

**Geographic Pieces in the Antebellum Puzzle:  
Early Nineteenth-Century Pennsylvania as a Case Study**

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### **Geographic Pieces in the Antebellum Puzzle: Early Nineteenth-Century Pennsylvania as a Case Study<sup>1</sup>**

As a general rule ... it is better that the farmer should produce what he needs for home consumption. He may obtain more money from tobacco, hops or broom corn, than from breadstuffs, but taking all things into consideration will he be better off?<sup>2</sup>

The nineteenth-century American farmer quoted above questioned the ultimate value of the involvement in markets at a time when market participation, although nearly universal in some areas, was neither the basis for all consumption nor completely accepted by the American populace. Theory and experience show that, over the long run, market participation certainly yielded higher material returns to most members of that society than did autarky. Yet, when evaluating short- and medium- term effects, particularly when considering non-pecuniary rewards, the results were not always as clear-cut in the early stages of modern economic growth. ‘To what degree did economic growth and its concomitant market integration provide short-term benefits to the American population during the antebellum period?’ is a question of interest to economic and social historians, physical anthropologists, as well as to development economists concerned with trends in living standards. The ultimate answers have important policy implications.

The most controversial and longest-lived academic debate in this regard pertains to the impact on the ‘standard of living’ of the English working class during the early phases of the Industrial Revolution. Yet, academics are not alone in their interest in this complex of issues. From Bangkok to Brasilia political leaders and policy experts are concerned with welfare, though its definition is contested. There are multiple yardsticks by which well-being can be judged: real wages, mean life span, unemployment rates, average number of televisions per dwelling, suicides, telephones per household, food consumption levels, percentage of homes with indoor plumbing, to name just a few. While today’s policy makers have the option of directing statistical bureaus to collect pertinent data, historians must be satisfied with records left behind by earlier generations of record keepers. Partially as a result, historians and economists, over the course of the last quarter century, have begun to utilize a type of data previously disregarded, namely those pertaining to the physical size of human populations, analyzed until then primarily by medical and biological researchers.<sup>3</sup> Adult physical stature reflects the cumulative net nutritional status of an individual over the course of his/her growth years. While at the individual level genes are an important co-determinant of final height attained, in large stable groups they do not determine short-term group variation either over time or cross-sectionally, in the absence of significant migration. Hence, the average height of a population can be used to assess how well a society was able, or chose, to meet its nutritional needs over time.<sup>4</sup> Since access to nutrition is related to, although not fully determined by, income, stature can also be used in some instances as an indicator of a society’s general level of material welfare. More directly, stature is a measure of a biological rather than a material standard of living.

This study, extracted from my work, *The Hidden Cost of Economic Development: The Biological Standard of Living in Antebellum Pennsylvania*, seeks to explore, in a regional geographic context and with a more emphasized spatial analysis component, an aspect of a rather fundamental and long controversial question, ‘What are the effects of rapid economic growth and development on the men, women, and children experiencing it?’ Specifically, within early nineteenth-century American context, ‘How did market integration in agricultural goods and the beginnings of industrialization affect the biological well-

being of Pennsylvanians in the antebellum era?’ Additionally, how did this occur differentially across the state? What spatial patterns existed in stature variation and temporal stature change. The spatial/temporal focus of this study, antebellum Pennsylvania, has some unusual, though not entirely unique, features. The process of market integration and early industrialization occurred in the first half of the nineteenth century, took place at a time when settlement of much of North America by persons of European ancestry was still relatively recent. European methods of intensive cultivation had only recently been introduced across much of the land. A ‘transportation revolution’ was also under way. The improved transportation system of canals and railroads not only traversed densely settled locales of long standing but also areas which had only recently been controlled by persons of European descent. In the ‘west’ a wilderness was being subdued coincident with, or only shortly before, the introduction of long-distance transport systems and the linking of these areas with distant agricultural markets.<sup>5</sup> Although generally thought of as a distinct phenomenon within the context of the contemporaneous Industrial Revolution across the ocean, these processes were actually an integral part of it in Pennsylvania.

Economic historians generally agree that early nineteenth century per capita economic growth in the United States was substantial. There are debates over the exact rate of economic expansion, as well as about the timing of the upswing in economic activity,<sup>6</sup> but not over the direction of the trend. The antebellum years in the North, except in a few large metropolises which had already experienced these changes, were a time of market integration and expansion, of early industrialization and urbanization. The transportation network grew both denser and more extensive as the country east of the Mississippi and west of the Alleghenies was first settled and then linked to Atlantic coastal cities. Regional and city/hinterland specialization lead to increased output per head and increased opportunity to participate in markets for numerous goods.

However, there were some negative external effects. There is some evidence, not uncontested however, that the 1830s and 1840s were a period of increasing occupational wage differentials and wealth concentration.<sup>7</sup> Additionally, studies of numerous disparate populations, blacks and whites, Northerners and Southerners, show declines in mean adult physical stature over portions of the antebellum period. The timing of the decline varies slightly from group to group as does its size and intensity. However, its presence was almost universal. The only exception found hitherto is the case of slave men, whose productivity was so inextricably linked to their nutritional intake that their owners seemingly made certain that their nutritional status did not decline even at a time when the price of food was increasing. With the vast majority of early nineteenth-century Americans living in rural locales, the antebellum diminution in physical stature was to a considerable degree a rural phenomenon as well.<sup>8</sup> Limited data indicate that, as the decline continued into the middle and later decades of the century, its effect became concentrated among urban residents.<sup>9</sup> Though the trend in heights is clear, its causes are less so. This decline in heights at a time of obvious economic prosperity has become known as the ‘antebellum puzzle’ in the American context or as the ‘early-industrial-growth puzzle’ in the European context.<sup>10</sup>

While the biological sciences have identified the factors which influence final height, historians must determine the relative weight of the various forces and the *relationship* between nineteenth-century economic and social developments and their biological consequences.<sup>11</sup> In both the American and European contexts investigations and ‘case-building’ for the various factors have begun. Studies of European populations have shown that the initial stages of industrial development were accompanied by a series of collateral developments which had negative biological results for some subsets of the population most heavily involved in market activities.<sup>12</sup>

In the American case, a series of hypotheses have been developed and await further examination. Some authors believe that changes in the epidemiological environment were mainly responsible for declining average stature. Such a

deterioration could have been caused by one or more of the following: 1) industrial and commercial expansion-related urbanization and subsequent crowding under unsanitary conditions, 2) the widening transportation network and the attendant increased movement of people and the infections they spread, and 3) the migration of people into areas more prone to harbor particular infections and their carriers.<sup>13</sup>

Another potential explanation is the tendency in the nineteenth-century toward rising levels of income and wealth inequality.<sup>14</sup> With growing inequality,<sup>15</sup> the upper classes, numerically only a small fraction of the population, benefited only marginally in physical stature and health from increased income. Their stature tended to be as high as their chosen diet structure and the disease environment would allow. In contrast, the lower classes, who tended to spend a significantly larger proportion of their income on food, had less money to spend on food; their nutritional status was reduced, and consequently their stature and health declined.<sup>16</sup> Rapid population and labor force growth were also characteristic of nineteenth-century America. However, with rapid technological change in the industrial sector, a declining share of workers was employed directly in agriculture. If, as has been argued, agricultural productivity gains did not keep pace with population growth and the expansion of agricultural exports, per capita food availability would have declined.<sup>17</sup> The result would have been lower per capita food consumption leading to reduced average height levels.<sup>18</sup>

Others contend that the increasing availability of manufactured goods in the nineteenth century may have induced some families to reduce their food consumption in order to market their crops more aggressively, especially high-protein meats and dairy products. While this might be a utility-increasing behavior, it would have a negative impact on the health of the children of the household. Such a change in the distribution of calories and high-protein foods from rural to urban consumption is also consistent with rural height declines.<sup>19</sup>

Only the initial steps have been taken to assess these hypotheses. To date, most large-scale anthropometric studies of U.S. whites have been national in scope.<sup>20</sup> More detailed studies of smaller localities with sample sizes large enough to bear the weight of detailed statistical analysis are needed to isolate the social, economic, and demographic factors most closely associated with the cycling in stature which has been identified both in Europe and the United States. A regional approach will show whether the local experience is identical to the national one, and help to determine how particular local economic and population characteristics were related to changes and spatial variation in physical well-being.

This work<sup>21</sup> describes an effort to begin to fill the knowledge gap noted above. It 1) seeks to confirm, at the local level, the existence of the ‘antebellum puzzle’ among U.S. males of European ancestry, 2) tests, within the setting of early nineteenth-century Pennsylvania, the hypothesis that separation from economic markets, i.e. relative economic self-sufficiency, provided a net nutritional advantage to early nineteenth-century Americans, 3) assesses the correlates of stature and spatial variation within this geographic and socio-economic context, and 4) adds to the body of literature which seeks to redefine economic well-being so as to include biological indicators and incorporate these types of costs and benefits into evaluations of economic development.

### **Antebellum Pennsylvania as a Case Study/Test Environment**

Several historical circumstances recommend Pennsylvania as a useful test environment for the hypothesis that economic development and the social changes related to it at least temporarily resulted in a decline in the biological well-being of the population. The antebellum period is acknowledged as one during which per capita income rose across the nation.<sup>22</sup>

Although data is not available for individual states, Pennsylvania during the first six decades of the century witnessed considerable economic development that must have produced significant gains in output both in total and on a per capita basis. Yet, a wide range of economic orientations existed across the state based on differences in the length of settlement, the level of accessibility of the region, and natural resource endowments. While Pennsylvania had some of the oldest communities of the new nation in 1800, there were also areas that had only recently been settled by persons of European descent. Yet other locales were not to be settled for another twenty or thirty years.<sup>23</sup> As a result, the nature of economic activity differed greatly from locale to locale across the commonwealth. The extent to which communities were part of local or regional trade networks also varied widely in 1800, as did the rate at which they entered into such systems. Early nineteenth-century Pennsylvania exhibited the entire gamut of economic orientations that existed in the United States at the time.<sup>24</sup> At one end of the continuum was Philadelphia, one of the major regional entrepôts and a major consumer of primary sector products.<sup>25</sup> However, such large urban agglomerations were the exception rather than the rule. In 1800, nearly 90 per cent of the state's population lived in rural areas or towns with fewer than 2500 inhabitants.<sup>26</sup> The state was a near textbook example of an area economically segmented by transportation barriers. The Allegheny Mountains, which had served as the western boundary of colonial settlement, posed a serious hindrance to the transport of goods from the seaboard to the interior after the Revolution.<sup>27</sup> They divided the state naturally into regions which, in the early nineteenth century, 'faced' in opposite directions in terms of their primary trade orientation.<sup>28</sup> Although the northwest corner of the state, after 1825, was linked to New York City via Lake Erie [to Buffalo] and the Erie Canal, at that point in time even common roads were lacking in portions of the state. Travel in these regions was extremely difficult. With such hindrances the economic value of much of the state's land was limited. Some counties were not even settled until the 1830s.<sup>29</sup> In such areas farmers were primarily engaged in subsistence-plus farming and local community exchange,<sup>30</sup> while many farmers in Southeastern Pennsylvania had already specialized in production to serve urban markets.

Over the course of the antebellum years the state as a whole experienced a relatively rapid process of economic development and urbanization. However, the integration of interior entrepôts with seaboard trading towns and the linking of more remote inland sites with regional cities did not occur uniformly across the land. Rather, topography, natural resource endowments, and transportation connections affected the speed with which locales became part of the antebellum trade network and made the transition from self-sufficient to interdependent communities.<sup>31</sup> These physical and cultural 'facts on the ground,' along with their spatial variation, create an important context for understanding economic development, and its consequences, in this region.

Throughout this period approximately one-half of the state's population lived in the Southeastern Region (Figure 1).<sup>32</sup> Its indicators of market development, the dollar value of market gardening and the value of land, were the highest in the state, while the percentage of the work force in agriculture and level of home manufactures, indicators of separation from economic markets, were the lowest. The Southeastern Region was very well connected by transportation systems both internally and with regions outside of Pennsylvania.

On the other end of the spectrum of development were the Allegheny Forest, Northeastern, and Pocono Regions. With late settlement dates and low population densities, these regions, poorly linked by road, canal, or rail, with some of the highest levels of home manufacturing and agricultural employment and lowest urbanization rates, characterized early nineteenth-century Pennsylvanian self-sufficiency. Farmers dominated these regions, but they were without a feasible outlet for any substantial crop surplus. Many were situated on relatively poor agricultural soils. These regions did not have any towns with a

population in excess of 2500 persons until the 1850 census. The difficult terrain and thin soil made producing sufficient crops to maintain one's family a difficult chore in the years immediately following settlement.<sup>33</sup>

In between these extremes of population density and economic development were three other regions, the Anthracite, the Ridge and Valley, and the Western. With very different terrain and resource endowments, the three moved in rather different economic directions. The Anthracite region became, over the period, the second most urbanized region in the state, whose *raison d'être* was the 'black rock' beneath its soil. Tied to the Southeast and eventually to New York State by canal and railroad, the region was well integrated into the market, both internally and with the Southeastern Region.

The Ridge and Valley was similarly tied to other regions, in-state and out, by the exchange of agricultural produce. Serving as a source of swine for both the Philadelphia and Baltimore markets, the farmers there oriented themselves to one or both cities as outlets for pork and, to a lesser extent, market garden crops. The region was cut by long-distance road, canal, and railroad connections, but a dense network of internal routes did not exist.

While its population density and level of urbanization lay between the two previous regions, the Western Region was one of the last to receive fully effective transportation linkages to the rest of the state. Although relatively well served by rivers and streams, many of these were only navigable in the spring. Steamships traveled throughout the region, even far up the Allegheny River; however, most traffic of this sort was found downstream from Pittsburgh on the Ohio. With the exception of the Mainline, canal and rail services were late in spreading throughout and internally connecting the region. Erie had ties of long standing via the lake to many ports, especially Buffalo. By 1860 industrial development had begun to spread along the Ohio, Monongehela, and Allegheny Rivers and their tributaries but through most of the period the bulk of the region was characterized by mixed farming.

As this overly brief summary makes clear, numerous types of economic activity existed across the state throughout the 60 years in question. By 1860, Philadelphia and Pittsburgh were large industrial centers. However, many pockets of semi-subsistence agriculture persisted.<sup>34</sup> The 'full range' of economic activity present in the United States existed within the state's borders throughout the period.<sup>35</sup> Great changes occurred in some areas and more modest ones elsewhere. Yet, the results of economic change are not always uniformly positive across the spectrum of economic actors nor across all aspects of human well-being. Development, while increasing total output and the level of output per capita, seldom results in an equal distribution of income or other material benefits. Similarly, the biological results of economic development and related social changes are not necessarily equally distributed. Antebellum Pennsylvanians experienced the often wrenching transition from a rural agricultural society to one increasingly urban and industrial. Material welfare was affected, but as the following description of height levels and height trends for the native-born male population<sup>36</sup> will show, so was physical well-being. What is both somewhat paradoxical, yet consistent with some anthropometric work focused on other areas experiencing the early stages of modern economic growth, is that mean stature declined over the period and that men in the **least** market-linked regions showed the greatest stature levels of any men across the state. Those men most distant from the activities which resulted in the greatest gains in output were the ones with the greatest biological standard of living, even though their material standard of living was below that of others.

## **The Pennsylvanians Under Study**

To date, only a relatively few groups of Pennsylvanians have been examined by anthropometric historians. Although not large, Pennsylvania is one of only a few states which has had researchers focus exclusively on men or women drawn from one particular sub-division of the nation.<sup>37</sup> Data for this study were drawn from regimental and company descriptive books<sup>38</sup> of Pennsylvania units which served the Union Army during the U.S. Civil War.<sup>39</sup> A statewide sample was constructed in order to assess stature trends across Pennsylvania and provide a context for a second geographically smaller regional sample. This second sample was drawn from the same sources, but was limited to men from units raised in fifteen 'western' counties (Figures 1 and 2). The statewide sample includes 11,953 observations of men **born in Pennsylvania** and enlisted in her Civil War regiments.<sup>40</sup> (Of these, 2330 are from the Union Army sample collected as part of Robert Fogel's Nutrition and Mortality project.<sup>41</sup>) The western sample contains an additional 7357 observations of Pennsylvania-born enlistees in Pennsylvania units.<sup>42</sup> In addition to physical stature, rank, birth place and enlistment place, occupation, and year of enlistment were captured for each man in both samples.

## **What Anthropometric Measures Tell Us About The Results of Economic Development in Antebellum Pennsylvania<sup>43</sup>**

### *National and International Comparisons*

Early anthropometric research has established the very significant net nutritional and stature advantage which eighteenth and nineteenth-century North Americans enjoyed over their European contemporaries.<sup>44</sup> This difference is also evident between Pennsylvania Civil War soldiers and several nineteenth-century European military samples (Table 3). The mean adult heights of antebellum Pennsylvanians were two and one-half to four inches greater than those of the European soldiers.

However, Pennsylvania Union soldiers were not as tall as those born in other parts of the United States (Table 4). There was a half inch deficit in height between the statewide sample of Pennsylvanians and the national sample of Civil War soldiers.<sup>45</sup> This is consistent with Baxter's summary of the heights of men by state of enlistment during the Civil War which showed Pennsylvanians to be below the national mean. This variation is also consistent with Sokoloff's finding that in the antebellum period men from the Mid-Atlantic Region tended to be shorter than U.S. males generally.<sup>46</sup> The mean adult height for the western sample of 68.5 inches is equivalent to the national average of Civil War soldiers calculated by Sokoloff and much closer to the 68.8 inch level of Union men from the Midwest/West.<sup>47</sup> Western Pennsylvanians had a mean stature between that of the statewide sample and that of Midwestern soldiers.

West Point cadets born in Pennsylvania in the mid-1800s were taller than the Union sample at younger ages, but the mean stature of the soldiers exceeded that of the cadets by age 18 in the Western sample and at age 19 in the statewide sample<sup>48</sup> (Figure 3). After age 19 the cadets were markedly shorter than the soldiers from the western sample.<sup>49</sup> Cadets were drawn in much greater proportion from urban areas than was the case for the Civil War soldiers.<sup>50</sup> The West Pointers' advantage of being from higher socio-economic class families possibly was counteracted by the fact that the cadets were to a large extent of urban origin.

### ***Variation in Height by Personal Characteristics***

Variation in mean height also existed across the characteristics of age, occupation, and migrant status. Each comparison provides additional insight into the nature of Pennsylvania's antebellum society and some results indicate that the assumed positive relationship between wealth and physical well-being was not always present during this period in this region.

**Age** Pennsylvanian's mean height at various ages, in both the western and the statewide samples, follows the standard pattern described in the biological literature with moderate growth over the late teen years and then a tailing off with final height attainment in the early twenties.<sup>51</sup> The process of growth ended by the age 21 in both the statewide and western samples (Figure 3). This is not far from the age of growth cessation in modern well-nourished populations, 18 years of age,<sup>52</sup> and is consistent with the level of adult stature in the western sample, a mean height equivalent to the 35th percentile of current American standards. The statewide mean only reached the level of the 25th percentile of modern American standards.<sup>53</sup> This height "level" is notable in that European populations will not reach this range of modern height standards until the twentieth century.

**Occupation** There are clear occupational differences in height across both the statewide and western samples.<sup>54</sup> Other studies have shown that farmers and rural residents had a substantial advantage in height over most other men during the early stages of industrialization.<sup>55</sup> This pattern is quite evident in nineteenth-century Pennsylvania as well (Figures 4 and 6 - 8). Such variation did not exist in the colonial period. Changes in the American antebellum social and economic environment seemingly helped to create a stature gap between occupational groupings and between individuals experiencing their growth years in different environments.

Farmers from both the statewide and western samples were 0.4-0.6 inch taller than their contemporaries who were proprietors, skilled or unskilled workers. They were not the tallest, however, being about a half-inch shorter than professionals. In the western sample, farmers had only a negligible height advantage over professionals: 0.1 inch, but they were more than 0.75 inches shorter than soldiers who noted only a work site as a place of employment. In both samples, skilled and unskilled workers show only a slight stature difference as skilled workers were just over two-tenths of an inch taller. Regression analysis indicates the height advantage of farmers over both skilled and unskilled workers are robust and consistent across several formulations of the model. Few other differences across occupations were statistically significant, either because there were few observations available, or because the variation was of negligible size. The propinquity to nutrients and distance from disease centers seems to have conferred a net nutritional advantage to farmers.<sup>56</sup> The stature advantage of farmers over most other men is also consistent across regions so that, regardless of a farmer's birthplace, he was likely to be taller than most other workers<sup>57</sup> (Table 5 and 6, Figures 7 and 8).

**Migrant/non-migrant status** Economic and social historians interested in the nature of migration and its effect on economic development have long examined the characteristics of the persons who left one place bound for settlement elsewhere in order to assess the differences between those who migrated and those who stayed behind. Sokoloff and Villaflor's study of French and Indian War and Revolutionary War soldiers found that men who migrated across county lines but within a single state, during the years between birth and enlistment, exhibited no difference in final adult height, whereas those crossing state boundaries did.<sup>58</sup> The latter had a height advantage of 0.45-0.85 inches over their less mobile counterparts, after accounting for



other variables. Margo and Steckel note that, in their analysis of Fogel's national sample of Civil War soldiers, short-distance migrants (which they defined as men moving within census-based regions) exhibited no difference in stature over non-migrants. However, long-distance migrants moving into the West were 'significantly taller (0.7-0.9 inches).'<sup>59</sup>

A sample which only includes Pennsylvania-born men obviously can only be used to evaluate in-state migration. The height of migrants, men who enlisted in a county other than the one in which they were born, were not consistently different from those of non-migrant men. The height difference in the western sample, while statistically significant, is small, less than two-tenths of an inch. Statewide, however, an opposite pattern is evident. Stayers are taller than leavers, but again by a very small and statistically insignificant amount. These findings are, in the main, consistent with the results reported by Sokoloff and Villaflor, and Margo and Steckel. Men who migrated short distances were not particularly different from men who did not. However, the pattern is strikingly different among men born in Philadelphia and Allegheny Counties (Figure 5). From 1815 through 1844, the mean relative height of men born and enlisted in Philadelphia County fell slowly, while the mean relative height of those men born in Philadelphia but who later migrated out of it slowly rose.<sup>60</sup> Apparently, as time went on, the cost, in biological terms, of staying in the state's largest urban area, became increasingly high, both relatively and absolutely. The pattern in Allegheny County, the West's urban center, is rather different. Post 1830 birth cohorts of stayers and migrants had nearly identical physical stature. This suggests that the impact of the small but growing Pittsburgh may have had an increasingly negative impact on men growing up not only in the city but in its hinterland as well.<sup>61</sup>

### ***Birth Cohort and Regional Stature Patterns***

The antebellum stature time trends in the Pennsylvania statewide and western samples are consistent with the trends found in other studies of the antebellum United States. From the 1820-24 through the 1840-44 quinquennia, a slight and uneven fall in mean stature of about two-thirds of an inch occurred in both samples.<sup>62</sup> The mean data show an upward 'blip' of two-tenths of an inch in the western sample in the 1830-34 cohort and a much smaller jump statewide. Regression analysis reveals that, after adjusting for other variables, this general trend – a decline between 1820 and 1844 with a one quinquennium upward jump in the 1830-34 cohort – is still present in the western sample but a somewhat slower, steadier decline occurred statewide. The stature differences in the statewide sample between the earlier and later quinquennia are only weakly statistically significant and on the order of one-quarter inch. (Table 5)

The same time trend is apparent across the occupational spectrum. If the samples are disaggregated by occupational category the mean height for each of the categories follows a trend similar to the one described above. While there is a degree of variability, especially in the early quinquennia in which there are relatively few observations, the trend is rather consistent with falling mean height evident over the entire period, although again, not monotonically. Just as forces had produced an occupational gradient in height by the early nineteenth century, so they caused mean average stature to fall in the later antebellum years. One small, but important, exception is the height of the professionals in the statewide sample, which do not decline in the second half of the 1830s.<sup>63</sup>

Regional analysis of height variation reveals patterns that support the view that men in areas least able to be involved in market activity benefited biologically from their separation.<sup>64</sup> An aggregate view of age standardized height by county for men born between 1815 and 1844 is presented in Figure 12, while Figures 13-18 show the spatial pattern of height distribution by birth quinquennium. The overall east-west and north-south gradients in height are immediately evident moving away from Philadelphia.<sup>65</sup> Philadelphia County never had a mean height above 99.25 per cent of the state average over the 1815-1844

period. However, the relatively low stature levels exhibited by Philadelphia County's birth cohorts are not restricted to that county hard on the banks of the Delaware River. Short soldiers were found across the whole of the southeastern corner of the state. It is especially noteworthy that Lancaster County, renowned for its productive farms and shipments of agricultural produce to both the Philadelphia and Baltimore markets, nonetheless, failed to reach the state average except for one quinquennium. This pattern follows the general pattern of both settlement and population density. (Figure 10)

This pattern is not perfectly uniform, however, as several counties in the Western Region had average or below average heights. These include Erie and Crawford, two counties that were more deeply integrated early into an interregional trading network because of their access to Lake Erie. Allegheny County, the most urbanized county in the western region, and a county whose border's were defined by the region's key trade routes, the Monongehela and Allegheny Rivers, had height levels near the statewide mean, roughly equivalent to those of Erie and Crawford. The tallest men were found in the most remote counties, Mercer, Lawrence, and Greene.

Regional trends reveal two primary groupings<sup>66</sup> (Figure 19). The Anthracite and Southeast regions had age standardized heights which, with one exception, were below the state mean for the entire period. In contrast, mean stature in the Ridge and Valley, Allegheny Forest, Northeast, and Western regions was consistently above the state average. The height-by-age profiles reveal a similar regional ranking by height (Figures 20 and 21).<sup>67</sup> With the exception of the Ridge and Valley region, the regions with the greatest mean stature were found in the most isolated parts of the state. Yet a slight downward trend in mean stature is evident in all regions across the 1815-1844 period.

Occupational composition variation does not seem to be the basis for the regional disparity in mean height. The relative position of the regions is maintained, as is the basic time profile, across the three largest occupational groupings, farmers, unskilled workers, and skilled workers, though with some greater variability due to the reduction in cell sizes.<sup>68</sup> However, age standardized stature reductions were concentrated more among the unskilled and skilled workers than with farmers. Farmers displayed a more stable height profile in the 1830s. The 1840-44 cohort of Western farmers had mean heights nearly identical to that of the 1815-19 group.

Regression analysis does not alter the statewide story described above. Men from the Southeastern and Anthracite Regions were almost a full inch shorter than men from the Western Region. These coefficients, along with much smaller ones (in absolute value) for the other regions, are consistently statistically significant under numerous formulations. Only the adult men from the undeveloped Allegheny Forest were as tall as the men in the Western Region, and those from the Pocono and Northeastern Regions were insignificantly different, in statistical terms, from heights prevailing in the West. (Table 5) The large variation between the Southeast and the West is not simply a function of the number of Philadelphians in the sample. The results remain unaffected if all Philadelphia County born men are removed from the data set.

Pennsylvania's urban residents, less than fifty years after the Revolutionary War, had a significant deficit in height relative to their rural neighbors. Sokoloff and Villaflor's study of revolutionary-era American soldiers found no significant difference between these groups,<sup>69</sup> although later work on early national period samples did.<sup>70</sup> The disparity between those born in the most urbanized county in the state, Philadelphia, compared to residents of the 'non-urban' counties of the Western Region, was 1.0-1.5 inches throughout the growth years<sup>71</sup> (Figure 21). Even after accounting for their Southeastern Region of birth, which is associated with about a one inch height deficit compared to the Western Region, the mean stature of men born in counties containing towns with a population of 25,000+ carried an additional penalty of 0.5 inches relative to men born in counties with no towns larger than 5000 persons. This implies that the difference between rural men born in the Western

Region and those born in Philadelphia was a substantial 1.5 inches. Between the birth cohorts of the 1770s and the 1820s, conditions changed significantly enough so that Pennsylvanians born in Philadelphia County were more than an inch shorter than residents of the most isolated counties.

The large sample of Civil War soldiers drawn from the Western Region allows a more disaggregated analysis of this area.<sup>72</sup> The region was divided into six sub-regions (Figure 2). Sub-regions were determined by geography, topography, the nature of economic activity, and the relationship to Pittsburgh, the region's major city. Because of its urban character, Allegheny County is considered separately. The far southwest corner of the state, which had the oldest agricultural settlements and most mature agricultural system in Western Pennsylvania, is considered as the Southern Hinterland, made up of Fayette, Greene, Washington, and Westmoreland Counties. Its name reflects its connection to the Pittsburgh market via the Monongehela and Youghigheny Rivers. The Mountain/Mineral sub-region, made up of Armstrong, Cambria, Indiana, and Somerset Counties, had difficult terrain, only moderately productive agricultural soils, and large deposits of bituminous coal. Butler and Beaver Counties, tied to Pittsburgh by the Ohio River as well as by a series of overland routes, comprised the Northern Hinterland. Throughout most of the antebellum period they were predominantly agricultural, although industrial production began to develop about 1860 especially along the Ohio River. Two productive agricultural counties, Mercer and Lawrence, formed the Isolated Agricultural sub-region. They were not settled until very late in the eighteenth century, and until late in the antebellum period transportation routes did not effectively connect them to the rest of the region. In the far northwest corner of the state, Erie and Crawford Counties made up the Lake Transport sub-region. With only moderate per capita crop production levels, this sub-region was the nexus of transshipment of goods from western Pennsylvania to Buffalo and other lake ports. It served as Pennsylvania's connection, via the Erie Canal, to New York City.

Mean heights varied widely across the region. In the most isolated agricultural lands of Mercer and Lawrence Counties, adult mean heights were a full inch over the average for Erie and Crawford Counties, with smaller differences between the other sub-regions (Figure 22). These differences are consistent in size and significance using several different regression models (Table 6). The differences in height between the Isolated Agricultural area and the Mountain/Mineral Region and the Southern Hinterland were about half as large. After adjusting for other variables, Allegheny County had mean heights slightly less than one-half inch below those of the Isolated Agricultural region. The differences in height between the Northern Hinterland and the Isolated Agricultural Region were insignificant.

The temporal patterns of height in the Western sub-regions were somewhat different from those in the rest of the state. Except for the Lake Transport Region, which had heights between one and one and one-half per cent below those of the rest of the West, heights across the Western Region varied in a narrow band between 1.5-1.75 per cent higher than the state mean. Region-wide temporal decline is evident only in the last quinquennium. Prior to that, stature declines were concentrated in Allegheny County. The decline in heights statewide evident during this period is not as clear in the West.<sup>73</sup>

An important spatial pattern *within* the Western Region is similar to that across the rest of the state. Men born in the most recently settled sub-region, the counties least connected by transportation routes, the Isolated Agricultural Region, were the tallest. Those areas with the greatest concentration of population and most connected with the other regions, Allegheny County, the Lake Transport, and Mountain/Mineral Regions, had noticeably lower mean heights.

### *Variation by County Economic Characteristics*

The trends described above are not artifacts of sample composition and cannot be explained by age or occupational variation within the sample of early nineteenth-century Pennsylvanians. Hypotheses by other anthropometric researchers explain antebellum stature variation by the propinquity to food resources and by remoteness from urban centers, with their burdensome disease environments, and their markets for food. Regional, occupational, and age-standardized analysis of variation in height indicates that the regional patterns expected on the basis of such hypotheses are obtained in this sample of Pennsylvanians as well. Areas least densely populated, least tightly connected by transportation routes, and most agriculturally based had mean stature levels significantly above regions at the other end of the developmental continuum. Even these small regions, however, were characterized by disparate economic and social circumstances. These patterns can also be evaluated at a level of aggregation below the regional one in order to account for more localized variation across the Commonwealth. In order to do so, multivariate regression analysis using data on the economic characteristics of counties with all the requisite data was used to evaluate the correlates of height.<sup>74</sup>

A series of proxies was developed to characterize the economies of the counties in the antebellum period.<sup>75</sup> The level of economic development was represented by the proportion of the population involved in agriculture. Propinquity to nutrients was proxied by the number of swine per capita, the per capita dollar value of dairy production, and the number of per capita surplus calories per day (in thousands) and grams of surplus protein (in hundreds) generated in the birth county.<sup>76</sup> Several potential proxies for the intensity of the disease environment were tested. These include population density, the percentage of the county population living in places with populations over 2500, over 10,000, and over 25,000, as well as the size of the largest city (in the census year nearest to the year of birth). The extent of market participation was proxied by the per capita value of market garden production and by the per capita value of home manufactures. Access to economic markets was proxied by 1845 average land values as well as by the presence of a navigable water transport route in 1850.<sup>77</sup> Anticipating that wealth would provide access to nutritional resources, the per capita value of agricultural and manufacturing assets in the county of birth in 1850 was also included in the equation.<sup>78</sup> Dummy variables to control for occupation, the year of enlistment, 'migrant' status, and the quinquennium of birth were also included, as was a dummy for the region of birth. The latter served as a proxy variable for some of the unexplained, but regionally associated, variation.

Regressions were run including these variables on the restricted statewide sample described above. The exercise was then repeated excluding the men born in the city and county of Philadelphia in order to ascertain the extent to which the results were influenced by this rather atypical region.<sup>79</sup> Regression coefficients for the non-economic/non-demographic variables remain basically the same as reported previously. The inclusion of these new proxy variables does not have an effect on those results. The basic time profile of stature between 1820 and 1839 remains as previously described. Even after accounting for the economic variables, farmers had a significant stature advantage of four-tenths of an inch or larger, depending upon the model. Other occupational variables did not reach the level of statistical significance, although the near equivalence of the stature of skilled and unskilled workers remained. Migrants in both samples were taller than stayers, but not at a statistically significant level.

Several variables consistently appear the most closely linked to stature variation across the 29 counties in the statewide sample<sup>80</sup> Regardless of the model, the per capita number of swine and the presence of water transportation routes within the county of birth are two variables with the largest consistent relationship to stature variation. The presence of a large number of hogs per capita in the county of birth is associated with greater stature, while the presence of a navigable water route

is associated with lesser stature. When observations for Philadelphia County and dummy regional variables are included in the model, a one standard deviation change in the level of swine per capita (See Table 11 for means and standard deviations for the independent variables.)<sup>81</sup> yields a two-third inch increase in anticipated stature levels, while the presence of water transportation in the county of birth was associated with nearly one inch lesser height. Other strongly influential variables in statewide-sample regressions include protein and calorie surpluses per capita, the dollar value of dairy production, and the dollar value of home manufacturing. Each is associated with approximately a two-tenth of an inch increase in stature for each one standard deviation positive change in the independent variables. A series of variables with negative coefficients, including the dollar value of market gardening, the mean land value, and population density, are not as statistically significant, nor do they have such a large absolute influence on stature. The percentage of the work force employed in agriculture also had a significant positive effect on stature levels. Dummy variables for the presence of a town in the county of birth or enlistment generally carried negative coefficients ranging from a -0.48 inch for birth in a county containing a town of 25,000 or more persons to -0.34 inch for enlistment in such a county. The coefficient on birth in a county containing a town of 5-10,000 population was negligible. In sum, the signs of the variables were quite consistent with the hypothesis noted earlier. The proxies for propinquity to nutrients (protein and calorie surpluses, swine stocks, and dairy production levels) were all positively correlated with stature, as in some other samples.<sup>82</sup> Distance from markets and urban centers proxied by low dollar values of market gardening, low population concentration levels, and high home manufacturing levels were all correlated with greater stature and thus higher net nutritional status. Connections to markets proxied by the availability of water transportation, high dollar value of market gardening, and high population concentration levels were associated with lower stature. Further analysis indicates that these statewide results did not arise from the statistical dominance and uniqueness of the Philadelphia-born in the sample. Therefore, the link between market participation and stature levels is not simply a function of the effects of the huge Philadelphia urban center on its residents. Rather, the net nutritional effect of a large city spreads well beyond the urban area's boundaries.

### **Conclusion: What Has it Told Us? What Might it Tell Us?**

The analysis presented above confirms and expands upon earlier findings within historical anthropometric literature and points the way for further efforts. Pennsylvanians who fought in the American Civil War had a mean height that ranged between the 20–35<sup>th</sup> percentile of modern height standards. However, they were probably among the tallest populations in their world, with considerably greater stature than their European contemporaries.<sup>83</sup> Men born in western Pennsylvania were taller than the statewide average and had height levels between those of their Midwestern neighbors and their 'cousins' in Philadelphia. Statewide stature levels reflect the relatively easy access to nutrients, the extremely productive soil, the favorable climate, as well as the low level of large-scale urbanization in early nineteenth-century Pennsylvania. Similar stature levels would not be achieved by the majority of even West Europeans until the turn of the twentieth-century.<sup>84</sup>

The decline in mean stature described by most studies of the antebellum United States is uniformly evident in these samples as well. It is more clearly apparent in the statewide sample and concentrated more among skilled and unskilled workers than in other occupational categories. However, spatial variation exists in this regard. Farmers' heights in the Western Region show very little decline in this period. They also tended, as did farmers across Pennsylvania, to have mean heights greater than most other occupation groups.

Men from counties which were the least involved in market activity and least developed economically were significantly taller than men in more market integrated locales. Stature was positively and strongly correlated with the production of home manufactures and negatively related to the level of market gardening. Men from counties with the largest proportions of their work force in agriculture tended to be taller, as were men from counties without water transport routes – the latter were not linked to distant markets. In antebellum Pennsylvania, being self-sufficient obviously conferred nutritional advantages. Those who were economically ‘behind’ literally looked down on those who were ‘ahead.’

Distance from markets was not the sole factor related to greater stature. Proximity to nutrients, the per capita levels of swine stocks, dairy production, and protein and calorie surpluses were all positively correlated with height. While having a somewhat weaker effect, county population characteristics also influenced stature trends. Population density and the presence of large cities in the counties of birth and/or enlistment were negatively related to stature. The case of relatively short men in agriculturally productive Lancaster County highlights the interplay of factors. While large quantities of foodstuffs were harvested in this county, and a considerable nutritional surplus produced, this was not sufficient to generate a high nutritional status for the children growing up there. Either the disease effects associated with being close to an urban center or familial choice to market high value protein foods outweighed the effect of being close to large amounts of proteins and calories. As the cases above indicate, the presence of a navigable water route in Erie County and one in Clearfield County are not equivalent because of who and what was at the other end of that water route and how long it took to reach its terminus. Per capita protein and calorie surpluses in Lancaster County, destined for sale in Philadelphia or Baltimore, clearly mean something different from surpluses of similar size in isolated Tioga County. While statistical analysis using various proxies has outlined the relationship between economic and demographic variables and stature, understanding the full pattern also requires understanding the nature of the places and of the connection (or lack thereof) between them.

### **Future Directions**

To date research in Pennsylvania history via anthropometric techniques has informed several fields of study. Civil war historians have been provided with another angle on who the men who fought for the Union from Pennsylvania were and the shifts in their characteristics over the years of the conflict. Those interested in the economic development of the state now know that, from a biological perspective, the economic outcomes of life in Pennsylvania were much better than those in Europe for men of similar classes. Additionally, the net nutritional outcomes of economic development in Pennsylvania varied significantly from region to region within the state. This pattern of regional variation is consistent with some patterns found in Europe in the early phases of modern economic growth. Areas less tightly linked to distant markets, i.e., more self-sufficient, displayed greater stature than those regions, highly urban or otherwise, that were heavily involved in market-based production.

Relatively recent developments in the area of geographic information systems have significantly advanced our ability to examine and analyze spatial components and tendencies within historical data. While the analysis described in this paper utilized, in only a very simplistic fashion, GIS technologies to produce visual representations of data, the potential for such analysis over the past several years has expanded immensely and some of the other papers in this conference have utilized these capabilities. Such software, including versions of the “Reki-show” software highlighted in one of this session’s papers, will enable researchers to investigate relationships in ways that have not previously been possible, providing a means of bringing together anthropometric data and understandings of physical and cultural geography so that relationships that might

have earlier been hypothesized can now be visualized and potential statistical relationships identified for later confirmation or refutation. Some associated techniques hold the promise of transcending the difficulty which categorical data (such as that collected and organized by political jurisdiction) poses to understanding variation across space. Historical actors, human and otherwise, are not necessarily influenced by arbitrary political boundaries and behavior/phenomena present in one political jurisdiction, might well influence outcomes in another, even though it is not possible to capture such developments/effects directly from government data.<sup>85</sup>

While numerous studies of the antebellum United States have been conducted, few have examined trends in biological well-being for birth cohorts from the decades just preceding and following the Civil War.<sup>86</sup> With support from the Pennsylvania Historical and Museum Commission and the Economic History Association, I have collected and digitized an 8,000 observation sample of men who enlisted in Pennsylvania's National Guard between 1866 and 1918. Analysis of this data, from this period of rapid large-scale industrialization and urbanization, will begin next year. Hopefully, it will provide an opportunity to more extensively utilize some of the GIS capabilities noted above and show how later economic development affected Pennsylvanians across the Commonwealth.

Anthropometric techniques have deepened our understanding of economic activity and its consequences. Use of GIS technology will help us to visualize and analyze such results more fully across space. However, and potentially most importantly, the use of each can help make explicit the multi-dimensional nature of human well-being and the many faceted outcomes of economic activity. In societies dominated by images of consumption and the assumption that increased consumption is the ultimate goal of economic activity, this work points to the fact that economic activity has many consequences, some immediately obvious, others not. It points out that the results of economic activity, literally can be bad for your health, and that historians examining the "well-being" of any society must use multiple rulers to take that measurement and fully understand the nature of the outcome.

**Table 1 Mean Height and Age by Category--Statewide Sample**

|                          | N     | %     | Mean<br>Height | SD   | Mean<br>Age | SD   |
|--------------------------|-------|-------|----------------|------|-------------|------|
| <u>Entire Sample</u>     | 11953 | 100.0 | 67.49          | 2.51 | 24.52       | 6.96 |
| <u>Birth Cohort</u>      |       |       |                |      |             |      |
| 1815-1819                | 198   | 1.7   | 68.05          | 2.26 | 45.02       | 3.14 |
| 1820-1824                | 501   | 4.2   | 68.15          | 2.37 | 41.20       | 2.11 |
| 1825-1829                | 873   | 7.3   | 68.06          | 2.41 | 35.97       | 1.97 |
| 1830-1834                | 1232  | 10.3  | 68.08          | 2.46 | 30.64       | 2.08 |
| 1835-1839                | 2339  | 19.6  | 67.93          | 2.42 | 25.23       | 2.03 |
| 1840-1844                | 4754  | 39.8  | 67.48          | 2.43 | 20.58       | 1.81 |
| 1845-1849                | 2056  | 17.2  | 66.21          | 2.49 | 18.27       | 0.85 |
| <u>Enlistment Year</u>   |       |       |                |      |             |      |
| 1861                     | 2936  | 24.6  | 67.83          | 2.65 | 23.99       | 6.68 |
| 1862                     | 2166  | 18.1  | 67.80          | 2.43 | 24.10       | 6.46 |
| 1863                     | 640   | 5.4   | 67.27          | 2.44 | 25.17       | 6.23 |
| 1864                     | 4661  | 39.0  | 67.34          | 2.44 | 24.92       | 7.28 |
| 1865                     | 1550  | 13.0  | 66.97          | 2.48 | 24.65       | 7.29 |
| <u>Occupation</u>        |       |       |                |      |             |      |
| Farmer                   | 3543  | 29.6  | 67.84          | 2.56 | 23.85       | 6.68 |
| Proprietor               | 564   | 4.7   | 67.25          | 2.51 | 23.72       | 6.21 |
| Professional             | 69    | 0.6   | 68.35          | 2.36 | 29.25       | 7.25 |
| Work Site Only           | 58    | 0.5   | 67.92          | 2.54 | 26.16       | 6.96 |
| Skilled Worker           | 3882  | 32.5  | 67.43          | 2.39 | 25.66       | 7.24 |
| Unskilled<br>Worker      | 3458  | 28.9  | 67.22          | 2.54 | 24.12       | 6.93 |
| None (Student)           | 95    | 0.8   | 67.59          | 2.84 | 20.04       | 3.05 |
| Unknown                  | 284   | 2.4   | 67.44          | 2.79 | 23.72       | 6.09 |
| <u>Rank</u>              |       |       |                |      |             |      |
| Officer                  | 46    | 0.4   | 68.38          | 2.07 | 30.09       | 6.55 |
| Non-comm                 | 976   | 8.2   | 68.27          | 2.40 | 25.10       | 5.81 |
| Private                  | 6741  | 71.1  | 67.41          | 2.50 | 24.31       | 7.00 |
| Musician                 | 67    | 0.6   | 65.22          | 3.12 | 21.39       | 6.18 |
| Artisan                  | 31    | 0.3   | 67.33          | 1.88 | 26.61       | 5.95 |
| Unknown                  | 2331  | 19.5  | 67.50          | 2.51 | 25.01       | 7.16 |
| <u>Enlistment Status</u> |       |       |                |      |             |      |
| 'Standard'               | 8629  | 72.2  | 67.52          | 2.52 | 24.30       | 6.80 |
| Drafted                  | 337   | 2.8   | 67.57          | 2.28 | 29.33       | 7.47 |
| Substitute               | 209   | 1.7   | 66.50          | 2.44 | 21.50       | 6.71 |
| Recruit                  | 61    | 0.5   | 67.73          | 2.48 | 22.66       | 6.48 |
| Bounty Recipient         | 387   | 3.2   | 67.26          | 2.66 | 24.13       | 6.82 |
| Unknown                  | 2330  | 19.5  | 67.51          | 2.48 | 25.01       | 7.16 |



**Table 1 (continued)**

| <u>Type of Unit</u>   | <u>N</u> | <u>%</u> | <u>Mean<br/>Height</u> | <u>SD</u> | <u>Mean<br/>Age</u> | <u>SD</u> |
|---|----------|----------|------------------------|-----------|---------------------|-----------|
| Infantry  | 9800     | 82.0     | 67.47                  | 2.52      | 24.75               | 7.09      |
| Cavalry   | 1187     | 9.9      | 67.72                  | 2.45      | 23.29               | 6.17      |
| Artillery   | 711      | 5.9      | 67.40                  | 2.50      | 23.81               | 6.42      |
| Reserve Inf.  | 255      | 2.1      | 67.44                  | 2.61      | 23.35               | 5.59      |
| <u>Age</u>  |          |          |                        |           |                     |           |
| Under 15  | 9        | 0.1      | 61.36                  | 3.72      |                     |           |
| 16  | 56       | 0.5      | 64.04                  | 3.97      |                     |           |
| 17  | 228      | 1.9      | 65.99                  | 2.51      |                     |           |
| 18  | 1799     | 15.1     | 66.36                  | 2.35      |                     |           |
| 19  | 1215     | 10.2     | 66.99                  | 2.49      |                     |           |
| 20  | 1016     | 8.5      | 67.46                  | 2.38      |                     |           |
| 21  | 1184     | 9.9      | 67.82                  | 2.33      |                     |           |
| 22  | 786      | 6.6      | 67.77                  | 2.41      |                     |           |
| 23  | 725      | 6.1      | 67.86                  | 2.52      |                     |           |
| 24  | 593      | 5.0      | 67.86                  | 2.47      |                     |           |
| 25-49   | 4327     | 36.2     | 67.99                  | 2.41      |                     |           |
| 50+   | 15       | 0.1      | 68.45                  | 1.83      |                     |           |
| <u>Largest town in county of birth (at previous census)</u> |          |          |                        |           |                     |           |
| < 5,000   | 9606     | 80.4     | 67.54                  | 2.54      | 24.39               | 7.08      |
| 5,000-10,000  | 1164     | 9.7      | 67.25                  | 2.30      | 24.92               | 6.32      |
| 10,000-25,000   | 366      | 3.1      | 68.01                  | 2.65      | 23.84               | 5.03      |
| 25,000+   | 817      | 6.8      | 66.93                  | 2.30      | 25.80               | 6.88      |
| <u>By Statewide Regions<sup>a</sup></u>                     |          |          |                        |           |                     |           |
| Southeastern  |          |          |                        |           |                     |           |
| with Phila Co.  | 3659     | 34.0     | 66.99                  | 2.41      | 24.89               | 7.14      |
| w/out Phila Co.   | 2654     | 24.6     | 67.13                  | 2.38      | 25.04               | 7.19      |
| Phila. Co.  | 1005     | 9.3      | 66.63                  | 2.46      | 24.50               | 7.00      |
| Anthracite  | 1401     | 13.0     | 67.01                  | 2.52      | 23.82               | 6.55      |
| Pocono  | 73       | 0.7      | 68.23                  | 2.20      | 25.88               | 7.15      |
| Northeastern  | 603      | 5.6      | 68.01                  | 2.49      | 24.22               | 7.12      |
| Ridge & Valley  | 1704     | 15.8     | 67.82                  | 2.37      | 25.36               | 7.26      |
| Allegheny Forest  | 535      | 5.0      | 67.98                  | 2.40      | 24.36               | 6.30      |
| Western   |          |          |                        |           |                     |           |
| with Algny Co.  | 2794     | 25.9     | 68.13                  | 2.52      | 23.57               | 6.31      |
| w/out Algny Co.   | 2291     | 21.3     | 68.22                  | 2.48      | 23.70               | 6.40      |
| Algny Co.   | 503      | 4.7      | 67.72                  | 2.66      | 22.95               | 5.84      |

<sup>a</sup> Summed percentages do not total 100% because of double listing of Philadelphia and Allegheny Counties. Percentages based on the number of cases with valid county codes.

**Table 2 Mean Height and Age by Category--Western Sample**

|                          | <u>N</u> | <u>%</u> | <u>Mean<br/>Height</u> | <u>SD</u> | <u>Mean<br/>Age</u> | <u>SD</u> |
|--------------------------|----------|----------|------------------------|-----------|---------------------|-----------|
| <u>Entire Sample</u>     | 7537     | 100      | 67.96                  | 2.54      | 24.14               | 6.77      |
| <u>Birth Cohort</u>      |          |          |                        |           |                     |           |
| 1815-1819                | 145      | 1.9      | 68.89                  | 2.62      | 44.58               | 2.75      |
| 1820-1824                | 314      | 4.2      | 68.57                  | 2.53      | 40.84               | 2.06      |
| 1825-1829                | 441      | 5.9      | 68.50                  | 2.42      | 35.80               | 1.98      |
| 1830-1834                | 698      | 9.3      | 68.68                  | 2.57      | 30.37               | 2.07      |
| 1835-1839                | 1577     | 20.9     | 68.38                  | 2.41      | 24.90               | 1.98      |
| 1840-1844                | 3230     | 42.9     | 67.91                  | 2.45      | 20.35               | 1.70      |
| 1845-1849                | 1132     | 15.0     | 66.56                  | 2.41      | 18.26               | 0.92      |
| <u>Enlistment Year</u>   |          |          |                        |           |                     |           |
| 1861                     | 2217     | 29.4     | 68.19                  | 2.57      | 23.99               | 6.80      |
| 1862                     | 1932     | 25.6     | 68.34                  | 2.54      | 23.74               | 6.09      |
| 1863                     | 298      | 4.0      | 67.58                  | 2.55      | 25.20               | 6.59      |
| 1864                     | 2173     | 28.8     | 67.58                  | 2.47      | 24.58               | 7.24      |
| 1865                     | 917      | 12.2     | 67.59                  | 2.41      | 23.94               | 6.86      |
| <u>Occupation</u>        |          |          |                        |           |                     |           |
| Farmer                   | 2919     | 38.7     | 68.24                  | 2.49      | 23.64               | 6.62      |
| Proprietor               | 402      | 5.3      | 67.75                  | 2.65      | 22.97               | 5.18      |
| Professional             | 42       | 0.6      | 68.11                  | 2.31      | 27.64               | 7.06      |
| Work Site Only           | 50       | 0.7      | 69.09                  | 2.17      | 22.10               | 5.10      |
| Skilled Worker           | 2252     | 29.9     | 67.87                  | 2.48      | 25.33               | 7.05      |
| Unskilled<br>Worker      | 1675     | 22.2     | 67.62                  | 2.64      | 23.98               | 6.92      |
| None (Student)           | 100      | 1.3      | 68.11                  | 2.53      | 19.96               | 2.42      |
| Unknown                  | 97       | 1.3      | 67.47                  | 2.44      | 22.90               | 6.24      |
| <u>Rank</u>              |          |          |                        |           |                     |           |
| Officer                  | 16       | 0.2      | 69.58                  | 1.80      | 28.00               | 5.95      |
| Non-comm                 | 691      | 9.1      | 68.89                  | 2.44      | 25.37               | 6.05      |
| Private                  | 6763     | 89.7     | 67.87                  | 2.51      | 24.01               | 6.82      |
| Musician                 | 37       | 0.5      | 64.56                  | 3.77      | 19.62               | 4.00      |
| Artisan                  | 30       | 0.4      | 68.59                  | 2.54      | 28.53               | 7.96      |
| <u>Enlistment Status</u> |          |          |                        |           |                     |           |
| 'Standard'               | 7132     | 94.6     | 67.99                  | 2.54      | 24.17               | 6.77      |
| Drafted                  | 83       | 1.1      | 67.94                  | 2.46      | 28.69               | 7.10      |
| Substitute               | 97       | 1.3      | 66.65                  | 2.27      | 20.74               | 5.03      |
| Recruit                  | 63       | 0.8      | 67.72                  | 2.86      | 22.41               | 5.92      |
| Bounty Recipient         | 162      | 2.1      | 67.35                  | 2.29      | 23.26               | 6.80      |

**Table 2 (continued)**

| <u>Type of Unit</u>  | <u>N</u> | <u>%</u> | <u>Mean<br/>Height</u> | <u>SD</u> | <u>Mean<br/>Age</u> | <u>SD</u> |
|--|----------|----------|------------------------|-----------|---------------------|-----------|
| Infantry   | 5131     | 68.1     | 67.88                  | 2.53      | 24.05               | 6.84      |
| Cavalry  | 1617     | 21.5     | 68.06                  | 2.55      | 24.03               | 6.55      |
| Artillery  | 541      | 7.2      | 68.14                  | 2.53      | 25.62               | 7.08      |
| Reserve Inf.   | 248      | 3.3      | 68.49                  | 2.48      | 23.33               | 5.41      |
| <u>Age</u>   |          |          |                        |           |                     |           |
| Under 15   | 12       | 0.2      | 62.73                  | 5.12      |                     |           |
| 16   | 30       | 0.4      | 64.93                  | 3.15      |                     |           |
| 17   | 113      | 1.5      | 66.03                  | 2.41      |                     |           |
| 18   | 1171     | 15.5     | 66.70                  | 2.29      |                     |           |
| 19   | 796      | 10.6     | 67.56                  | 2.50      |                     |           |
| 20   | 665      | 8.8      | 67.92                  | 2.33      |                     |           |
| 21   | 842      | 11.2     | 68.35                  | 2.32      |                     |           |
| 22   | 573      | 7.6      | 68.25                  | 2.52      |                     |           |
| 23   | 480      | 6.4      | 68.38                  | 2.42      |                     |           |
| 24   | 352      | 4.7      | 68.49                  | 2.41      |                     |           |
| 25-49  | 2496     | 33.1     | 68.48                  | 2.50      |                     |           |
| 50+  | 7        | 0.1      | 67.89                  | 3.51      |                     |           |
| <u>Largest town in county of birth (at closest census)</u> |          |          |                        |           |                     |           |
| < 5,000  | 6315     | 83.8     | 67.98                  | 2.54      | 24.03               | 6.82      |
| 5,000-10,000   | 286      | 3.8      | 67.79                  | 2.67      | 29.13               | 8.23      |
| 10,000-25,000  | 797      | 10.6     | 67.99                  | 2.43      | 23.04               | 6.97      |
| 25,000+  | 139      | 1.8      | 67.24                  | 2.42      | 25.24               | 6.87      |
| <u>Regional<sup>b</sup></u>                                |          |          |                        |           |                     |           |
| Allegheny Co.  | 1520     | 18.9     | 67.77                  | 2.58      | 23.04               | 6.01      |
| Mntn/Mineral   | 1973     | 24.6     | 68.07                  | 2.42      | 24.35               | 6.83      |
| Southern   |          |          |                        |           |                     |           |
| Hinterland   | 2144     | 26.7     | 68.30                  | 2.47      | 24.52               | 6.80      |
| Northern   |          |          |                        |           |                     |           |
| Hinterland   | 878      | 10.9     | 68.35                  | 2.57      | 23.93               | 6.46      |
| Lake Transport   | 609      | 7.6      | 67.61                  | 2.57      | 23.10               | 6.05      |
| Isolated Agric.  | 910      | 11.3     | 68.51                  | 2.52      | 22.82               | 5.91      |

<sup>b</sup> This section is based not on the western sample but rather from all observations (statewide and western sample) for men born in the western region. See Figure 2 for definitions of these regions.

**Table 3 Mean Heights of Adult Males (in inches)**

| Pennsylvania<br>European Ancestry |                     | Europe        |               |               |
|-----------------------------------|---------------------|---------------|---------------|---------------|
| 1861-1865                         |                     | Hungary       | England       | Sweden        |
| Western<br>Sample                 | Statewide<br>Sample | 1813-<br>1835 | 1816-<br>1821 | 1843-<br>1886 |
| 68.5                              | 68.0                | 64.2          | 65.8          | 66.3          |

*Sources:* Hungary: Komlos, *Nutrition and Economic Development*, Table 2.1, 57 (using QBE); Britain: Floud, Wachter, and Gregory, *Height, Health, and History*, Table 4.1, 148 (using RSMLE); Sweden: Sandberg and Steckel, 'Overpopulation and Malnutrition,' Table 2, 7 (using QBE).

*Note:* Dates refer to dates of measurement.

**Table 4 Mean Heights of Adult Males, U.S. (in inches)**

| North America        |               |                     |               |               | Pennsylvania<br>European Ancestry<br>1861-1865 |                     |
|----------------------|---------------|---------------------|---------------|---------------|--|---------------------|
| European<br>Ancestry |               | African<br>Ancestry |               |               | Western<br>Sample                              | Statewide<br>Sample |
| 1775-<br>1783        | 1861-<br>1865 | 1943-<br>1944       | 1811-<br>1861 | 1943-<br>1944 |  |                     |
| 68.1                 | 68.5          | 68.1                | 67.0          | 67.9          | 68.5   | 68.0                |

*Sources:* U.S. whites, 1775-1783: Sokoloff and Villaflor, 'Early Achievement,' 458 (using QBE); U.S. whites, 1861-65: Margo and Steckel, 'Height of Native Born Whites,' 168; U.S. whites and blacks, 1943-44: Karpinos, 'Height and Weight of Selective Service Registrants,' Table 5, 302; U.S. blacks, 1811-1861: Margo and Steckel, 'Height of American Slaves,' Table 1, 518.

*Note:* Dates refer to dates of measurement.

**Table 5 Determinants of the Height of Soldiers--Statewide Sample**

|                | (A)      | (B)      | (C)      | (D)      | (E)      |
|----------------|----------|----------|----------|----------|----------|
| Constant       | 68.25*** | 68.35*** | 68.44*** | 68.55*** | 68.54*** |
| 15 & Below     | -6.02*** | -6.06*** | -6.74*** |          |          |
| 16             | -3.80*** | -3.81*** | -4.01*** |          |          |
| 17             | -1.73*** | -1.69*** | -1.79*** |          |          |
| 18             | -1.52*** | -1.51*** | -1.60*** |          |          |
| 19             | -0.94*** | -0.93*** | -0.99*** |          |          |
| 20             | -0.57*** | -0.58*** | -0.61*** |          |          |
| 21             | -0.18    | -0.20    | -0.21    |          |          |
| 22             | -0.30**  | -0.31**  | -0.31**  |          |          |
| 23             | -0.19    | -0.19    | -0.19    |          |          |
| 24             | -0.16    | -0.16    | -0.15    |          |          |
| 25-49          |          |          |          |          |          |
| 50 & Above     | 0.56     | 0.46     | 0.44     |          |          |
| 1815-1819      | -0.11    | -0.12    | -0.16    | 0.03     | 0.09     |
| 1820-1824      | 0.28**   | 0.27**   | 0.23*    | 0.24     | 0.24     |
| 1825-1829      | 0.23**   | 0.22**   | 0.21*    | 0.20     | 0.09     |
| 1830-1834      | 0.15     | 0.16*    | 0.15     | 0.19     | 0.14     |
| 1835-1839      |          |          |          |          |          |
| 1840-1844      | 0.04     | 0.04     | 0.04     | -0.37    | -0.52    |
| 1845-1849      | -0.10    | -0.16    | -0.13    |          |          |
| 1861           | 0.50***  | 0.53***  | 0.54***  | 0.42***  | 0.51***  |
| 1862           | 0.15*    | 0.17**   | 0.19**   | 0.09     | 0.03     |
| 1863           | -0.24*   | -0.20    | -0.23    | 0.19     | 0.28     |
| 1864           |          |          |          |          |          |
| 1865           | -0.18**  | -0.16**  | -0.16*   | -0.05    | 0.02     |
| Farmer         | 0.31***  | 0.28***  | 0.26***  | 0.08     | 0.23     |
| Proprietor     | -0.06    | -0.05    | -0.01    | -0.03    | -0.09    |
| Professional   | 0.40     | -0.36    | 0.43     | 0.12     | -0.05    |
| Work Site      | -0.03    | -0.04    | -0.10    | 0.02     | 0.13     |
| Skilled Wrkr   |          |          |          |          |          |
| Unskilled Wrkr | 0.01     | -0.01    | -0.04    | 0.02     | -0.01    |
| Unknown        | 0.02     | 0.01     | -0.04    | 0.19     | 0.39     |
| None           | 0.55**   | 0.51**   | 0.55**   | 1.64     | 1.63     |
| Officer        | 0.30     | 0.26     | 0.24     | 0.27     |          |
| Non-comm       | 0.58***  | 0.58***  | 0.49***  | 0.49***  |          |
| Private        |          |          |          |          |          |
| Artisan        | -0.49    | -0.54    | -0.85    | -0.20    |          |
| Musician       | -1.75*** | -1.75*** | -1.24*   | -1.58*   |          |
| 'Standard'     |          |          |          |          |          |
| Drafted        | -0.00    | 0.09     | 0.01     |          |          |

**Table 5 (continued)**

|   | (A)               | (B)               | (C)               | (D)               | (E)               |
|---|-------------------|-------------------|-------------------|-------------------|-------------------|
| Substitute  | -0.18             | 0.28              | 0.22              |                   |                   |
| Recruit   | -0.07             | -0.04             | -0.08             |                   |                   |
| Bounty Recpnt   | -0.12             | -0.06             | -0.11             |                   |                   |
| Infantry  |                   |                   |                   |                   |                   |
| Cavalry   | 0.29***           | 0.31***           | 0.27***           | 0.23              |                   |
| Artillery   | 0.08              | 0.11              | 0.06              | 0.11              |                   |
| Reserve Inf.  | -0.18             | -0.37*            | -0.41**           | -0.75*            |                   |
| Stayer  |                   |                   |                   |                   |                   |
| Migrant   | -0.04             | -0.08             | -0.07*            | -0.17             | -0.12             |
| Southeast   | -1.13***          | -1.03***          | -1.02***          | -0.97***          | -1.02***          |
| Anthracite  | -1.06***          | -1.06***          | -1.06***          | -0.84***          | -0.87***          |
| Pocono  | -0.16             | -0.16             | -0.13             | -0.88             | -1.39**           |
| Northeast   | -0.23**           | -0.29**           | -0.30***          | -0.31             | -0.38             |
| Ridge & Valley  | -0.31***          | -0.38***          | -0.35***          | -0.45***          | -0.50***          |
| Allegheny Forest  | -0.28**           | -0.32***          | -0.28**           | -0.11             | 0.12              |
| West  |                   |                   |                   |                   |                   |
| Largest City Size in Enlistment County (Under 5K omitted) |                   |                   |                   |                   |                   |
| 5K to 10K   |                   | -0.19***          | -0.18**           | -0.36**           | -0.39**           |
| 10K to 25K  |                   | -0.10             | 0.09              | -0.04             | -0.04             |
| 25K+  |                   | -0.08             | -0.09             | -0.13             | -0.25             |
| Largest City Size in Birth County (Under 5K omitted)      |                   |                   |                   |                   |                   |
| 5K to 10K   |                   | -0.12             | -0.13             | -0.32*            | -0.27             |
| 10K to 25K  |                   | -0.25*            | -0.27*            | -0.45             | -0.15             |
| 25K+  |                   | -0.47***          | -0.46***          | -0.62***          | -0.54**           |
| N   | 9945 <sup>a</sup> | 9945 <sup>b</sup> | 9945 <sup>c</sup> | 2574 <sup>d</sup> | 2134 <sup>e</sup> |
| Adjusted R <sup>2</sup>                                   | 0.14              | 0.15              | 0.14              | 0.06              | 0.07              |
| F   | 36.3***           | 33.0***           | 34.5***           | 5.6***            | 5.7***            |

\*\*\*significant at the 0.01 level, \*\*significant at the 0.05 level, \*significant at the 0.10 level

<sup>a</sup> Intercept represents an 25-49 year old private, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, who was a skilled worker born between 1835 and 1840 in the Western Region

<sup>b</sup> Intercept represents an 25-49 year old private, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, a county which had no town larger than 5000 persons either at his birth or at the time of enlistment, and who was a skilled worker born between 1835 and 1840 in the Western Region.

<sup>c</sup> Intercept represents an 25-49 year old, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, a county which had no town larger than 5000 persons either at his birth or at the time of enlistment, and who was a skilled worker born between 1835 and 1840 in the Western Region.

<sup>d</sup> Intercept represents an private, age 25-49, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, a county which had no town larger than 5000 persons either at his birth or at the time of enlistment, and who was a skilled worker born between 1835 and 1840 in the Western Region. This regression only contains standard enlistees age 25-49.

<sup>e</sup> Intercept represents an 25-49 year old private, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, a county which had no town larger than 5000 persons either at his birth or at the time of enlistment, and who was a skilled worker born between 1835 and 1840 in the Western Region. This regression only contains standard infantry enlistees age 25-49.

**Table 6 Determinants of the Height of Soldiers--Western Sample**

|                        | (A)      | (B)      | (C)      |
|------------------------|----------|----------|----------|
| Constant               | 68.17*** | 68.12*** | 68.12*** |
| 15 &<br>Below          | -4.18*** |          |          |
| 16                     | -3.30*** |          |          |
| 17                     | -1.74*** |          |          |
| 18                     | -1.45*** |          |          |
| 19                     | -0.74*** |          |          |
| 20                     | -0.49*** |          |          |
| 21                     | -0.14    |          |          |
| 22                     | -0.22    |          |          |
| 23                     | -0.04    |          |          |
| 24                     | -0.10    |          |          |
| 25-49<br>50 &<br>Above | -1.12    |          |          |
| 1815-1819              | 0.40*    | 0.44*    | 0.64**   |
| 1820-1824              | 0.20     | 0.27     | 0.44**   |
| 1825-1829              | 0.23*    | 0.29*    | 0.20     |
| 1830-1834              | 0.29**   | 0.37***  | 0.33**   |
| 1835-1839              |          |          |          |
| 1840-1844              | 0.01     | 0.24     | -0.07    |
| 1845-1849              | -0.11    |          |          |
| 1861                   | 0.71***  | 0.77***  | 0.86***  |
| 1862                   | 0.47***  | 0.45***  | 0.33*    |
| 1863                   |          | 0.42     | 0.32     |
| 1864                   |          |          |          |
| 1865                   | 0.21*    | 0.37*    | 0.42*    |
| Farmer                 | 0.50***  | 0.44***  | 0.43***  |
| Proprietor             | -0.18    | -0.16    | 0.17     |
| Skilled Worker         |          |          |          |
| Unskilled<br>Worker    | 0.00     | 0.19     | 0.22     |
| Work Site              | 0.78**   | 0.39     | 0.54     |
| None                   | 0.66***  | 0.09     | 1.26     |
| Professional           | 0.33     | 0.69     | 0.81     |
| Unknown                | 0.20     | 0.42     | 0.64     |
| Non-comm               | 0.67***  | 0.47***  | 0.53***  |
| Officer                | 0.49     | 0.17     | 0.15     |
| Private                |          |          |          |
| Artisan                | -0.20    | -0.41**  | 0.15     |
| Musician               | -2.04*** | -0.05*   | -0.44*   |
| Unknown<br>'Standard'  | 0.02     |          |          |
| Drafted                | 0.16     |          |          |
| Substitute             | -0.47    |          |          |
| Recruit                | 0.21     |          |          |
| Bounty<br>Rcpnt        | 0.07*    |          |          |

**Table 6 (continued)**

|  | (A)               | (B)               | (C)               |
|--|-------------------|-------------------|-------------------|
| Infantry                               |                   |                   |                   |
| Artillery                              | 0.41***           | 0.50***           |                   |
| Reserve Inf.                           | 0.18              | 0.52              |                   |
| Cavalry                                | 0.32***           | 0.41***           |                   |
| Stayer                                 |                   |                   |                   |
| Migrant                                | 0.01              | 0.14              | 0.06              |
| Mountain/<br>Mineral                   | -0.37***          | -0.47**           | -0.45*            |
| Allegheny                              | -0.55***          | 0.83              | 0.59              |
| Southern                               |                   |                   |                   |
| Hinterland                             | -0.33***          | -0.47**           | -0.56**           |
| Northern                               |                   |                   |                   |
| Hinterland                             | -0.18             | -0.14             | 0.18              |
| Lake                                   | -0.90***          | -1.39***          | -1.32***          |
| Transport                              |                   |                   |                   |
| Isolated                               |                   |                   |                   |
| Agricultural                           |                   |                   |                   |
| Largest City Size in Enlistment County |                   |                   |                   |
| Under 5K                               |                   |                   |                   |
| 5K to 10K                              | -0.14*            | -0.12             | -0.09             |
| 10K to 25K                             | -0.37             | -0.21             | -0.24             |
| 25K+                                   | 0.02              | -0.09             | -0.19             |
| Largest City Size in Birth County      |                   |                   |                   |
| Under 5K                               |                   |                   |                   |
| 5K to 10K                              | 0.39              | -1.01             | -1.17             |
| 10K to 25K                             | -0.08             | -1.48             | -1.24             |
| N                                      | 8034 <sup>a</sup> | 2263 <sup>b</sup> | 1541 <sup>c</sup> |
| Adjusted R <sup>2</sup>                | 0.12              | 0.04              | 0.05              |
| F                                      | 22.5***           | 3.8***            | 3.4***            |

\*\*\* significant at the 0.01 level

\*\* significant at the 0.05 level

\* significant at the 0.10 level

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<sup>a</sup> Intercept represents a 25-49 year old private, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, who was a skilled worker born between 1835 and 1840 in the Western Region. Unknown rank signifies a man from Fogel's sample.

<sup>b</sup> Intercept represents a private, age 25-49, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, a county which had no town larger than 5000 persons either at his birth or at the time of enlistment, and who was a skilled worker born between 1835 and 1840 in the Western Region. This regression contains only standard enlistees aged 25-49. Unknown rank signifies a man from Fogel's sample.

<sup>c</sup> Intercept represents a private, age 25-49, a standard enlistee in 1864, who enlisted in the infantry in the same county in which he was born, a county which had no town larger than 5000 persons either at his birth or at the time of enlistment, and who was a skilled worker born between 1835 and 1840 in the Western Region. This regression contains only standard enlistees aged 25-49 from infantry units. Unknown rank signifies a man from Fogel's sample.



**Table 7** Determinants of the Height of Soldiers--Statewide Sample: Single Economic/Demographic Variables with Regional Dummy

|                         | (A)      | (B)      | (C)      | (D)      | (E)      |
|-------------------------|----------|----------|----------|----------|----------|
| Constant                | 67.72*** | 67.50*** | 67.33*** | 67.22*** | 67.46*** |
| 1820-1824               | 0.41**   | 0.40**   | 0.40**   | 0.38**   | 0.41**   |
| 1825-1829               | 0.19     | 0.16     | 0.16     | 0.15     | 0.18     |
| 1830-1834               | 0.30**   | 0.28**   | 0.28**   | 0.28**   | 0.30**   |
| 1835-1839               |          |          |          |          |          |
| 1840-1844               | -0.07    | -0.07    | -0.07    | -0.06    | -0.07    |
| 1861                    | 0.59***  | 0.59***  | 0.59***  | 0.61***  | 0.58***  |
| 1862                    | 0.33*    | 0.31*    | 0.30*    | 0.31**   | 0.33**   |
| 1863/64                 |          |          |          |          |          |
| 1865                    | 0.32**   | 0.29*    | 0.29*    | 0.30*    | 0.31*    |
| Farmer                  | 0.38***  | 0.29**   | 0.30**   | 0.25*    | 0.36**   |
| Proprietor              | 0.25     | 0.24     | 0.24     | 0.26     | 0.23     |
| Skilled Worker          |          |          |          |          |          |
| Unskilled Worker        | -0.00    | -0.07    | -0.06    | -0.07    | -0.02    |
| High Status             | 0.06     | 0.01     | 0.01     | 0.01     | 0.04     |
| Unknown                 | 0.47     | 0.40     | 0.42     | 0.36     | 0.48     |
| Stayer                  |          |          |          |          |          |
| Migrant                 | 0.18     | 0.11     | 0.12     | 0.06     | 0.18     |
| Southeast               | -0.81*** | -0.81*** | -0.80*** | -0.70*** | -0.91*** |
| Anthracite              | -0.80**  | -0.64**  | -0.66**  | -0.54*   | -0.77**  |
| PNF                     | -0.02    | -0.08    | 0.01     | -0.16    | -0.03    |
| West                    |          |          |          |          |          |
| Protein                 |          | 0.24***  |          |          |          |
| Calorie                 |          |          | 0.09***  |          |          |
| Swine                   |          |          |          | 0.61***  |          |
| Wealth                  |          |          |          |          | 0.001**  |
| N                       | 1907     | 1907     | 1907     | 1907     | 1907     |
| Adjusted R <sup>2</sup> | 0.05     | 0.05     | 0.05     | 0.06     | 0.05     |
| F                       | 6.7***   | 7.4***   | 7.2***   | 7.7***   | 6.6***   |

\*\*\* significant at the 0.01 level

\*\* significant at the 0.05 level

\* significant at the 0.10 level

*Note:* Intercept represents a man aged 25-45, a standard infantry enlistee, who enlisted during 1863 or 1864 in the same county in which he was born, and who was a skilled worker born between 1835 and 1839 in the Western Region of Pennsylvania.

**Table 8** Determinants of the Height of Soldiers--Statewide Sample: Single Economic/Demographic Variables with Regional Dummy

|                         | (A)      | (B)      | (C)      | (D)      | (E)       |
|-------------------------|----------|----------|----------|----------|-----------|
| Constant                | 68.47*** | 67.42*** | 67.59*** | 67.83*** | 67.74***  |
| 1820-1824               | 0.38**   | 0.40**   | 0.41**   | 0.41**   | 0.42**    |
| 1825-1829               | 0.19     | 0.18     | 0.18     | 0.17     | 0.19      |
| 1830-1834               | 0.29**   | 0.29**   | 0.31**   | 0.30**   | 0.31**    |
| 1835-1839               |          |          |          |          |           |
| 1840-1844               | -0.09    | -0.05    | -0.06    | -0.04    | -0.05     |
| 1861                    | 0.59***  | 0.60***  | 0.60***  | 0.64***  | 0.60***   |
| 1862                    | 0.27*    | 0.25     | 0.31*    | 0.33**   | 0.36**    |
| 1863/64                 |          |          |          |          |           |
| 1865                    | 0.30*    | 0.31*    | 0.31*    | 0.35**   | 0.30*     |
| Farmer                  | 0.32**   | 0.30**   | 0.36**   | 0.31**   | 0.35**    |
| Proprietor              | 0.27     | 0.26     | 0.25     | 0.25     | 0.24      |
| Skilled Worker          |          |          |          |          |           |
| Unskilled Worker        | -0.06    | -0.04    | -0.00    | -0.03    | -0.02     |
| High Status             | 0.14     | 0.11     | 0.05     | 0.05     | 0.02      |
| Unknown                 | 0.24     | -0.30    | 0.41     | 0.45     | 0.49      |
| Stayer                  |          |          |          |          |           |
| Migrant                 | 0.10     | 0.12     | 0.13     | 0.14     | 0.15      |
| Southeast               | -0.74*** | -0.52*** | -0.89*** | -0.81*** | -0.67***  |
| Anthracite              | -0.60*   | -0.54    | -0.70**  | -0.84*** | -0.80**   |
| PNF                     | -0.03    | -0.10    | -0.15    | -0.10    | -0.02*    |
| West                    |          |          |          |          |           |
| Water Tran.             | -0.83*** |          |          |          |           |
| Home Mfctr.             |          | 0.18***  |          |          |           |
| Dairy                   |          |          | 0.09***  |          |           |
| Mrkt Grdn.              |          |          |          | -0.45**  |           |
| Land Value              |          |          |          |          | -0.0003** |
| N                       | 1907     | 1907     | 1907     | 1907     | 1907      |
| Adjusted R <sup>2</sup> | 0.06     | 0.05     | 0.05     | 0.05     | 0.05      |
| F                       | 8.1***   | 7.1***   | 6.9***   | 6.6***   | 6.7***    |

\*\*\* significant at the 0.01 level  
 \*\* significant at the 0.05 level  
 \* significant at the 0.10 level

*Note:* Intercept represents a man aged 25-45, who enlisted in the infantry as a standard enlistee in the same county in which he was born, who enlisted during 1863 or 1864, and who was a skilled worker born between 1835 and 1839 in the Western Region of Pennsylvania.

**Table 9** Determinants of the Height of Soldiers--Statewide Sample: Single Economic/Demographic Variables with Regional Dummy

|                         | (A)       | (B)      | (C)      | (D)      | (E)      |
|-------------------------|-----------|----------|----------|----------|----------|
| Constant                | 67.75***  | 67.26*** | 67.85*** | 67.79*** | 67.73*** |
| 1820-1824               | 0.41**    | 0.41**   | 0.40**   | 0.41**   | 0.42**   |
| 1825-1829               | 0.19      | 0.18     | 0.17     | 0.18     | 0.19     |
| 1830-1834               | 0.31**    | 0.30**   | 0.30**   | 0.30**   | 0.31**   |
| 1835-1839               |           |          |          |          |          |
| 1840-1844               | -0.05     | -0.04    | -0.04    | -0.04    | -0.05    |
| 1861                    | 0.60***   | 0.62***  | 0.61***  | 0.62***  | 0.60***  |
| 1862                    | 0.36**    | 0.34**   | 0.33**   | 0.35**   | 0.36**   |
| 1863/64                 |           |          |          |          |          |
| 1865                    | 0.30*     | 0.34*    | 0.32*    | 0.33*    | 0.30*    |
| Farmer                  | 0.35**    | 0.32**   | 0.34**   | 0.32**   | 0.35**   |
| Proprietor              | 0.25      | 0.26     | 0.25     | 0.25     | 0.24     |
| Skilled Worker          |           |          |          |          |          |
| Unskilled Worker        | -0.03     | -0.03    | -0.01    | -0.03    | -0.02    |
| High Status             | 0.02      | 0.05     | 0.03     | 0.03     | 0.02     |
| Unknown                 | 0.49      | 0.47     | 0.44     | 0.47     | 0.50     |
| Stayer                  |           |          |          |          |          |
| Migrant                 | 0.15      | 0.14     | 0.13     | 0.14     | 0.15     |
| Southeast               | -0.67***  | -0.68*** | -0.72*** | -0.74*** | -0.68*** |
| Anthracite              | -0.80**   | -0.80**  | -0.78**  | -0.85*** | -0.80**  |
| PNF                     | -0.03     | -0.11    | -0.11    | -0.06    | -0.02    |
| West                    |           |          |          |          |          |
| Pop. Density            | -0.0003** |          |          |          |          |
| Agric. Emp. %           |           | 0.007**  |          |          |          |
| % Pop. 2.5K+            |           |          | -0.004*  |          |          |
| % Pop. 10K+             |           |          |          | -0.006** |          |
| % Pop. 25K+             |           |          |          |          | -0.007** |
| N                       | 1907      | 1907     | 1907     | 1907     | 1907     |
| Adjusted R <sup>2</sup> | 0.05      | 0.05     | 0.05     | 0.05     | 0.05     |
| F                       | 6.7***    | 6.6***   | 6.5***   | 6.7***   | 6.7***   |

\*\*\* significant at the 0.01 level  
 \*\* significant at the 0.05 level  
 \* significant at the 0.10 level

*Note:* Intercept represents a man aged 25-45, who enlisted in the infantry during 1863 or 1864 as a standard enlistee in the same county in which he was born, and who was a skilled worker born between 1835 and 1839 in the Western Region of Pennsylvania.

**Table 10** Determinants of the Height of Soldiers--Statewide Sample: Single Economic/Demographic Variables with Regional Dummy

|  | (A)      | (B)      |
|--|----------|----------|
| Constant                               | 68.00*** | 67.78*** |
| 1820-1824                              | 0.40**   | 0.39**   |
| 1825-1829                              | 0.19     | 0.18     |
| 1830-1834                              | 0.31**   | 0.30**   |
| 1835-1839                              |          |          |
| 1840-1844                              | -0.06    | -0.04    |
| 1861                                   | 0.50***  | 0.61***  |
| 1862                                   | 0.22     | 0.35**   |
| 1863/64                                |          |          |
| 1865                                   | 0.35*    | 0.33     |
| Farmer                                 | 0.35**   | 0.33**   |
| Proprietor                             | 0.25     | 0.29     |
| Skilled Worker                         |          |          |
| Unskilled Worker                       | -0.03    | -0.03    |
| High Status                            | 0.06     | 0.02     |
| Unknown                                | 0.41     | 0.42     |
| Stayer                                 |          |          |
| Migrant                                | 0.14*    | 0.15     |
| Southeast                              | -0.79*** | -0.75*** |
| Anthracite                             | -0.83**  | -0.84*** |
| PNF                                    | -0.16    | -0.05    |
| West                                   |          |          |
| Largest City Size in Enlistment County |          |          |
| Under 5K                               |          |          |
| 5K to 10K                              | -0.46*** |          |
| 10K to 25K                             | -0.11    |          |
| 25K+                                   | -0.34**  |          |
| Largest City Size in Birth County      |          |          |
| Under 5K                               |          |          |
| 5K to 10K                              |          | 0.07*    |
| 10K to 25K                             |          | -0.20    |
| 25K+                                   |          | -0.48**  |
| N                                      | 1907     | 1907     |
| Adjusted R <sup>2</sup>                | 0.05     | 0.05     |
| F                                      | 6.2***   | 6.0***   |

\*\*\* significant at the 0.01 level  
 \*\* significant at the 0.05 level  
 \* significant at the 0.10 level

*Note:* Intercept represents a man aged 25-45, who enlisted during 1863 or 1864 in the infantry as a standard enlistee in the same county in which he was born (a county which at the time of enlistment had no town of over 5000 population), and who was a skilled worker born between 1835 and 1839 in the Western Region of Pennsylvania in a county with no town larger than 5000 persons.

**Table 11 Statewide Means and Standard Deviations for County Level Regression Variables (29 Counties)**

|  | Including<br>Philadelphia Co. |                        | Excluding<br>Philadelphia Co. |                       |
|--|-------------------------------|------------------------|-------------------------------|-----------------------|
|  | Mean                          | Standard.<br>Deviation | Mean                          | Standard<br>Deviation |
| Population Density<br>(persons/sq. mile)                     | 112.9                         | 347.1                  | 48.8                          | 29.4                  |
| Protein Surplus<br>(Per Capita, Per Day)                     | 128.2                         | 85                     | 135                           | 77                    |
| Calorie Surplus<br>(Per Capita, Per Day)                     | 5206                          | 1969                   | 5380                          | 1764                  |
| Wealth Per Capita, 1850<br>(Agric. and Mnfctr)               | \$357                         | \$143                  | \$365                         | \$139                 |
| Value of Dairy Production<br>Per capita                      | \$3.12                        | \$2.79                 | \$3.20                        | \$2.81                |
| Value of Home<br>Manufactures Per Capita                     | \$1.39                        | \$1.30                 | \$1.44                        | \$1.29                |
| Number of Swine<br>Per Capita                                | 0.91                          | 0.40                   | 0.94                          | 0.38                  |
| Value of Land<br>Per Acre 1845                               | \$85                          | \$339                  | \$22                          | \$21                  |
| Value of Market Garden<br>Production Per Capita              | \$0.10                        | \$0.23                 | \$0.08                        | \$0.20                |
| Percentage of County Workforce<br>in Agricultural Sector     | 65.1                          | 20.8                   | 67.2                          | 17.9                  |
| Percentage of County Population<br>in Towns of 2500-10,000   | 19.2                          | 24.1                   | 16.4                          | 19.3                  |
| Percentage of County Population<br>in Towns of 10,000-25,000 | 4.3                           | 17.2                   | 1.4                           | 7.3                   |
| Percentage of County Population<br>in Towns of 25,000+       | 2.5                           | 13.2                   | 0                             | 0                     |

*Note:* Unless indicated all figures refer to 1840

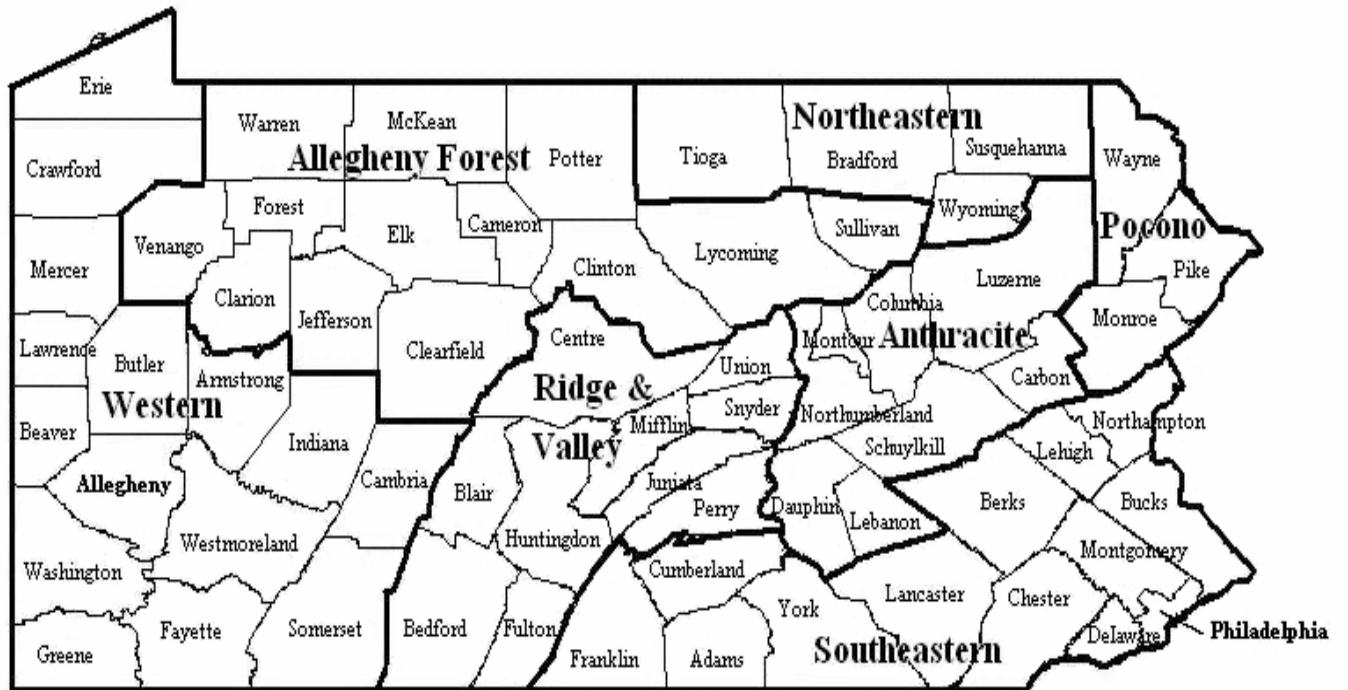


Figure 1 Regions of Pennsylvania

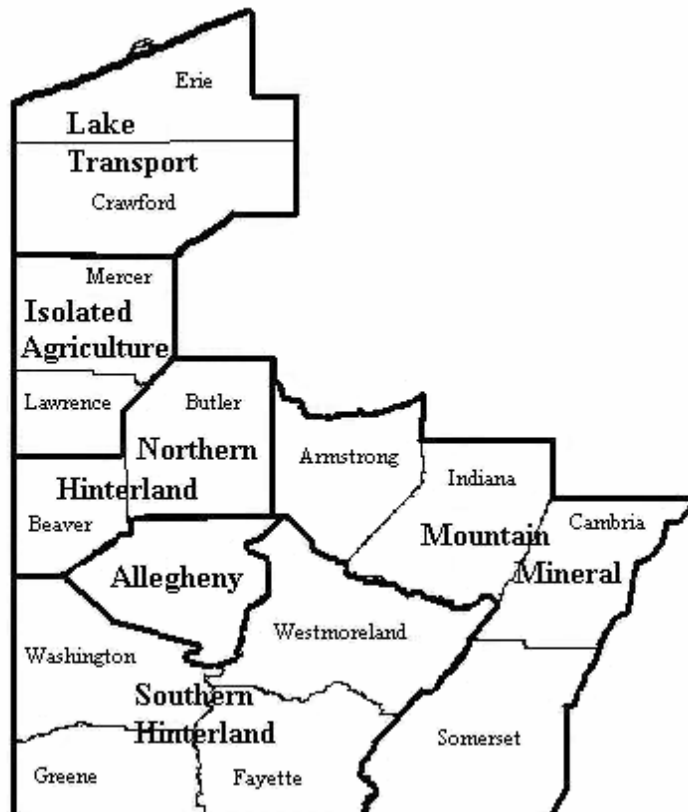


Figure 2 Western Sub-Regions

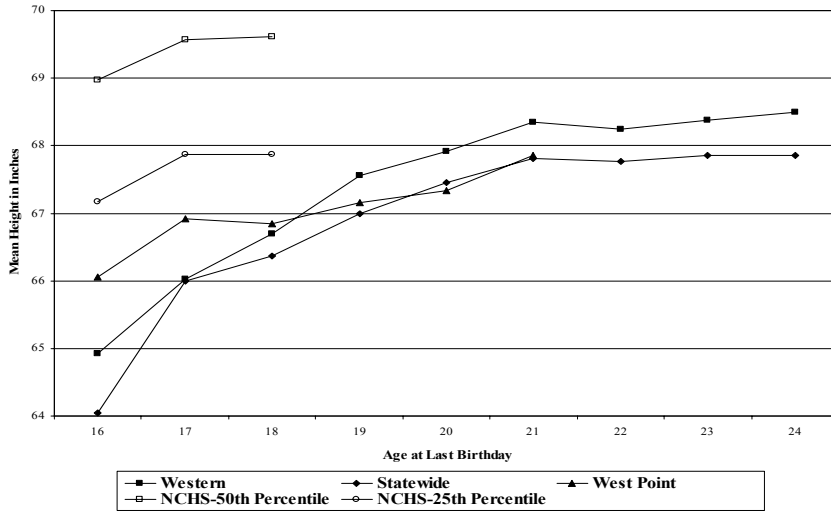


Figure 3 Height by Age: Civil War Soldiers, West Point Cadets, & NCHS Standards

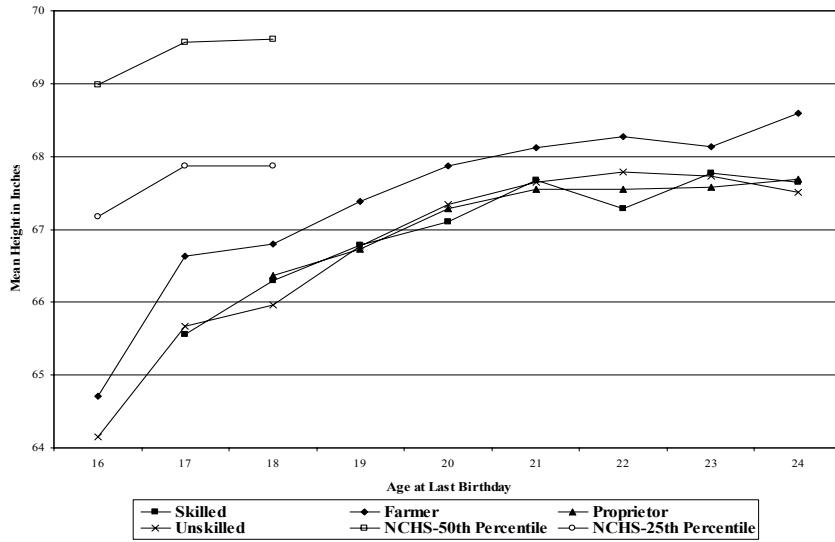


Figure 4 Height by Age by Occupation: Civil War Soldiers, Statewide Sample & NCHS Standards

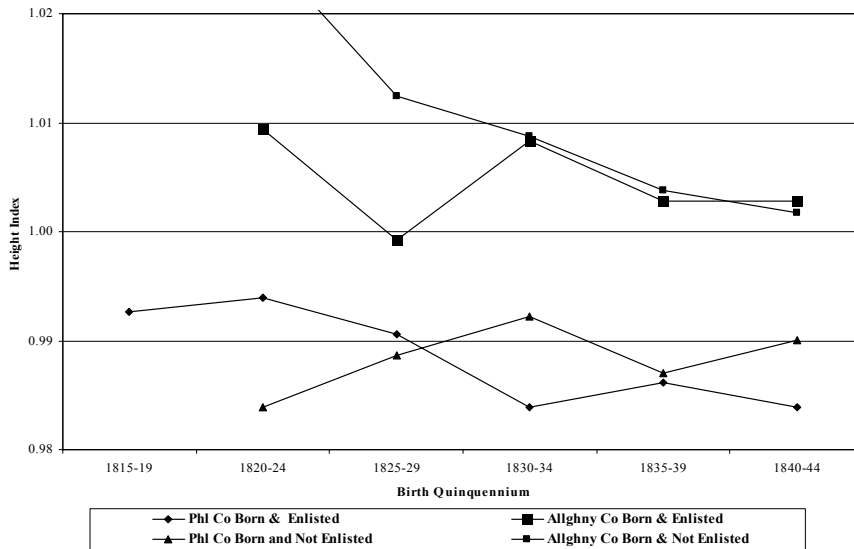


Figure 5 Standardized Height: Urban Birth Counties



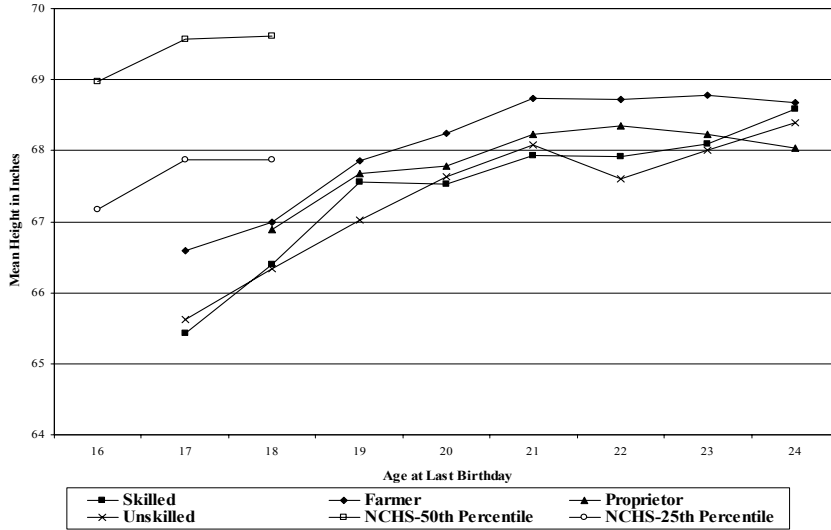


Figure 6 Height by Age by Occupation: Civil War Soldiers, Western Sample & NCHS Standards

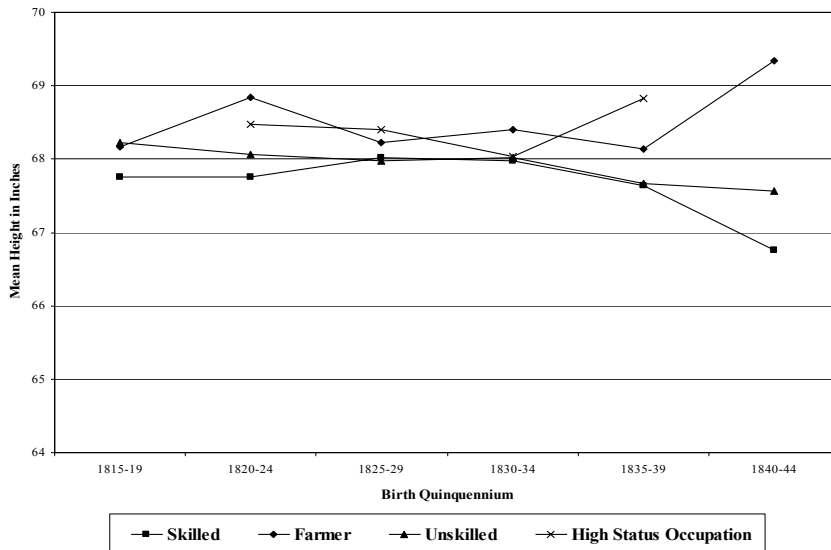


Figure 7 Adult Height by Occupation: Statewide Sample

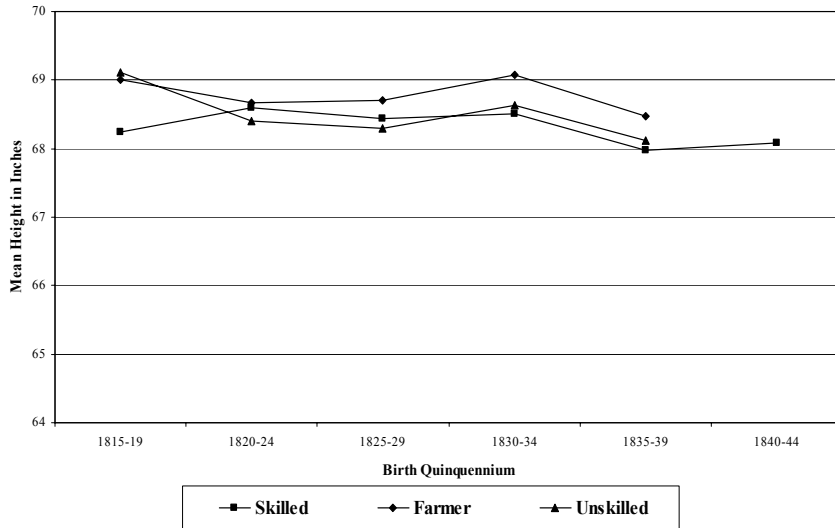


Figure 8 Adult Height by Occupation: Western Sample

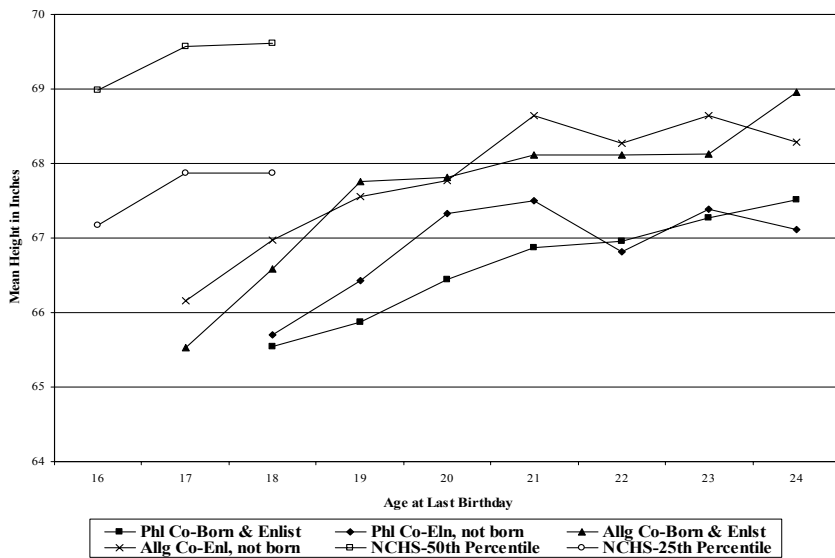
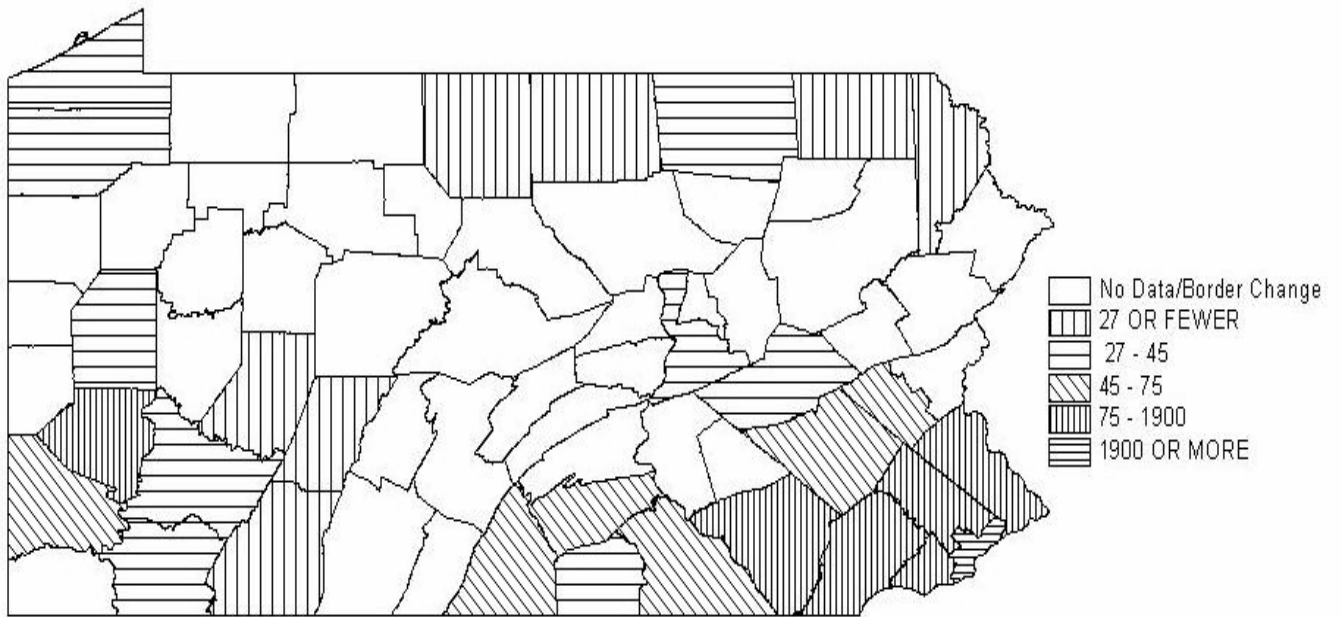
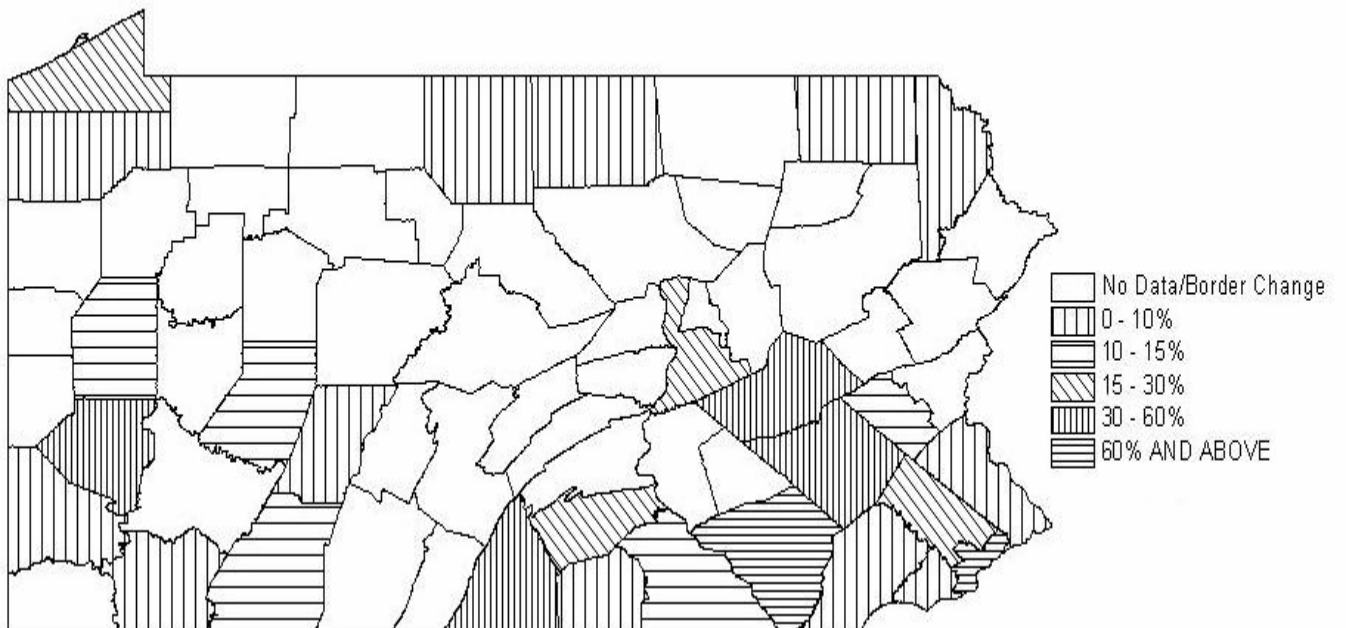


Figure 9 Height by Age: Urban Enlistment County



**Figure 10** Population Density (PSM)–1840



**Figure 11** Percent of County Population in Towns of 2500+ –1840

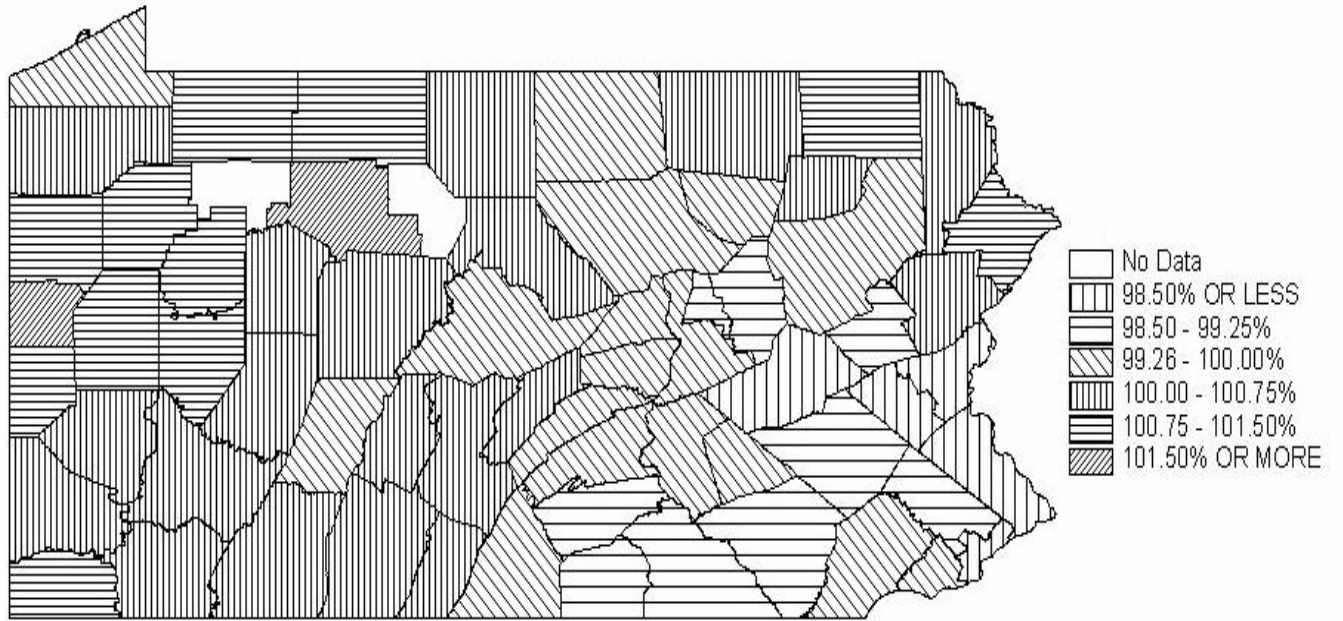


Figure 12 Mean Age Standardized Height by County, 1815-44

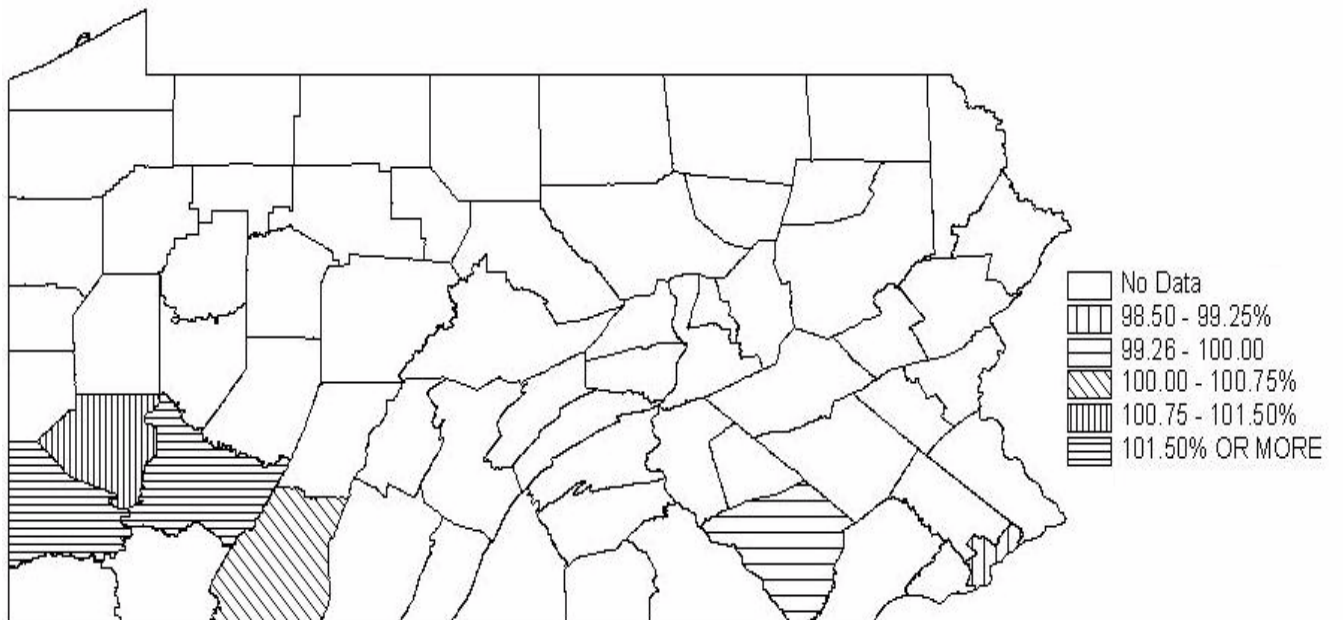


Figure 13 Mean Age Standardized Height by County, 1815-19

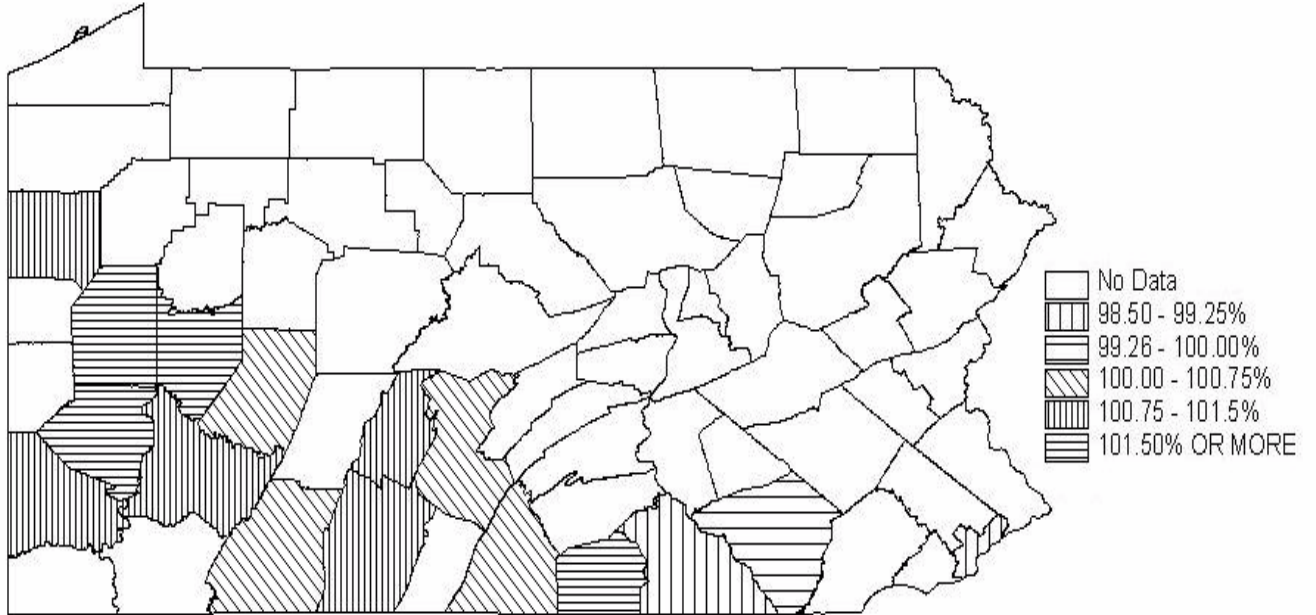


Figure 14 Mean Age Standardized Height by County, 1820-24

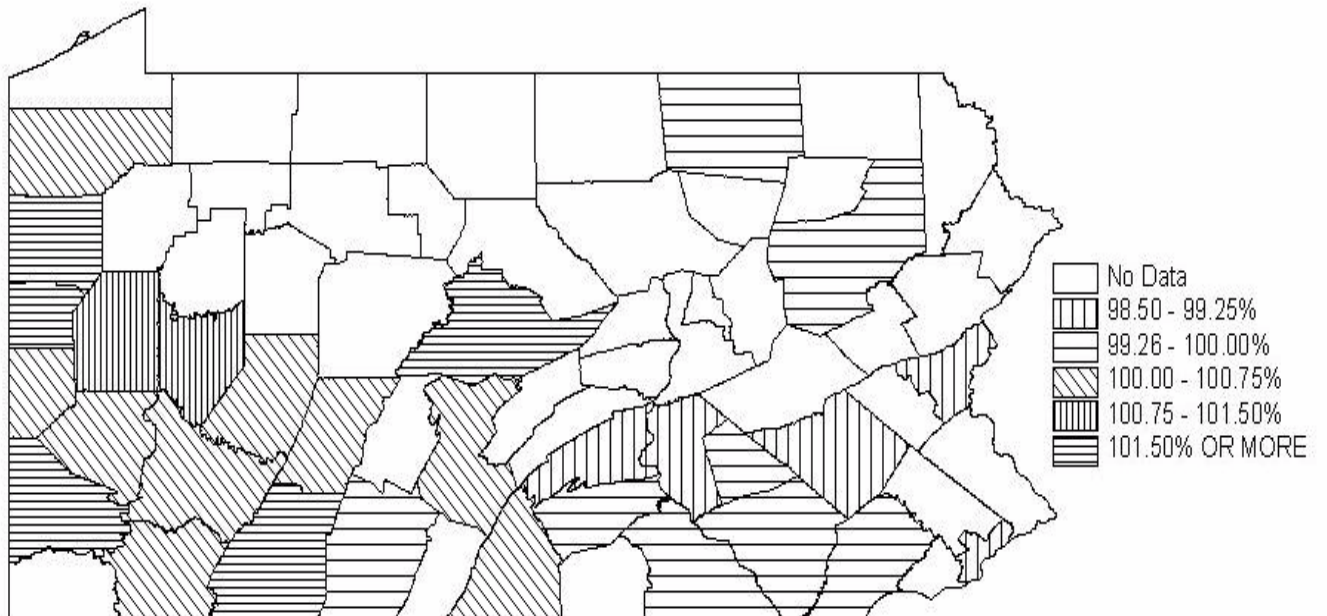


Figure 15 Mean Age Standardized Height by County, 1825-29

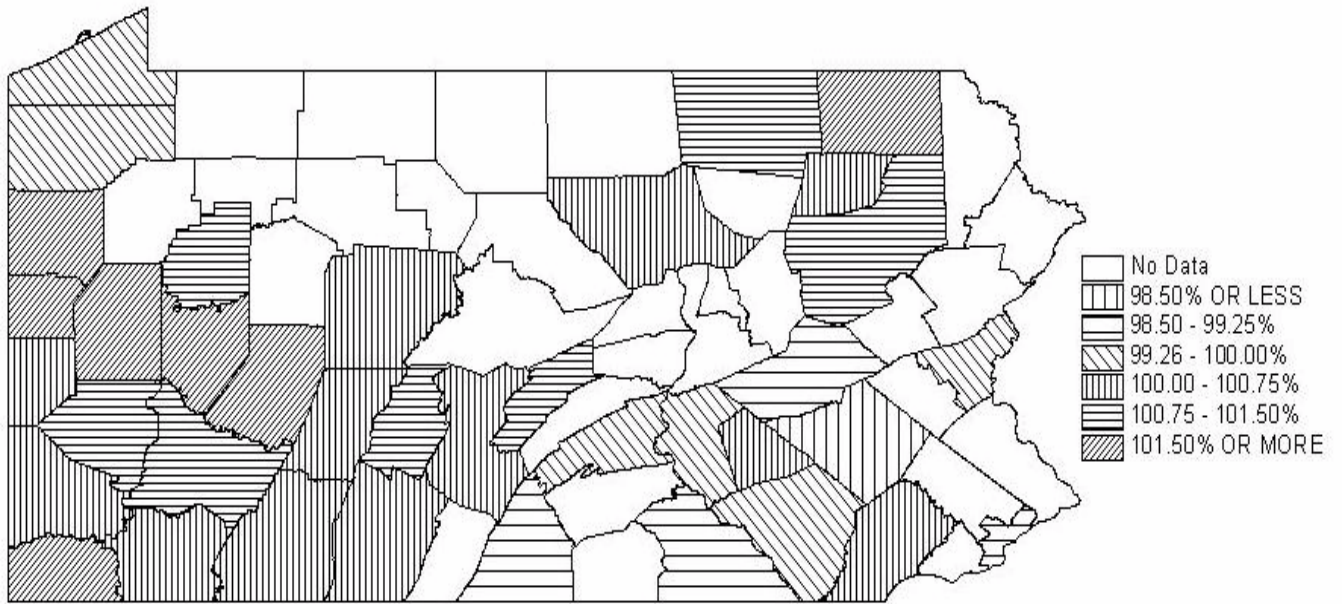


Figure 16 Mean Age Standardized Height by County, 1830-34

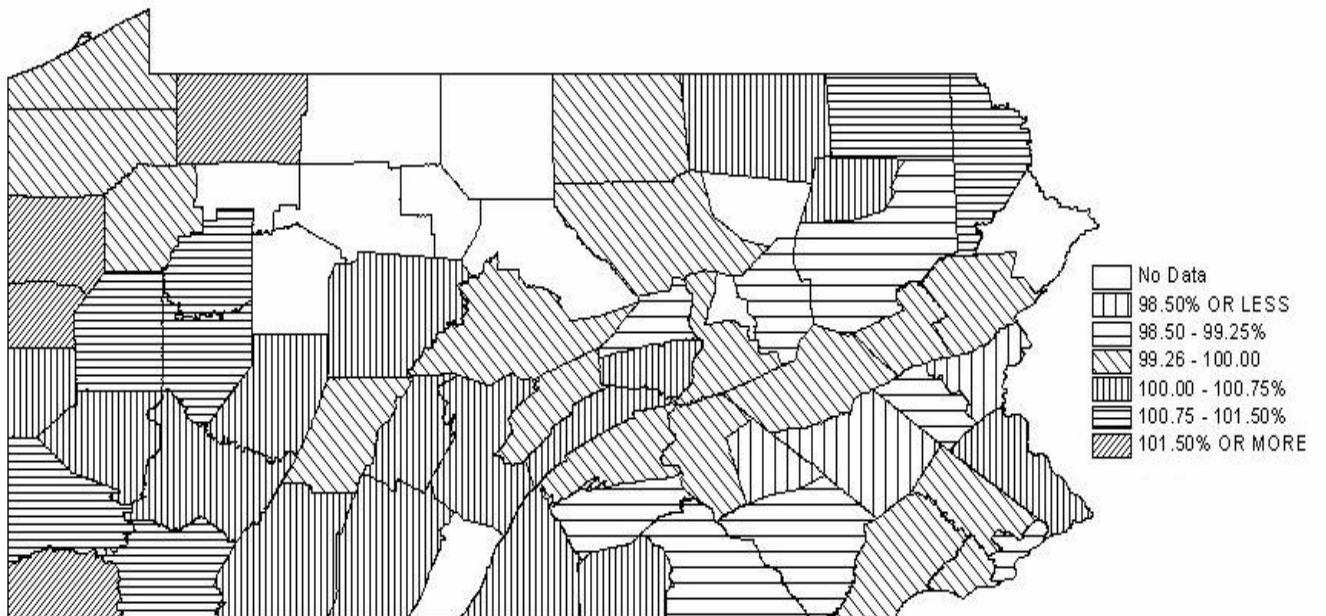
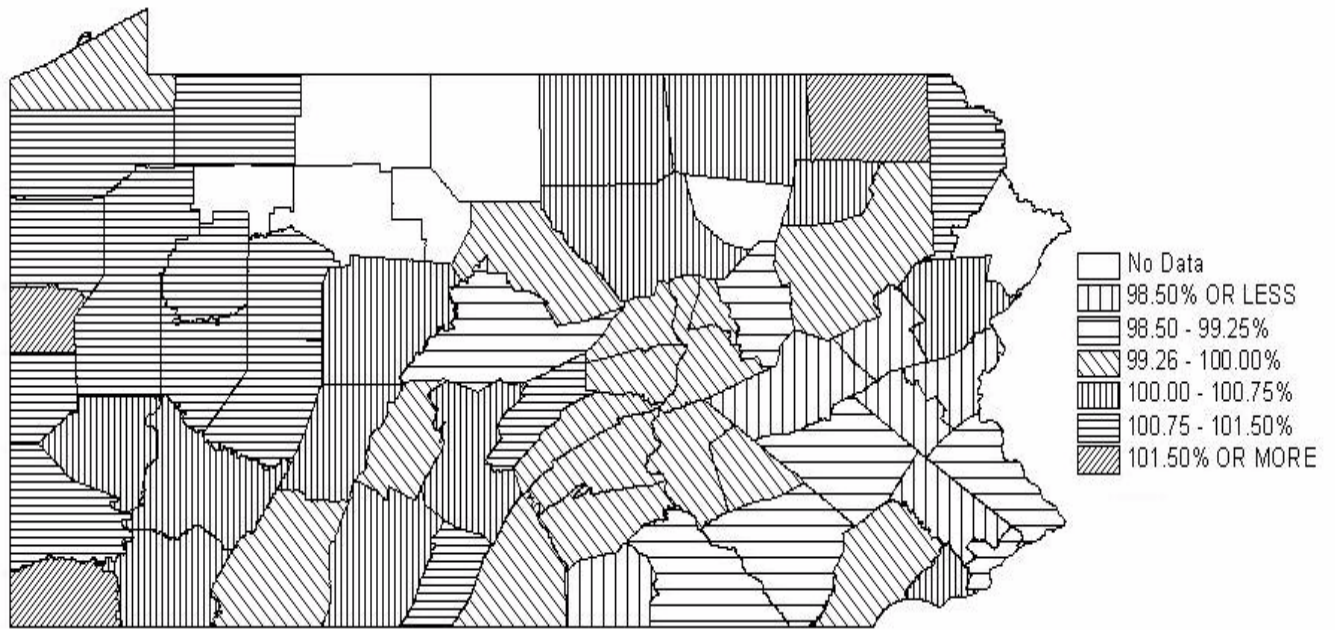


Figure 17 Mean Age Standardized Height by County, 1835-39



**Figure 18** Mean Age Standardized Height by County, 1840-44

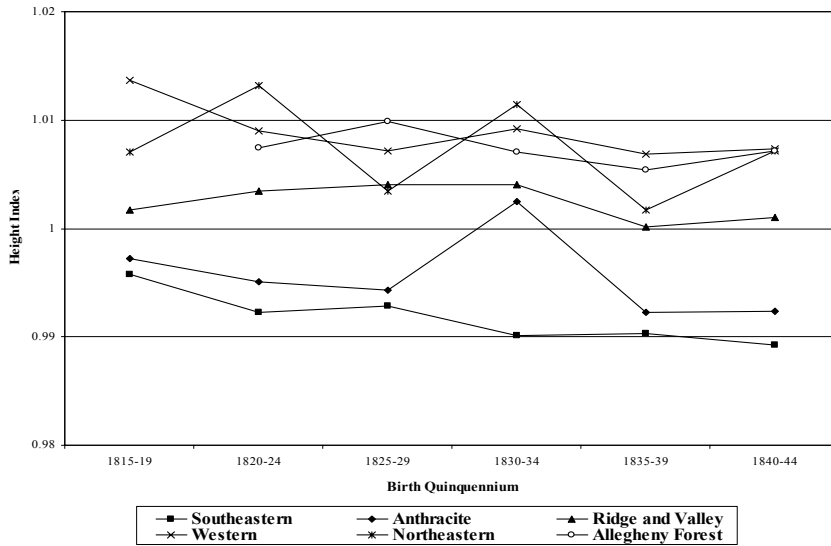


Figure 19 Standardized Height by Region

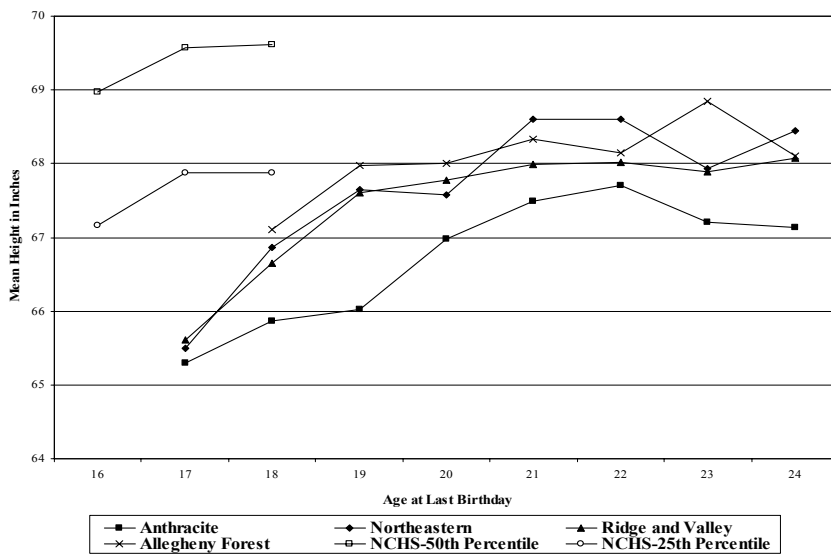


Figure 20 Height by Age: Non-Urban Birth Regions



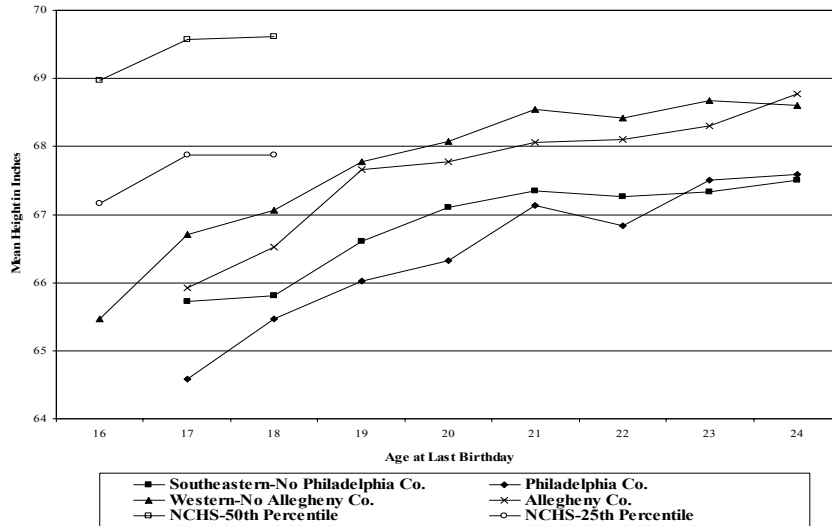


Figure 21 Height by Age: Urban Birth Regions

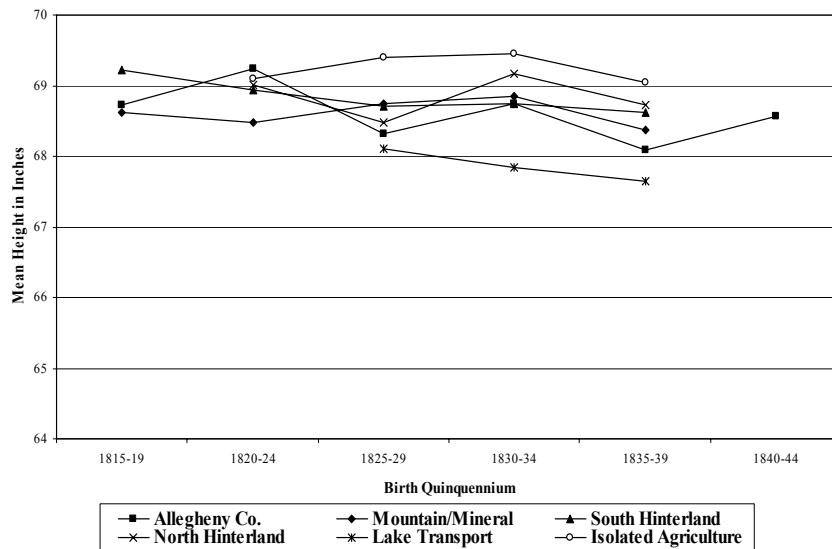


Figure 22 Adult Male Height: Western Sub-Regions

## Notes

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- <sup>1</sup> Thanks are due to the many individuals who helped me to locate, collect, make machine-readable, code, and manipulate the stature data utilized in this study. They include Michael Meier (U.S. National Archives), Jonathan Stayer (Pennsylvania State Archives), Anne Leonard, Mark Pietrzyk, Dave Sherman, Ed Danielson, Christina Sherman, Eric Foltyn, Meredith Ridl, Matt Boccardi, Kristin Kronstain, Matthew Kurtz, Abigail Sumpter, Laura Cuff, Margaret Cuff, Carolyn Cuff, Evann Garrison, Phil Sidel and Eileen S. Kopchik, Ann Throckmorton, and Todd Fleckenstein. Financial and material support was provided by the University of Pittsburgh Faculty of Arts and Sciences, the University's Department of History, Westminster College (PA), and the Pennsylvania Historical and Museum Commission. Many friends and colleagues read all or portions of the manuscript from which this article is an off-spring. They include Eric Davin, Paul Riggs, Mike Naragon, Sue Corbesero, Sam Farmerie, Jim Hines, John Murray, Tom Weiss, Lee Craig, Joerg Baten, Farley Grubb, W. Peter Ward, Michael Haines, and Bernard Harris.. To each of the thoughtful and congenial scholars who composed my dissertation committee and advised me on the work out of which this article originated, Van Beck Hall, Ted Muller, Richard Steckel, and Jerome Wells, I will always be indebted. Additional thanks are due to participants at the October 2005 meeting of the Pennsylvania Historical Association, the November 2006 meeting of the Social Science History Association, a November 2005 Westminster College, "Faculty Forum," and participants in the March 2006 Keio Conference (a pre-conference to Session 50 of the XIVth International Economic History Congress). My greatest professional appreciation, however, is reserved for John Komlos. However, as is almost always the case, without the support and love of my wife and children, my parents, and my siblings, this work would not have been completed. Many thanks are due to the members of my immediate and extended families.
  - 2 *Plough, Loom and Anvil* 4 (1852): 686 cited in Gavin W. Wright, *The Political Economy of the Cotton South: Households, Markets, and Wealth in the Nineteenth Century* (New York: W.W. Norton and Co., 1978), 71.
  - 3 John Komlos and Timothy Cuff (ed.), *Classics of Anthropometric History: A Selected Anthology* (St. Katharinen, Germany: Scripta Mercaturae, 1998); John Komlos (ed.), *Stature, Living Standards, and Economic Development: Essays in Anthropometric History* (Chicago: The University of Chicago Press, 1994).
  - 4 This is in relation to caloric needs based on work requirements and disease load.
  - 5 This is one factor which differentiates the European and U.S. experiences of industrialization.
  - 6 Paul David, 'The Growth of Real Product in the United States Before 1840: New Evidence, Controlled Conjectures,' *Journal of Economic History* 27 (1967): 151-197; Robert Gallman, 'The Statistical Approach: Fundamental Concepts as Applied to History,' in *Approaches to American Economic History*, edited by G.R. Taylor and L.R. Ellsworth (Charlottesville: University of Virginia Press, 1971), 87-105.
  - 7 Jeffrey G. Williamson and Peter H. Lindert, *American Inequality: A Macroeconomic History* (New York: Academic Press, Inc., 1980), 36-46, 67-75; Robert A. Margo and Georgia C. Villaflor, 'The Growth of Real Wages in Antebellum America: New Evidence,' *Journal of Economic History* 47 (1987): 873-895.
  - 8 John Komlos and Jörg Baten (ed.), *The Biological Standard of Living in Comparative Perspectives: Proceedings of a Conference Held in Munich January 18-23, 1997*, (Stuttgart: Franz Steiner Verlag, 1999); Richard Steckel, 'Stature and the Standard of Living,' *Journal of Economic Literature* 33 (1995): 1927; Michael R. Haines, Lee A. Craig; and Thomas Weiss, 'The Short and the Dead: Nutrition, Mortality, and the "Antebellum Puzzle" in the United States.' *Journal of Economic History* 63 (2003): 382-413.
  - 9 Richard Steckel, 'Stature and Living Standards in the United States,' in *American Economic Growth and Standards of Living before the Civil War*, ed. Robert E. Gallman and J.J. Wallis (Chicago: National Bureau of Economic Research by University of Chicago Press, 1992), 265-310.
  - 10 John Komlos, 'Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution,' *Journal of Economic History* 58 (1998) 3: 779-802; John Komlos and Peter Coclanis 'On the "Puzzling" Antebellum Cycle of the Biological Standard of Living: the Case of Georgia,' *Explorations in Economic History* 34 (Oct. 1997) 4: 433-59; John Komlos, 'Anomalies in Economic History: Reflections on the "Antebellum Puzzle",' *Journal of Economic History* 56 (March, 1996): 202-214, Marco Sunder, "The Height of Tennessee convicts: Another Piece of the 'Antebellum Puzzle,'" *Economics and Human Biology* 2 (2004): 75-86; Ricardo Salvatore's essay in this session points out, however, that when industrialization and urbanization occurred after the introduction of water and sewer systems the outcome may be somewhat different. See Ricardo Salvatore, "Stature Growth in Industrializing Argentina: The Buenos Aires Industrial Belt, 1916-

- 
- 1950,” in *Proceedings of the Keio Conference: Anthropometrics, Markets and Disease in Historical Standards of Living: Eurasian and American Countries*, March 2006.
- 11 James C. Riley, ‘Stature’s Problems,’ manuscript, Indiana University, 1993; Robert W. Fogel, ‘Nutrition and the Decline in Mortality since 1700: Some Preliminary Findings,’ in *Long-Term Factors in American Economic Growth*, ed. S. Engerman and R. Gallman (Chicago: University of Chicago Press for National Bureau of Economic Research, 1987), 506.
  - 12 Roderick Floud, Kenneth Wachter, and Annabelle Gregory, *Height, Health, and History: Nutritional Status in the United Kingdom, 1750-1980* (Cambridge, England: Cambridge University Press, 1990); John Komlos, ‘Height and Social Status in Eighteenth-Century Germany,’ *Journal of Interdisciplinary History* 20 (1990): 607-621; Lars G. Sandberg and Richard H. Steckel, ‘Soldier, Soldier, What Made you Grow so Tall? A Study of Height, Health and Nutrition in Sweden, 1720-1881,’ *Economy and History* 23 (1980): 91-105.
  - 13 C. Mosk and S. R. Johansson, ‘Income and Mortality: Evidence from Modern Japan,’ *Population and Development Review* 12 (1986): 417-428; Steckel, ‘Stature and the Standard of Living,’ 1929.
  - 14 Williamson and Lindert. *American Inequality*; Richard Steckel, ‘Height and Per Capita Income,’ *Historical Methods* 16 (1983): 1-7.
  - 15 This is not to imply that wealth or income was necessarily equally distributed in regions characterized by self-sufficiency. See for example Lee Soltow, ‘Inequality Amidst Abundance: Land Ownership in Early Nineteenth-Century Ohio,’ *Ohio History* 88 (1979): 133-151.
  - 16 Fogel describes how differing demand elasticities and income limitations result in different responses to high food prices among different classes of a society. Robert W. Fogel, ‘The Conquest of High Mortality and Hunger in Europe and America: Timing and Mechanisms,’ in *Favorites of Fortune: Technology, Growth, and Economic Development Since the Industrial Revolution*, ed. P. Higonnet, D.S. Landes, and H. Rosovsky (Cambridge, MA: Harvard University Press, 1991), 33-71.
  - 17 Timothy Cuff, ‘A Weighty Issue Revisited: New Evidence on Commercial Swine Weights and Pork Production Trends in Mid-Nineteenth-Century America,’ *Agricultural History* 66 (1982): 55-74; John Komlos, ‘The Height and Weight of West Point Cadets: Dietary Change in Antebellum America,’ *Journal of Economic History* 47 (1987): 897-927.
  - 18 Parker (1957) has noted that a substantial portion of nineteenth-century American population growth was the result of immigration from Europe. Most of these individuals would have been accustomed to much lower per capita food consumption than those of native-born Americans. Parker hypothesizes that the influx of these individuals may have lowered per capita demand for food, and consequently the reduction of per capita food supply might not have resulted in increased prices. William N. Parker, ‘Trends in Food Consumption in the United States, 1840-1910: An Experiment in Econometrical History’ (Unpublished manuscript presented to the Econometrical Society, 1957).
  - 19 Komlos, ‘West Point Cadets;’ Komlos, ‘Shrinking in a Growing Economy.’ Steckel thinks that this effect must have been weak. Steckel, ‘Stature and the Standard of Living,’ 1928-1929. This also raises the difficult issue of intra-family food distribution and control.
  - 20 Steckel and Haurin’s Ohio National Guard sample is an obvious exception. Richard Steckel and Donald Haurin, ‘Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsmen, 1850-1910,’ in *Stature, Living Standards, and Economic Development: Essays in Anthropometric History*, ed. John Komlos (Chicago: University of Chicago Press, 1994), 117-128. See also Komlos and Coclanis, ‘On the “Puzzling” Antebellum Cycle;’ John Komlos and Peter Coclanis, ‘Nutrition and Economic Development in Post-Reconstruction South Carolina: an Anthropometric Approach,’ *Social Science History* 19 (1995): 91-116; Sunder, ‘Height of Tennessee Convicts.’ A few studies of African-Americans with large samples from relatively small geographic areas have been carried out. John Komlos, ‘Toward an Anthropometric History of African-Americans: The Case of the Free Blacks in Antebellum Maryland,’ in *Strategic Factors in Nineteenth-Century American Economic History: A Volume to Honor Robert W. Fogel*, ed. C. Goldin and H. Rockoff (Chicago: University of Chicago Press, 1992), 267-329.
  - 21 This article is an excerpted and edited version of Timothy Cuff, *The Hidden Cost of Economic Development: The Biological Standard of Living in Antebellum Pennsylvania* (Aldershot, U.K.: Ashgate Publishing, Ltd., 2005).
  - 22 Robert Gallman, ‘The Statistical Approach: Fundamental Concepts as Applied to History,’ in *Approaches to American Economic History*, ed. George Rogers Taylor and L.R. Ellsworth (Charlottesville, University of Virginia Press, 1971), pp. 87-105; Paul David, ‘The Growth of Real Product in the United States Before 1840: New Evidence, Controlled Conjectures,’ *Journal of Economic History* 27 (June 1967): 151-197; Robert Gallman, ‘The

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- Pace and Pattern of American Economic Growth,' in *American Economic Growth: An Economist's History of the United States*, ed. Lance Davis, Richard Easterlin, and William N. Parker (New York: Harper and Row, 1972), 15-60; Thomas Weiss, 'Long Term Changes in U.S. Agricultural Output Per Worker, 1800-1900,' Working Paper 23, National Bureau of Economic Research Series on Historical Factors in Long Run Growth, 1991.
- <sup>23</sup> John William Florin, *The Advance of Frontier Settlement in Pennsylvania, 1638-1850: A Geographic Interpretation* (University Park, PA: Pennsylvania State University, 1977), 9-10. Florin's definition for 'settlement' was the date of the first permanent settlement in a minor civil division (townships, towns, boroughs). He obtained his data from county histories.
- <sup>24</sup> With the obvious exception of slave-based plantation agriculture.
- <sup>25</sup> Diane Lindstrom, *Economic Development in the Philadelphia Region, 1810-1850* (New York: Columbia University Press, 1978), 18-19.
- <sup>26</sup> John L. Andriot, *Population Abstract of the United States, Vol. 1* (McLean, VA: Andriot Associates, 1983), 670. The census-based definition of 'urban' at 2500 persons is somewhat arbitrary and understates the importance of many early nineteenth-century trading towns as centers of commerce. The 2,500 figure was first imposed in 1906 in a Census publication generated after the census of 1900. Early definitions had placed the urban threshold much higher. United States Bureau of the Census, *Historical Statistics of the United States: Colonial Times to 1970* (Washington, D.C., 1975), 2.
- <sup>27</sup> George Rogers Taylor, *The Transportation Revolution, 1815-1860*, Vol. 4, *The Economic History of the United States* (New York: Rinehart and Company, Inc., 1951), 158.
- <sup>28</sup> Susan P. Lee and Peter Passell, *A New Economic View of American History* (New York: W.W. Norton and Company, 1979), 64. This was not simply the result of transportation difficulties however, but also the inability of western Pennsylvanians, at that stage of development, to produce goods for Philadelphia and other eastern seaboard communities which residents of these areas could not obtain more cheaply, after factoring in transportation costs, from their own hinterlands. Solon J. Buck and Elizabeth H. Buck, *The Planting of Civilization in Western Pennsylvania* (Pittsburgh: University of Pittsburgh Press, 1939), 291-292.
- <sup>29</sup> Dykstra notes that portions of the anthracite coal region of East Central Pennsylvania, as well as the Pocono and Allegheny Forest regions, remained unsettled until this relatively late date. Ann Dykstra, 'Region, Economy and Party: The Roots of Policy Formation in Pennsylvania,' (Ph.D. dissertation, University of Pittsburgh, 1988), pp. 46, 53, and 63.
- <sup>30</sup> Stevenson Whitcomb Fletcher, *Pennsylvania Agriculture and Country Life: 1840-1940* (Harrisburg: Pennsylvania Historical and Museum Commission, 1955), 1. See the following for descriptions of local community exchange: Robert E. Mutch, 'Yeoman and Merchant in Pre-industrial America: Eighteenth-century Massachusetts as a Case Study,' *Societas* 7 (1977): 279-302; James A. Henretta, 'Families and Farms: Mentalite in Pre-Industrial America,' *William and Mary Quarterly* 3rd series, 35 (1978): 3-32; Michael Merrill, 'Cash is Good to Eat: Self-Sufficiency and Exchange in the Rural Economy of the United States,' *Radical History Review* 3 (1977): 42-71.
- <sup>31</sup> For example, the Pennsylvania Mainline, a system of railroads, canals, and inclined planes linked Philadelphia and Pittsburgh by the mid-1830s. However, the multiple transfers across method of transport involved in cross-state shipments made this route quite expensive and never as important as the Erie Canal.
- <sup>32</sup> See Chapter Four for regional definitions and descriptions as well as the sources of the population and agricultural production figures used in this chapter.
- <sup>33</sup> Stevenson Whitcomb Fletcher, *Pennsylvania Agriculture and Country Life*, 78.
- <sup>34</sup> Fletcher notes that, as late as 1930, 25 per cent of the farms in Clearfield County were still self-sufficient as defined by the census (50 per cent or more of production consumed on the farm itself). 'They are most common on rough and poor land, especially in the coal regions and in areas remote from markets.' Fletcher, *Country Life, 1840-1940*, 8.
- <sup>35</sup> Obviously, slave based plantation agriculture was an exception.
- <sup>36</sup> The term 'native-born' Pennsylvanian has a more restrictive definition than 'native-born' may carry in some other contexts. For purposes of this study, a native-born Pennsylvanian is not a Pennsylvania resident born in the United States but rather a Pennsylvanian born within the boundaries of the Keystone State.
- <sup>37</sup> Komlos' study of nineteenth-century slaves from Maryland, Komlos and Coclanis's study of convicts in Georgia, and Steckel's study of Ohio National Guardsmen being the most prominent examples.
- <sup>38</sup> Housed in the U.S. National Archives, these books were compilations of various rolls kept by company clerks. Data were drawn from the descriptive rolls, a roll of men who enlisted when the unit was formed as well as those who enlisted later to take the place of the fallen. It was one of four record books kept at the company

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level. United States War Department, *United States Army Regulations of 1861 with an Appendix Containing the Changes and Laws Affecting Army Regulations and Articles of War to June 25, 1863* (Washington, D.C.: G.P.O., 1863), 20 and 24. Data for each soldier included name, date of enlistment, age, birth place, place of enlistment, occupation, rank, and remarks about the man's military career. Data collected for each company and applied to each man's data record included company name and unit type (e.g. infantry, artillery). Adjutant General's Office, *Descriptive Books of Volunteer Organizations: Civil War, 1861-65*, Record Group 94, Item 114, (National Archives. Washington, D.C.).

<sup>39</sup> For a discussion of the extent to which the sample is representative of the Pennsylvania male population see the Appendix of Cuff, *The Hidden Cost of Economic Development*.

<sup>40</sup> For the primary place of origin of the units, see R.A. Sauers, *Advance the Colors: Pennsylvania Civil War Battle Flags* (Harrisburg: Capitol Preservation Committee, 1987); Samuel P. Bates, *Bates's History of Pennsylvania Volunteers, 1861-1865* (Harrisburg: B. Singerly, 1869). See the Appendix for a description of the process of selecting units for inclusion.

<sup>41</sup> Robert W. Fogel, Stanley Engerman, et.al., *Union Army Recruits in White Regiments in the United States, 1861-65*, computer file, Study # 9425 (Chicago: University of Chicago, Center for Population Economics\producer\,1990). Ann Arbor, MI: Inter-University Consortium for Political and Social Research\distributor\,1990.

<sup>42</sup> For full details of sample creation, issues of sample representativeness and the evaluation of potential left-tail truncation, please see the Appendix of Timothy Cuff, *The Hidden Cost of Economic Development: The Biological Standard of Living in Antebellum Pennsylvania* (Aldershot, U.K.: Ashgate Publishing, Ltd., 2005).

<sup>43</sup> While this paper focuses on the economic consequences of such developments, other interesting findings about Pennsylvania(ns) are also evident in these data. Such data help to inform debates over the nature of Civil War soldiers and the consequences of the military draft and substitution policies of the 1860s.

<sup>44</sup> See Chapters One and Two of Cuff, *The Hidden Cost of Economic Development*.

<sup>45</sup> Robert Margo and Richard Steckel, 'Heights of Native Born Whites During the Antebellum Period,' *Journal of Economic History* 43 (1983): 167-174.

<sup>46</sup> Kenneth L. Sokoloff, 'The Heights of Americans in Three Centuries: Some Economic and Demographic Implications' in *The Biological Standard of Living on Three Continents: Further Explorations in Anthropometric History*, ed. John Komlos (Boulder, CO: Westview Press, 1995), 136.

<sup>47</sup> Sokoloff, 'Three Centuries,' 136.

<sup>48</sup> See John Komlos, 'The Height and Weight of West Point Cadets: Dietary Change in Antebellum America,' *Journal of Economic History* 47 (1987): 897-327, for a complete analysis of this data set. The much lower mean heights for the Civil War soldiers below age 18 in all likelihood is a reflection of the role which such boys played in the Civil War. Many in this age category were noted as musicians rather than privates.

<sup>49</sup> This anomaly of 'very large' 16 and 17 year olds may be a function of the need for a 'young' potential cadet to be as physically developed as the standard 18 year old cadet in order to warrant 'early' admittance.

<sup>50</sup> Among the Pennsylvania-born cadets who reported the nature of their residence at the time of enlistment, 196 out of 245 indicated that they resided in a town or city, with only 98 indicating that they resided in a rural area.

<sup>51</sup> See Chapter One and James M. Tanner, *A History of the Study of Human Growth* (Cambridge: Cambridge University Press, 1981), 118.

<sup>52</sup> Richard Steckel, 'Percentiles of Modern Height: Standards for Use in Historical Research,' *Historical Methods* 29 (1996): 163.

<sup>53</sup> Age variation is obviously a critical issue in evaluating inter-group height differentials. As a result, most of the analysis will take account of it. In some cases data will be presented for the entire sample along with data for only the 25-49 year olds (in order to exclude any influence of variation due to the continuation of the growth process). In addition, height standardization by age will be performed in some cases, in order to allow for comparisons with larger sample sizes by including cases on youth.

<sup>54</sup> The use of reported occupation of the soldier has some inherent problems. It would be preferable to have information on father's occupation, as that had a more direct influence on the soldier's nutritional and health circumstances during most of his growing years. However, young men in the early nineteenth century entered the labor market before completion of the biological growth process, so their own occupation would also have had an effect on their final height. Additionally, 'occupation' was not always recorded in such a way to reflect the person's role in the business or firm. Men noting only a business site are believed to have been owners of these places of business. Theodore Herschberg and Robert Dockhorn, 'Occupational Classification,' *Historical Methods Newsletter* 9 (1976): 68.

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- <sup>55</sup> It is appropriate to say ‘most other men’ because most had occupations in the skilled and unskilled categories, categories which have lower mean stature than farmers.
- <sup>56</sup> Except for men without an occupation, the stature advantage of high status occupations over farmers in the unadjusted statewide mean disappeared in the regressions. The advantage apparently was a function of an average age two and a half to six years higher for the proprietor and work site groups. High status occupations have been defined as students, professionals, men listing only a work site, and men with no occupation.
- <sup>57</sup> Regressions run separately for men born in each of the seven regions all show farmers with a stature advantage over the omitted category (skilled workers) but it is only significant in the Southeastern Region (without Philadelphia County), Allegheny County, and the Western Region (without Allegheny County). These regional regressions also show that in the Southeastern Region and in Philadelphia County unskilled workers were one-quarter to one-fifth of an inch shorter than their skilled brethren and that this difference is weakly statistically significant (0.10 level).
- <sup>58</sup> Kenneth L. Sokoloff and Georgia C. Villaflor, ‘The Early Achievement of Modern Stature in America,’ *Social Science History* 6 (1982): 462-465.
- <sup>59</sup> R.W. Fogel, S. Engerman, et al., ‘Changes in American and British Stature Since the Mid-Eighteenth Century: A Preliminary Report on the Usefulness of Data on Height for the Analysis of Secular Trends in Nutrition, Labor Productivity, and Labor Welfare,’ Cambridge, MA: NBER Working Paper #890; Robert Margo and Richard Steckel, ‘Heights of Native Born Whites During the Antebellum Period,’ *Journal of Economic History* 43 (1983): 171.
- <sup>60</sup> In order to standardize heights, the mean height for each age category was calculated. Each individual height was then divided by the mean height for that age of that individual to give the standardized height as a percentage of the mean over the whole of the 1815-1850 period. An eighteen year old soldier with a height of 66.66” would have an age standardized height of 1.01 if the mean height of eighteen year olds were 66 inches ( $66.66/66 = 1.01$ ). This technique allows for height comparisons across regional or occupational categories regardless of the age composition of that category.
- <sup>61</sup> It is also possible that more of the migrants moved after their growth ceased. Fuller understanding of this situation would require greater understanding than is available in this data of migration patterns and timing.
- <sup>62</sup> The 1845-49 quinquennium is omitted from this description. Most men born in that five year span had not completed their growth prior to enlistment. Additionally, almost all these men enlisted in 1863 or later – years known to have seen the enlistment of men of smaller stature.
- <sup>63</sup> This might well have been a general pattern, insofar as Komlos has already noted that the height of those West Point cadets who had middle-class parents did not decline in the second half of the 1830s, although decline in heights among the cadets in general was, indeed, evident John Komlos, ‘Anomalies in Economic History: Reflections on the “Antebellum Puzzle”,’ *Journal of Economic History* 56 (March, 1996): 202-214.
- <sup>64</sup> See Chapter Four for a list of the counties in each region, circa 1860.
- <sup>65</sup> These maps show county boundaries at the beginning of the war, not during the quinquennium of birth. Later regression analysis will include only men who were born in counties which experienced no border changes during the years between 1820 and 1860.
- <sup>66</sup> Fifteen observations per period minimum. Unless noted, the charts and maps do not account for county border changes which may have occurred during the antebellum period. No adjustment was made for such changes, except the analysis below does exclude data from counties which experienced border changes during the period under consideration.
- <sup>67</sup> The figures’ titles ‘urban’ and ‘non-urban’ refer to the presence or absence of a large urban center, i.e., Philadelphia or Pittsburgh.
- <sup>68</sup> Cell sizes were so small for several regions that unreasonably large fluctuation existed in the mean heights by quinquennium and they were not plotted.
- <sup>69</sup> There was a difference between urban and rural residents but it was only significant at the 0.10 level. In their view, the situation was one in which the less well off became concentrated in cities as time went on. Sokoloff and Villaflor, ‘Early Achievement,’ 463.
- <sup>70</sup> Sokoloff, ‘Three Centuries,’ 137.
- <sup>71</sup> Note that Allegheny County is plotted separately and is *not* part of the Western Region in this graph.
- <sup>72</sup> Due to the interesting patterns across the West, men who were born in Lawrence County (which actually would have been possible only for those 20 years and younger since Lawrence County was not formed until 1845) were reported as such, even though they would have been born in either Mercer or Beaver County. This is true

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only for the regional analysis, not the analysis involving county level economic data. Men from all three counties were excluded from that analysis.

<sup>73</sup> The Lake Transport region's time trends in age standardized height and mean adult height diverge sharply. The standardized height moves upward toward the values of the other sub-regions, while the absolute mean (based only on men who have completed their growth) declines. This would seem to indicate some divergence in the net nutritional status of men who had not completed their growth from men who had in the late 1820s and 1830s.

<sup>74</sup> The statewide regression utilized the data for anyone in the statewide or western samples who fit the noted characteristics. The western analysis included all men who met the noted requirements and who also were born in one of the ten 'western' counties. In order to eliminate the influence of small categories of observations which might be unrepresentative and to stabilize the regression results, the sample was pared rather extensively. Only infantrymen, who enlisted as 'standard' enlistees, between 25 and 45 years of age, and who were born in counties a) without border changes between 1820 and 1845 and b) for which all relevant economic data were available, were included in this reduced sample. A total of 1907 men from 29 counties fit these characteristics and are included in the statewide county level regression analysis.

<sup>75</sup> See Tables 4.4 through 4.16 in Chapter Four of *The Hidden Cost of Economic Development* for sources of the various indicators. Most data used in this analysis were drawn directly from the U.S. Census.<sup>75</sup> However, several variables were obtained from data gathered by Craig and Weiss, and by Craig, Palmquist and Weiss on agricultural surpluses in 1840 and access to water transportation routes in 1850. These variables and their calculation are fully described in Lee A. Craig and Thomas Weiss, 'Nutritional Status and Agricultural Surpluses in the Antebellum United States,' NBER Working Paper Series on Historical Factors in Long Run Growth, Historical Paper 99, April 1997 and Lee A. Craig, Raymond B. Palmquist, and Thomas Weiss, 'Transportation Improvements and Land Values in the Antebellum United States: A Hedonic Approach,' Working Paper 95-2-5, North Carolina State University, May 1997. I adjusted several of their specifications according to whether or not a county had usable access to a navigable waterway, slightly expanding the list of those that did. The initial file supplied only included rivers and canals as waterways. Erie County, according to that definition, did not have access to a waterway. It was one of three counties which had their waterway variables changed.

<sup>76</sup> The amounts produced in a county minus the amounts consumed are considered agricultural surpluses.

<sup>77</sup> Since canal construction had, for the most part, ended by 1840 and river navigability did not change appreciably between 1840 and 1850, using a variable developed for 1850 does not pose a difficulty in this analysis.

<sup>78</sup> Craig and Weiss note that these data were not collected during the 1840 Census. Craig and Weiss, 'Nutritional Surpluses,' 11-12.

<sup>79</sup> See Cuff, *The Hidden Cost of Economic Development* for detailed results of additional regression formulations.

<sup>80</sup> See the Appendix of Cuff, *The Hidden Cost of Economic Development* for a description of why no counties with border changes were entered into this part of the analysis.

<sup>81</sup> Means and standard deviations for all the economic/demographic variables in both the statewide and western regression models are found in Tables 5.20 and 5.21 in Cuff, *The Hidden Cost of Economic Development*.

<sup>82</sup> Craig and Weiss, 'Nutritional Status and Agricultural Surpluses.'

<sup>83</sup> This is consistent with other work on Union soldiers. Margo and Steckel, 'Native Born Whites,' 168; Sokoloff, 'Heights of Americans in Three Centuries,' 136.

<sup>84</sup> See Chapters One and Two of Cuff, *The Hidden Cost of Economic Development* for more details and sources.

<sup>85</sup> See Sunder, 'The Height of Tennessee Convicts,' and Samson B. Adebayo, Ludwig Fahrmeir, and Stephen Klasen, 'Analyzing Infant Mortality with Geospatially Additive Categorical Regression Models: A Case Study for Nigeria,' *Economics and Human Biology* 2 (2004): 229-244.

<sup>86</sup> Komlos, 'West Point Cadets,' and Steckel and Haurin, 'Health and Nutrition.'