addresses a persistent question about the relationship between stature and the type of agricultural work performed, and Nebraska ranchers were consistently taller than workers in other occupations. Ranchers were in close proximity to rural diets rich in animal proteins, which had more essential amino acids that are indispensable in bone growth. Moreover, the Nebraska sample demonstrates agricultural laborers were taller than laborers in non-agricultural unskilled occupations, and simply combining common laborers with farm laborers understates the biological benefits to farm laborers and overstates the benefits for common laborer. Second, the large and significant increase in 19<sup>th</sup> century Nebraska statures indicate that biological conditions improved with economic development, and these gains were shared similarly between blacks and whites. Nebraska statures were also related with proximity to waterways and mounting evidence supports that proximity to western waterways increased the relative price of food and decreased statures in rural western states because close proximity to major waterways allowed western farmers to export excess food supplies to eastern and European markets, thereby increasing the relative price of food. On the other hand, close proximity to large eastern waterways was associated with taller statures because close proximity decreased the relative price of food from western state exports. Therefore, statures in the late 19<sup>th</sup> and early 20<sup>th</sup> century Nebraska indicates that

economic development in the mid-west was associated with improved net cumulative health, and there were complex relationships between health related to socioeconomic status, economic development, and proximity to trade routes.



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