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COLONIAL AND REVOLUTIONARY MUSTER ROLLS: SOME NEW EVIDENCE ON NUTRITION AND MIGRATION IN EARLY AMERICA

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ABSTRACT

That investment in human capital has made an important contribution to the increase of labor productivity and per capita income during the last several centuries is widely acknowledged. While much of the research on this issue has focused on education, many scholars have also directed attention to the significance of improvements in nutrition. Until recently, efforts to study this subject have been hampered by a lack of evidence, but it now appears possible to construct indexes of nutrition from height-by-age data. This paper employs a relatively underutilized type of historical document to investigate the level of nutrition in early America. The same material also provides a rich source of information about patterns of migration during this period.

This paper finds that native-born Americans approached modern heights by the time of the Revolution. On average, colonial Americans appear to have been 2 to 4 inches taller than Europeans, with southerners considerably taller than northerners and the rural population of greater stature than the urban. These differences may indicate that other factors besides nutrition were important in accounting for the dramatic changes in U.S. mortality rates during the nineteenth century.

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Introduction

The historian seeking to understand aspects of the past is heavily dependent on the nature of the documents prepared by previous generations. The specific reasons for collecting information from certain groups, the precise range of questions asked, and the extent to which such documents have survived and become accessible to the scholar all influence the issues which can be examined. This situation need not be viewed as being overly restrictive, however, since surviving documents can often be employed to study subjects which are unrelated to the particular concerns for which the materials were originally assembled.

In this paper we shall be reporting on our preliminary analysis of a type of historical document which has not generally been examined systematically. The military records we have utilized, referred to as muster rolls or size rolls (or descriptive lists), are predominantly from the years of the French and Indian War (1756-1763) and the American Revolution (1775-1783), and for the soldiers of the American Colonies. Such lists were compiled for most colonial military forces, typically by individual companies or regiments, and provided the basis for distributing supplies and payments, as well as aiding in the identification of deserters. Since there was no standard format for the muster rolls, the nature of the information contained varies widely. Lists have been retrieved which included for each soldier some, but never all, of the following information: place of birth, age, place of residence, occupation, height, hair color, eye color, complexion, place and date of enlistment, military rank, by whom enlisted, language spoken, term of service, pay scale, and other assorted remarks relevant to military service. These data facilitate the investigation of issues for which there has been in the past only sparse or scattered evidence available.

They are of particular value in studying levels of nutrition, patterns of migration, and participation in the military.

The analysis of the data is organized into two rather independent sections of the paper. The first part treats the potential of height-by-age profiles for studying levels of nutrition, and reports our findings and what they might suggest about the variation of nutrition across geographic regions, economic classes, and other relevant characteristics during this period. The next section is concerned with the utilization of the data for the analysis of patterns of migration, both inter- and intra-continental.

The information examined in this paper is drawn almost entirely from those muster rolls that list at a minimum, for each recruit, height, age, and place of birth. The subset of observations which included these variables is only a fraction of the total surviving sample of muster rolls, and it is possible that this sample is not fully representative of the population. If the data reflected only a small sub-sample of recruits, the amount of information provided by them might be quite limited. With regard to the French and Indian War period, the observations were retrieved from materials of New York, Pennsylvania, and Virginia, with an especially great reliance on the former, where the bulk of the American troops involved in that conflict were raised. The militia records of the only other colony which appears to have contributed

statistical significance). The southerners appear to have been experiencing a rapid increase in final heights. While the heights of the Middle Atlantic born grew at the relatively modest pace of 0.4 inches per generation, the stature of those born in the South mushroomed at the rate of 2.0 inches per generation. The latter is a rather high rate of increase in final heights, and is particularly unusual for a period so early in time.

It is also clear from the distribution of the final heights of the British Royal Marines, presented in Figure 1, that native-born Americans during the Revolutionary period were quite tall by relative standards. The mean terminal heights of those groups of Americans exceed the British figure by amounts ranging from 2.3 to 3.5 inches. Possibly more surprising is that the mean terminal heights of the groups of northern Revolutionary soldiers were equal (Middle Atlantic) and 0.30 inches shorter (New England) than the average of native-born northern recruits during the Civil War.[11] The southern revolutionaries were 0.9 inches taller. The total Revolutionary sample has a mean terminal height (68.33) which is equal to the World War II level.[12] Native-born Americans appear to have approached modern heights as long ago as two centuries.

The pattern of final heights suggested by the military data is so surprising as to deserve more careful analysis. One possibility is that the results may be statistical artifacts. As Figure 1 illustrates was the case in the British Army, the recruits may not have been drawn randomly with respect to height. The British usually applied a minimum height requirement, the minimum varying with the demand for, and supply of, recruits. Self-selection considerations might also produce a non-random sample of the population; short individuals might avoid military service. Either phenomenon would generate the left-tail truncation that is observed in the height distributions of the British soldiers. If such truncation

substantially to the war effort, Massachusetts, do not include height-by-age data.[1] As for the Revolutionary War period, our present sample has broad geographic coverage, and does not diverge substantially from the crude existing estimate of the actual distribution of soldiers across states (see Table 1).[2] Another potential source of sample selection bias is that muster rolls which report height may have been prepared in atypical localities. As we are ignorant of the true compositions of the two armies, consideration of aggregate characteristics would be difficult regardless, since even if all areas were encompassed by our sample, some might be disproportionately represented.

Although it seems likely that the sample includes a relatively large percentage of the French and Indian War troops, it is not clear what proportion of the population of Revolutionary War soldiers are contained. There is no consensus on the number of men that served in the militia or the Continental Army; estimates range from 100,000 to 250,000.[3] This paper is a report of an ongoing project, and we anticipate that when the collection of data is completed, our sample will constitute a significant proportion of the population of Revolutionary recruits. Even if one possessed a sample which was representative of all army and militia recruits, however, inferences about the general population would still have to be tendered with considerable caution.

I. Height-By-Age Analysis

There are a variety of reasons why scholars have been concerned with the level of nutrition in colonial America. It is of substantial interest by itself, of course, as the food supply is a major component of the standard of living of a population, particularly for an economy at an early stage of development. In addition, it has been proposed that during the period of the late seventeenth century to the early nineteenth century there was a great change in the capacity of men to work, largely

attributable to improvements in nutrition.[4] An index of nutrition would also be informative, because it is likely that nutrition will tend to be related to more conventional economic variables of which we have limited knowledge. Although it is unlikely that nutrition would move closely with per capita income, even at this early stage of development, evidence of significant changes in the former might suggest that there was at least the potential for change in the latter. Within a population of a relatively homogeneous culture, patterns of nutrition might reflect the distribution of income.

It was an interest in studying the trend in mortality during this period that originally led to these data being retrieved. One of the principal issues in the attempt to explain the secular decline in mortality rates over the last several centuries, both in Europe and in North America, is the role played by nutrition. While Brown, Higgs, McKeown, and Record have argued that improvement in nutrition was the major factor accounting for the decline in death rates, Razzell and Appleby have challenged this interpretation.[5] Alternative hypotheses for contributors to this development include medical advances, an increasing knowledge of the operation of the physical world (personal health measures), improvements in housing, decreasing virulence of disease, and the implementation of public health measures.

Despite the importance of the issues concerning the amount and nutritional adequacy of the food supply, efforts to study this subject were initially hampered by a lack of evidence. It may be possible to resolve this problem by utilizing information on height by age. Data on both height and weight, by age, are particularly desirable for identifying a population's "average nutritional status." While such joint distributions are sometimes available, only data on height have thus far been located in such quantities that they can be used to construct

time series extending back into the eighteenth century. Even without observations of weight, height-by-age data can be quite accurate indicators of the "average nutritional status" of populations, as well as of changes in this condition over time and place.[6]

Many researchers have studied the effects of nutritional deficiencies and illness on the height-by-age profile through observational studies of human populations and laboratory experiments.[7] Three statistics are particularly useful: the age at which the adolescent growth spurt peaks, the age at which full height is attained, and the change in terminal heights over time. Short periods of malnutrition or prolonged periods of moderate malnutrition, during childhood, merely delay the onset of the adolescent growth spurt. Severe, prolonged malnutrition may completely erode the typical growth-spurt pattern and cause permanent stunting. If malnutrition is prolonged and moderate, growth will continue beyond the age at which the growth of well-fed adolescents ceases. Hence, the age at which growth terminates is an important indicator, especially for older adolescents, of nutritional status. There is a clear pattern of "catching-up" after periods of malnutrition, but the longer the periods and the more severe the malnutrition, the more likely the terminal height will fall below what it would have been under conditions of good nutrition. Malnutrition is not the only environmental influence on height-by-age profiles. Major illnesses can be detected by the existence of "slowdowns" in the velocity profiles, followed by acceleration in growth after recovery.

Recent studies have suggested that the effects of malnutrition are manifested not only in the immediate generation, but in subsequent ones as well. This may be the mechanism which produces the observed secular increase in final heights of various populations for which long-term series are available.[8] The final heights of different populations thus appear to be a significant index of the

cumulative effect of the nutritional status of these populations over several generations.[9] This is not to imply that radical changes in diet cannot result in a large change in the average terminal heights between children and parents (i.e. a temporal span of a single generation). The experience of the Japanese during the post-war period is a well known case of rapid growth in the heights of a population within a generation. A study of Italian-Swiss immigrants in twentieth century California reported that the first generation achieved a mean terminal height that was approximately four centimeters taller than that of their fellow villagers and family members who remained in Switzerland.[10]

The muster rolls, of course, provide more abundant evidence on final heights and on the age at which growth terminates than on the peak of the growth spurt. As one would expect, very few individuals under the age of 16 enlisted in the military, making it difficult to utilize this data for studying adolescent growth spurts. Accordingly, the analysis of the height-by-age data, in this paper, will focus on the terminal heights achieved.

In Figures 1 and 2, we present, for the Revolutionary and French and Indian Wars, frequency distributions of the heights of white native-born recruits aged 25 through 35. One can safely treat these soldiers as having achieved terminal height. Since the Revolutionary sample is diverse with regard to geographic region, and one observes some relation between place of birth and stature, it is divided into three groups: New England, Middle Atlantic, and South. As our sample from the earlier war includes relatively few individuals from New England, this regional group does not appear in Figure 2. Having a small number of observations prevents us, at this stage, from dividing the sample any further. The more sub-groups that can be compared, the more differences within populations will be illuminated,

FINAL HEIGHTS OF RECRUITS IN ENGLAND AND AMERICA AT THE TIME OF THE AMERICAN REVOLUTION*

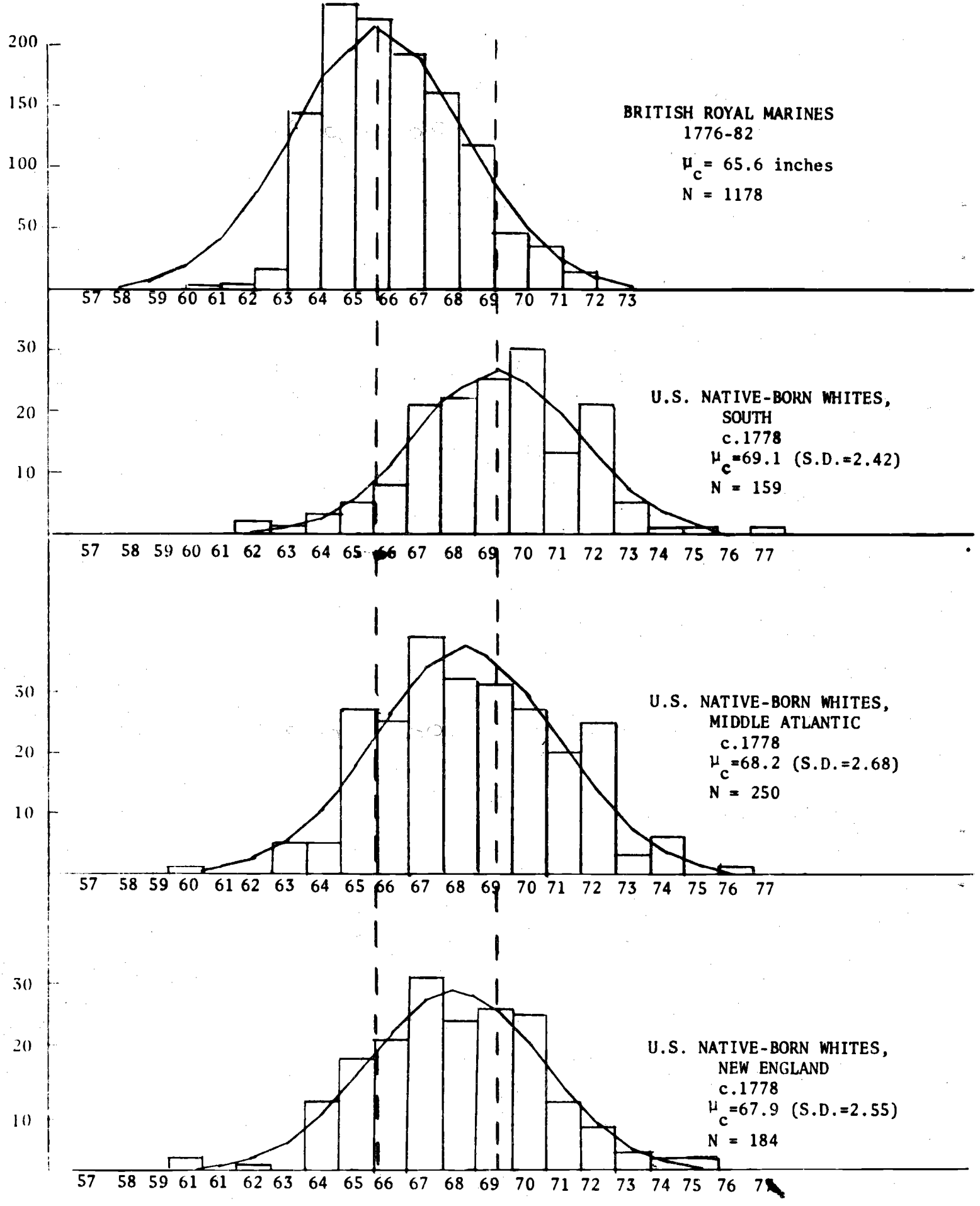
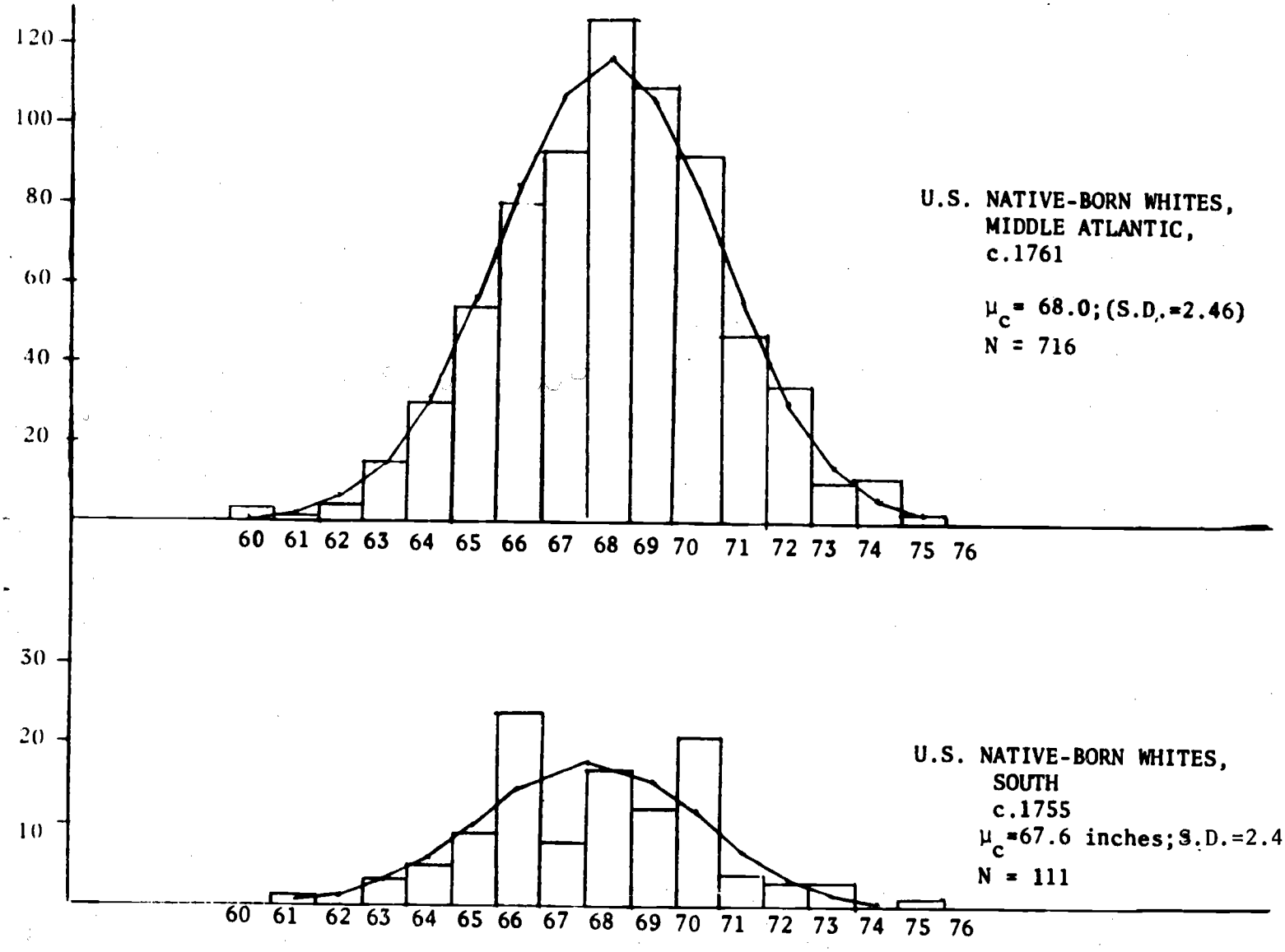


FIGURE 2

FINAL HEIGHTS OF RECRUITS IN AMERICA AT THE TIME OF THE FRENCH AND INDIAN WAR*

*In estimating the true means of these distributions, we have attempted to adjust for biases arising from "heaping" and truncation. We have employed an equation, derived from simulations, which estimates the amount of bias in the sample mean from several moments of the distribution. For a detailed discussion of the problem, and the method utilized, consult the reference in footnote 14. The standard deviation of the final heights of the British Royal Marines is not currently available, but the true figure should be in the neighborhood of 2.5 inches.



and the greater the likelihood that biases in the data will be detected. If one is examining a relatively homogeneous population, without sample selection bias, one should observe a normal distribution of final heights.[13] The frequency distribution for the aggregate Revolutionary War sample does not resemble a normal distribution, but two of the three sub-groups do generate distributions such that chi-square tests cannot reject the hypotheses that they are drawn from normal distributions. We suspect that the Middle Atlantic distribution diverges from normality, because heterogeneous populations are being lumped together (geographically, from Connecticut to Maryland). The Middle Atlantic distribution, for the French and Indian War, closely conforms to the properties of a normal distribution, however, a chi-square test rejects the hypothesis that the southern sub-group is drawn from a normal distribution. It should be noted that there appears to have been rounding to even inches in the South's distribution; if one assumes that this is the explanation for the "heaping", the appropriate adjustments, conservatively applied, produce a substantial increase in the probability that the underlying distribution is normal. In considering the deviations from normality, one should recognize that only crude attempts at isolating homogeneous sub-groups have yet been made.

Perhaps a more important point about these data is that there are substantive differences between the mean final heights of these sub-samples. The mean terminal height of the South group is 1.2 and 0.9 inches greater than those of New England and the Middle Atlantic respectively. Although the sample sizes are not very large, these differences are statistically significant. The difference between the heights of recruits from New England and the Middle Atlantic is not statistically significant. When one inspects the French and Indian War observations, it is interesting that the Middle Atlantic heights exceed those of the South (of marginal

statistical significance). The southerners appear to have been experiencing a rapid increase in final heights. While the heights of the Middle Atlantic born grew at the relatively modest pace of 0.4 inches per generation, the stature of those born in the South mushroomed at the rate of 2.0 inches per generation. The latter is a rather high rate of increase in final heights, and is particularly unusual for a period so early in time.

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or "censoring" occurred, the estimated mean final height would be biased upwards. However, left-tail truncation does not appear to be a major factor in the American height distributions, except perhaps in the New England group from the Revolutionary period. Employing an equation fitted over simulated cases, we estimated the degree of bias in the raw figures for means, and made the appropriate adjustments.[14] These corrected estimates of the mean are the only ones cited in the paper. None of the adjustments led to a qualitative change in the results.

As it seems unlikely that the genetic potential of the U.S. population has changed significantly, the rather tall heights observed suggest that the colonial population was reasonably well nourished. More specifically, the levels of calories and protein, which are often identified as being particularly important in the influence of nutrition on height, would appear to have been quite high. The inferences to be made from final heights about the average nutritional status of Americans are even more striking when one considers that members of the upper class, who would presumably be better nourished, would not be expected to appear frequently among the enlisted men. In addition, if the full effect of improvements in nutrition requires several generations to be manifested, it seems likely that the colonial level of nutrition was even higher than our sample's heights suggest. Although little is known about the diet of Americans during this period, there is some evidence that they were avid meat-eaters. One visitor to Virginia, in the 1770's remarked, "that they eat larger quantities of animal food [than at home]. . . you can be contented with one joint of meat is a reproach frequently thrown into the teeth of an Englishman."[15] If this rich source of protein was abundant, it could account for the tall stature, and if the supply of livestock increased in the South during the middle of the century, meat might be responsible for the growth observed. Of course, it may be that certain trace elementsare critical for growth, in which case one would need to investigate the possibility of subtle changes in the diet that might have affected the intake of one or more of these critical substances. If such an event transpired

it would be extremely difficult to identify given the paucity of evidence on food consumption.

One might remain troubled by the significant difference in mean final heights between the New England and the non-New England groups for the Revolutionary period. Since a higher class of individuals is supposed to have served in the New England military and this region's population had probably resided for the longest period in America, one might have expect heights in Massachusetts to be higher. A possible explanation is that southerners were measured with their shoes on.[16] Some contemporaries noticed, however, that southerners seemed to be taller: "The natives for the most part, rise above the middling stature: and they attain their full height sooner, than the people usually do in colder climates!"[17] There are several other hypotheses which could account for this divergence. The apparent difference in nutrition suggested by the height-by-age data might be related to regional differences in income. This explanation would be consistent with the finding derived from probate records that the average wealth holdings were substantially higher, for nearly all classes of society, in the South and Middle Atlantic relative to New England.[18] Another set of possible explanations concerns the agricultural differences between the two regions. Perhaps the farther south an individual lived, the more nutritious the crops, the larger the supply of livestock, the better the access to food, or the greater the quality of the food supply during the winter months. Other hypotheses might involved differences in occupational distributions, tastes in food, or in genetic potential. It should be further noted that a similar pattern appears in Civil War data. For example, the mean height of the New England-born soldiers of the Civil War, at age 26, was 68.16 inches, while for Kentucky and Tennessee (the closest states to the southern seaboard) the mean height was 69.05 inches.[19] The regional difference

in heights is puzzling, but it should not discredit the height-by-age analysis. It is the contention of this paper that the level of nutrition did vary within the population, and that height-by-age analysis can detect some of the systematic patterns of that variation.

From the discussion of regional differences in heights, it is clear that a multivariate analysis is desirable. Accordingly, a regression with height as the dependent variable was run over the sub-sample of Revolutionary soldiers, ages 25 to 35. The independent variables include age and a series of dummies representing occupational classes, places of birth and residence, and race, while the intercept reflects the height of a rural New England-born white farmer who lived in a rural area. The results are reported in Table 2. It is evident that even after allowing for other characteristics, the regional difference in height among native-born Americans persists. The results suggest that being born in Virginia adds 0.84 inches to an individual's height and North or South Carolina contributes 0.70 inches. The coefficients on the other domestic nativity dummies imply that New Yorkers are somewhat taller, and the Delaware born substantially shorter, than New Englanders. The stature of those born in other states is not significantly different from that for New England.

The regression also provides support for the view that Americans were better nourished than Europeans, as the coefficients on the foreign-born dummies are generally large, negative, and statistically significant. One must remember, however, that the immigrants who appear in the military data do not accurately reflect the populations of their home countries, since many of them probably arrived in America before reaching terminal height. Of particular interest are the coefficients for the three major immigrant groups, the English, Germans, and Irish; the English and Irish reduce the

TABLE 2

REGRESSION WITH HEIGHT AS DEPENDENT VARIABLE - AMERICAN REVOLUTION OBSERVATIONS, AGES 25-35

R^2 = 0.1258 N = 1141

Variable	Coefficient	t-statistic
Intercept	67.662	91.41
Years of Age	0.010	0.43
Native-Born Artisan	-0.060	-0.23
Native-Born Laborer	0.132	0.35
Foreign-Born Artisan	0.115	0.30
Foreign-Born Laborer	0.688	1.48
Foreign-Born Farmer	-0.491	-0.99
Seaman	0.116	0.23
Unknown Occupation	0.018	0.07
Native-Born Urban	-0.981	-1.87
Urban Resident	-0.857	-1.49
Foreign-Born Urban Resident	0.911	1.31
Foreign-Born Urban	-0.905	-1.44
English-Born Urban	-0.287	-0.33
Native-Born Black	-0.482	-0.81
Born in New York or New Jersey	0.490	1.52
Born in Connecticut	-0.186	-0.43
Born in Delaware	-1.516	-2.43
Born in Pennsylvania	-0.295	-0.60
Born in Maryland	0.309	0.68
Born in Virginia	0.840	2.48
Born in North or South Carolina	0.701	1.68
Born Elsewhere in America or Canada	-0.394	-1.03
Born in England	-1.483	-3.72
Born in Ireland	-1.168	-3.36
Born in Germany	-0.815	-1.75
Born in Scotland	-0.479	-0.74
Born in France or Switzerland	-2.330	-2.32
Born in Other Foreign Countries	-1.500	-2.35
Foreign-Born Residing in the South	0.795	2.21
Northern-Born Residing in the South	-0.231	-0.37
Native-Born Migrants Across State Lines	0.764	2.45

height by over an inch, while the German born are shorter by 0.81 inches. The relative sizes of these coefficients are influenced by the conditions in the home country, the average ages of immigration, and the conditions within the states which attracted these ethnic groups. It is also interesting that being black reduces an individual's height by only 0.48 inches, with this effect statistically insignificant.

The regression coefficients indicate that the level of nutrition varied between urban and rural areas, both in the U.S. and Europe. An individual born in an American urban area would be nearly an inch shorter, on average, than his rural-born countrymen. Besides the interpretation that the level of nutrition (or other environmental conditions) was simply worse in American cities, the coefficient might also reflect that those who were born in the cities were children of foreign born immigrants, and were still affected by malnutrition a generation ago. The effect of being a resident of an urban area, a reduction of 0.86 inches in stature, is extremely interesting. The statistically significant coefficient, when viewed together with our evidence on patterns of migration, may indicate that those who were malnourished when growing up (and perhaps more likely to be poor) tended to become concentrated in the cities. An interpretation of this coefficient which argues for a causal influence of urban conditions on height depends upon these residents moving to the urban areas at a young age, or a good portion of the urban born moving out of the cities at early ages. Foreigners who reside in urban areas appear to be about the same height as those in rural areas. The foreigners born in urban areas were approximately 0.90 inches shorter than those that were not There appears to have been no difference in the relative circumstances of English urban-born and other foreign urban-born recruits.

Finally, the lack of significant coefficients on the occupational class dummy variables is quite striking. The small coefficients, and their insignificance,

imply that the level of nutrition did not vary substantially over occupational, and perhaps income, classes. This may be indicative of the extent of economic equality, at least within a colony or region. If income is more closely related to region than to occupation, then our regional difference in heights may reflect a degree of income inequality. Of course, it is important to remember what underlying phenomena we are attempting to detect. The heights of individuals are influenced by the levels of nutrition they experience when they are young. Thus, we might prefer to know the occupations of the parents of these soldiers when investigating the relationship between occupation and nutrition. The greater the extent of social mobility, the less one would expect to observe a relation between an individual's occupation and his height (unless occupation was a function of height). Another reason why the occupational categories may not explain much of the variation in height is because they are not sufficiently precise. For example, our failure to distinguish between large planters and yeomen with minor holdings, or urban and rural laborers may be the critical element in achieving our result.

There are several variables included in the regression that refer to classes of migrants. Those native-born soldiers who migrated from their places of birth to reside or enlist in other colonies were approximately 0.76 inches taller than their more sedentary neighbors. It is not apparent whether the greater stature is attributable to superior material circumstances, or the net effect of migration to areas with better nutritional conditions. Foreigners residing in the South (North Carolina, South Carolina, and Virginia) are about 0.80 inches taller than those who have settled in the North, after adjusting for country of birth. This gap might reflect class differences between these groups of migrants, might be attributable to a younger age at migration on the part of the South's foreign population, or simply indicate that

foreigners arrived at a sufficiently early age to be affected by regional nutritional conditions. In contrast, northerners who migrated to the South were, after allowing for the generally greater heights of migrants, no taller than those who chose to remain in the colder climate.

A regression with a similar specification, run over the French and Indian War sample, is reported in Table 3. As is immediately evident, the patterns of variation in height are rather different from those in the later period. The native born are again of substantially greater stature than the foreign born. However, there are no statistically significant differences in height across places of birth. Focusing solely on the size of the regression coefficients, New Yorkers, as they do in the American Revolution sample, tend to be slightly taller than New Englanders, while the recruits born in Pennsylvania and Delaware are shorter. The major surprise is that during this earlier period, being born in the South reduced one's terminal height relative to New England levels. The lack of significant differentials might be attributable to a large portion of the sample being drawn from New York, with the consequence that many of the native born from other colonies had moved to New York and perhaps been affected by the nutritional conditions there. The results from the French and Indian Was sample also deviate from those of the Revolutionary sample in that there is no significant relation between height and birth or residence in an urban area. This may not be unreasonable for American cities, since they were still small and relatively undeveloped at the beginning of the 18th Century, but the absence of any effect of being born in foreign urban centers is unexpected.

The occupational dummy variables, in the French and Indian War sample, provide significant explanatory power in accounting for the variation in height across individuals. Both native-born artisans and laborers were about 0.6 inches shorter than native-born farmers, after adjusting for the urban-rural mix and other factors. It is not at all apparent why occupation

TABLE 3

REGRESSION WITH HEIGHT AS DEPENDENT VARIABLE - FRENCH AND INDIAN OBSERVATIONS, AGES 25-35

R^2 = 0.1389 N = 2675

Variable	Coefficient	T-Statistic
Intercept	68.076	119.88
Years of Age	0.006	0.36
Native-born Artisan	-0.566	-2.14
Native-born Laborer	-0.583	-2.08
Foreign-born Artisan	0.061	0.17
Foreign-born Laborer	0.124	0.33
Foreign-born Farmer	-0.166	-0.35
Professional	0.132	0.21
Seaman	-0.184	-0.44
Unknown Occupation	-0.379	-1.02
Native-born Urban	-0.183	-0.61
Urban Resident	-0.232	-0.68
Foreign-born Urban Resident	0.168	0.45
Foreign-born Urban	-0.246	-0.67
English-born Urban	-0.573	-0.96
Native-born Black	-2.096	-3.44
Born in New York or New Jersey	0.277	0.98
Born in Pennsylvania or Delaware	-0.444	-1.29
Born in Maryland	-0.665	-0.86
Born in Virginia	-0.254	-0.71
Born in North or South Carolina	-0.135	-0.05
Birthplace Specified as America	-1.051	-1.33
Born Elsewhere in America or Canada	1.831	1.45
Born in England	-2.006	-4.71
Born in Ireland	-1.368	-3.32
Born in Germany	-2.332	-5.58
Born in Scotland	-1.531	-3.24
Born in France or Switzerland	-1.737	-3.36
Born in Other Foreign Country	-1.332	-2.74
Unknown Place of Birth	-0.473	-0.98
Foreign-born Residing in the South	-0.764	-3.48
Northern-born Residing in the South	0.424	0.64
Native-born Migrants across State Lines	0.203	0.70

is related to height in this sample, but not in the Revolutionary sample. The above discussion noted that the greater the degree of social mobility, the weaker the link between the two variables. Thus, one might argue that social mobility increased during the inter-war period. An alternative view might identify the relative geographical homogeneity of the French and Indian sample, with its implications for consistent recording of occupations, as the critical element. Although this interpretation is not without appeal, the answer does not seem completely adequate, since one would expect a significant regression coefficient if, by all colonies of birth, laborers were shorter than farmers (a not especially stringent condition). A third explanation is that regional differences dwarfed the occupational effects in the later period, and that migratory behavior must be given more attention before the relationship between occupation and height can be isolated. None of these scenarios is very satisfying, however, and this issue will receive further study. As a final point, it should be mentioned that this concern with regional patterns, in a context of substantial geographical mobility, emerges again with the finding that, after allowing for country of birth etc., the foreign born in the South are shorter than those immigrating to the North. This relative stature of the two groups is the opposite of that observed in the American Revolution sample; the shift in the pattern may reflect the change, in the same direction and of similar magnitude, in the relative heights of regional native-born populations.

Although the above regressions are extremely informative about the variation of height in cross-section, we also seek to investigate changes in stature over time. For this purpose, we ran a regression over all of the recruits, ages 25 to 35, from the French and Indian and Revolutionary samples. In this regression, the results of which are reported in Table 4, the intercept represents the height of a rural New England-born white farmer who lived in a rural area during the Revolution. It has already been discussed how some of the estimated relationships shifted significantly during the inter-war period

TABLE 4

REGRESSION WITH HEIGHT AS DEPENDENT VARIABLE - OBSERVATIONS FROM BOTH PERIODS, AGES 25-35

$R^2 = 0.1521$ N = 3777

Variable	Coefficient	t-statistic
Intercept	67.951	159.59
Years of Age	0.009	0.68
Native-Born Artisan	-0.410	-2.25
Native-Born Laborer	-0.424	-2.06
Native-Born Seaman	-0.518	-1.26
Foreign-Born Artisan	-0.042	-0.16
Foreign-Born Laborer	0.114	0.44
Foreign-Born Farmer	-0.137	-0.45
Foreign-Born Seaman	0.404	1.32
Unknown Occupation	-0.084	-0.42
Native-Born Urban	-0.980	-2.01
Urban Resident	-0.361	-1.26
Foreign-Born Urban Resident	0.386	1.20
Foreign-Born Urban	-0.531	-2.23
Native-Born Black	-1.268	-3.01
Born in New York or New Jersey	0.537	2.62
Born in Connecticut	0.006	0.02
Born in Delaware	-1.564	-2.57
Born in Pennsylvania	-0.297	-1.00
Born in Maryland	0.038	0.10
Born in Virginia	0.833	2.79
Born in North or South Carolina	0.657	1.67
Born Elsewhere in America or Canada	-0.454	-1.41
Born in England	-1.628	-5.91
Born in Ireland	-0.983	-3.73
Born in Germany	-1.666	-5.86
Born in Scotland	-1.039	-3.06
Born in France or Switzerland	-1.337	-3.34
Born in Other Foreign Countries	-0.974	-2.79
Native-Born Migrants Across State Lines	0.511	2.47
Served During French and Indian War	-0.389	-2.13
Foreign-Born and Served During FI War	-0.591	-2.53
Born in South and Served During FI War	-0.764	-1.92
Native-Born Urban and Served During FI War	0.782	1.39

(or more precisely, over the two samples). For those variables where there was a dramatic change, a literal interpretation of the size of the coefficient would be misleading, since it will, for the most part, only reflect the average impact of the variable. In other cases, the combined sample may yield improved estimates of the effects of variables, due to having more observations.

The regression was primarily designed to determine, after adjusting for all of the relevant factors we can, the amount of increase in the final heights of various groups between the wars. The results indicate that the mean terminal heights of northern native-born recruits, born in rural areas, increased about 0.4 inches, of southern native-born recruits increased 1.1 inches (0.389+0.764), and that of foreign-born soldiers rose about 1.0 inches (0.389+0.591). These figures imply that the rural northerners were growing at a respectable, but not unusual, rate of 0.7 inches per generation, while the mean final height of southerners was increasing at the remarkable, for such an early period, rate of 1.4 inches per generation. Thus, the multivariate analysis has not altered the qualitative findings obtained from the simple comparison of the distributions of height for the various groups. It has, however, narrowed the gap in the implied rates of increase of final heights between the North and the South.

The rural northern rate of increase in final heights is augmented by multivariate analysis, because it is abstracted from the urban experience. The regression indicates that the stature of urban native-born recruits declined in absolute terms, between the wars, at a rate of 0.7 inches per generation. If one computes the rate of increase of final heights for all northerners, both urban and rural born, the rural figure is reduced to a more modest amount of 0.45 inches per generation.

The regression results imply that the stature of the foreign born increased substantially more than that of the northern native born, and nearly as much as that of the southerners. This is rather surprising, as the available data on the British military might suggest lower rates of growth. One possible

explanation is that the ethnic mix of the foreign-born category shifted towards greater representation of well-nourished groups. There is a small increase in the proportion of Irish born in our sample between the wars, but it appears unlikely that this could account for much of the estimated effect. It would seem more likely that there may have been a change in some unmeasured background characteristic of the foreign born. Perhaps there was a change in the pattern of migration, such that a greater proportion of the foreign born in the Revolutionary military had arrived in America while they were young (a shift towards more migration by young families). In this way, their heights could have been influenced more by food supply conditions in the colonies than in the lands of their birth. Furthermore, it appears likely that some of the foreign born in the South benefited from the improved circumstances in that region.

As we discussed above, there is a possibility that our results are affected by sample selection bias. Although a preliminary examination of the distrubtion of heights suggested that any truncation or "censoring" which might have occurred is probably of a minor magnitude for native-born groups, it should be noted that such problems with our sample would be likely to produce underestimates of the differences in mean terminal heights between groups . This analysis would be relevant if the truncation decision based on height was applied equally across sub-populations and that all of these groups were characterized by the same degree of dispersion in heights. Both of these conditions would seem to be reasonable assumptions and would tend to imply that the regression coefficients would be biased toward zero.

If truncation occurred below some specific level of height, then the sample mean terminal heights of all sub-populations would be biased upwards as estimators of the true population values. However, the bias associated with the sample mean heights would be greater for the shorter groups, because larger proportions of their distributions would be subject to truncation (the argument is similar for right tail truncation). Therefore, analysis of the unadjusted heights will be likely to yield lower-bound estimates of the differences in stature between groups. The coefficients in our regressions are underestimates of the effects (in absolute value) of the respective variables, implying that the significant differences observed are not simply consequences of this type of sample selection bias.

Since the collection of data for the sample has not yet been completed, our results must be labelled tentative. Nevertheless, the analysis of the height-by-age data has yielded several important findings which seem unlikely to be overturned. Perhaps the most striking of these discoveries is that native-born men appear to have approached modern heights by the time of the American Revolution, particularly in the South. Americans seem to have been about two to four inches taller than their European contemporaries. It is also of substantial interest that the North and the South were characterized by very different rates of increase in final height during the inter-war period. After the French and Indian War, when the two regional populations had been of roughly equal stature, the much more rapid growth of southerners opened a gap between them. While the northern rate of increase of final heights was less than the British figure, the southern rate was twice that. The modest record of the North, in total, is partially attributable to what appears to have been an absolute decline in the stature of the urban-born population. These developments generated large urban-rural and North-South differentials in height, which came to be of much greater magnitude and significance than the variation across occupational classes.

II. Immigration and Migration

Collection of the colonial muster rolls has provided us with one of the most extensive sources of data on the movement of colonists across oceans and borders in the 18th Century. Most observations in the two samples include information on nativity, which allows us to study the ethnic composition of the militias. Tables 6 and 7 tabulate the birthplaces of foreign-born recruits in the two samples. Because of the large differences in ethnic composition between different colonies, these data must be examined colony by colony. Some common characteristics emerge from a general consideration of the two periods, however. One, by far the most striking, is the large percentage of foreign born in nearly every colony (see Table 5); another is the apparent over-representation of the Scotch-Irish among the foreign born, especially considering that many of the native born must be one or two generations removed from that same stock.

The settlement patterns of particular nationalities emerge from Table 7. We see a concentration of Irish born (by far the most numerous group in the Revolutionary militias) especially in Pennsylvania and Maryland. Virginia was a more popular destination for the English, although many also settled in Maryland and Pennsylvania. The major non-English-speaking nationalities--Germans, French, and Swiss--appeared in Massachusetts and Pennsylvania. Finally, those born in Scotland turned up in New York and North Carolina. The comparison of regional concentrations of immigrants in Table 8 is perhaps more meaningful for our purpose, since it highlights the overwhelming attraction to the Middle Atlantic region of the immigrants to the American colonies. This domination holds in every major ethnic category, but particularly for the Irish and Germans, three-fourths of whom were found, in our sample, in those three colonies. Although the sample from the Revolution contains fewer foreign immigrants than the French and Indian War sample, some of this difference can be explained by the

TABLE 5

FOREIGN BORN AS PERCENTAGE OF TOTAL ENLISTMENT

French & Indian War		American Revolution	
New York	47%	Massachusetts	14%
Pennsylvania	68%	Connecticut	5%
Virginia	50%	New York	10%
Maryland	42%	Pennsylvania	69%
		Delaware	38%
		Maryland	56%
		Virginia	18%
		North Carolina	7%
		South Carolina	16%

selection of colonies comprising the samples. The earlier period draws heavily from Pennsylvania, New York, and Virginia. The colonies that appear in the sample from the Revolution include the Carolinas, Massachusetts, and Connecticut, which received comparatively few Europeans during this era. That the Revolutionary army enjoyed more general participation of the population, and is characterized by a much higher socio-economic composition, may also account for a portion of the decline in the percentage of foreign born.

Pennsylvania is thought to have received nearly half the immigrants to the thirteen colonies during the middle 18th Century, and accordingly its foreign component is the highest of any colony sampled. Although the proportion of foreign born remains nearly the same over the two periods, it does undergo a slight shift in composition by nationality: numbers of English born doubled relative to Scotch-Irish and Germans. Since these three nationalities were not distributed evenly across the colony, it seems plausible that the different loci of the fighting in the two wars might account for this--the earlier war having been fought largely on the frontier, where the Scotch-Irish predominated.

However, a comparison of the ethnic breakdown of the youngest age groups

TABLE 6

DISTIRUBTION OF RESIDENCE BY NATIVITY: FOREIGN-BORN SOLDIERS

FRENCH & INDIAN WAR

Country of Birth

Place of Enlistment		England	Ireland	Scotland	Germany	France, Switzerland	West Indies	Other	TOTAL
		16	7	2	3	0	0	0	28
Maryland	a)	.57	.25	.07	.11	-	-	-	
	b)	.29	.10	.11	.15	-	-	-	
		710	1365	190	830	122	41	175	3433
New York	a)	.21	.40	.06	.24	.04	.01	.05	
	b)	.08	.13	.07	.27	.50	1.00	.20	
		33	267	22	87	4	0	11	424
Pennsylvania	a)	.08	.63	.05	.21	.01	-	.03	
	b)	.07	.46	.15	.52	.30	-	.23	
		184	134	70	8	2	0	19	417
Virginia	a)	.44	.32	.17	.02	--	-	.05	
	b)	.55	.32	.66	.07	.21	-	.56	
TOTAL		943	1773	284	928	128	41	205	4302

a) Proportion of row total

b) Weighted proportion of column total; see "Notes to Tables 9-11" and Table 11

TABLE 7

DISTRIBUTION OF RESIDENCE BY NATIVITY: FOREIGN-BORN SOLDIERS

Country of Birth

Place of Enlistment		Ireland	England	Germany	Scotland	France, Switzerland	Other	TOTAL
Massachusetts		44	43	45	7	11	15	165
	a)	.27	.26	.27	.04	.07	.09	(b) .07
	b)	.03	.06	.16	.04	.54	.23	
New York		26	3	6	8	0	4	47
	a)	.55	.06	.13	.17	-	.09	(b) .04
	b)	.04	.01	.04	.09	-	.12	
Pennsylvania		227	66	67	12	3	5	380
	a)	.60	.17	.18	.03	.01	.01	(b) .40
	b)	.47	.26	.62	.18	.38	.20	
Delaware		37	2	3	2	1	1	46
	a)	.80	.04	.07	.04	.02	.02	(b) .03
	b)	.05	-	.02	.02	.08	.03	
Maryland		126	80	11	12	0	5	234
	a)	.54	.34	.05	.05	-	.02	(b) .20
	b)	.22	.26	.08	.15	-	.17	
Virginia		21	47	4	5	0	3	80
	a)	.26	.59	.05	.06	-	.04	(b) .17
	b)	.09	.37	.07	.15	-	.24	
South Carolina		33	6	0	3	0	0	42
	a)	.79	.14	-	.07	-	-	(b) .05
	b)	.08	.03	-	.05	-	-	
North Carolina		4	1	0	7	0	0	12
	a)	.33	.08	-	.58	-	-	(b) .04
	b)	.02	.01	-	.30	-	-	
TOTAL		522	250	137	56	15	35	1015

a) Proportion of row total
b) Weighted proportion of column total; see "Notes to Tables 9-11" and Table 11

TABLE 8

REGIONAL DISTRIBUTION OF THE FOREIGN BORN

Country of Birth

Region of Enlistment	Ireland	England	Germany	Scotland	France, Switzerland	Total Immigration	Total Population
NORTHEAST (Ma., Ct., N.Y.)	.07	.07	.20	.13	.54	.11	.30
MIDDLE ATLANTIC (Pa., De., Md.)	.74	.52	.72	.35	.46	.63	.27
SOUTH (Va., N.C., S.C.)	.19	.41	.07	.50	-	.26	.43

Figures are aggregations of the weighted averages reported for individual colonies in row (b) of Table 7. See "Note to Tables 9-11" for an explanation of the weighting procedure.

The last column is the proportion of the total population of the 9 colonies in the sample residing in the three colonies of each region.

in the earlier war with the group 20 years older during the Revolution[21] suggests that the shift was a result of a change in patterns of immigration, rather than a change in the tendency of a particular nationality to enlist. The ethnic composition remains the same in the two wars for the same cohort. Virginia and New York provide much sharper contrasts. Although the numbers of foreigners decline drastically in both colonies, it is the English and Germans responsible for the drop in New York, while the Scotch-Irish fell most precipitously in Virginia. Since changing patterns of immigration could not be of a magnitude great enough to explain such discrepancies, some changes in the propensities to enlist must have occurred.

In the remaining colonies, the proportion of foreigners decreases as the distance from the Middle Atlantic region increases. On the northern end, only the presence of Germans in western Massachusetts indicates an inflow into New England. In South Carolina, the small number of foreigners (particularly considering the much shorter history of settlement in that colony) seems to imply that the ranks of the militia were peopled more heavily by migrants who had come down the overland route through the Appalachians, rather than through the port of Charleston, and furthermore that the process of removing to the frontier after entering the country generally consumed more than one generation.

Pennsylvania's large component of foreigners--over two-thirds in both wars--is excessive even for the colony likely to have had the largest proportion. Similarly, in most of the other colonies, rates of immigration implied by our sample far exceed what seems plausible, even considering the huge inflows in the middle 18th Century. We cannot escape the conclusion that the foreign born are greatly over-represented in the colonial militia, although rankings of the colonies by the percentage of foreign born coincide roughly with our prior expectations.[22] Furthermore, it appears that some nationalities are disproportionately represented relative to other foreign-born groups. Within some colonies one can appeal to ad hoc explanations of these strange changes and persistent patterns: political

loyalties, cultural antagonisms, language barriers, and religion could be cited. It is obvious that, in both wars, the Scotch-Irish are too numerous in nearly every colony, and the Germans and English relatively scarce even in those colonies in which they are thought to have predominated.

Geographical Mobility

The colonial muster rolls offer one of the broadest sources so far examined of the extent and direction of migration between colonies. Muster rolls often include both place of birth (town and province) and place of residence at the time of enlistment. Residence is reported for most of the recruits in the Revolutionary sample. For the other soldiers, including nearly all of those in the French and Indian sample, place of enlistment is treated as residence. We are thus presented with two points on the migratory paths of each individual, and an imaginary line connecting them. Three problems with the interpretation of these implied routes of migration deserve consideration.

First, we recognize many of the inherent biases in our sample that make inferences about the behavior of the population as a whole risky. The overrepresentation of the foreign born, of certain occupational classes, of low-status and probably lower-class members of society is discussed below. The biases may work in several directions with respect to the question of mobility. The preponderance of younger men (average age was between 25 and 27 in both wars) means that many had not yet wandered as far as their feet were likely to take them before they settled down--or died. On the other hand, since the militia drew what was in many respects an unrepresentative subset of the population, it might be argued that the recruits were likely to be more footloose than the typical colonist. These possibilities suggest that one should draw conclusions about the magnitude of migratory flows with some caution; they do not, however, convince us to doubt the evidence bearing on the direction of these flows.

A second limitation of the sample consists in the present lack of data from particular colonies. The French and Indian War sample, although numerically the larger, draws primarily from New York, with significant numbers available only as far away as Pennsylvania and Virginia. The sample from the Revolution includes at least a hundred men residing in each colony except Rhode Island, New Jersey, and Georgia, and scattered recruits from these as well. Whereas we can discuss the flow of migrants, no matter what their origin, into each colony represented, we have only a partial record of the eventual destinations of men born in a particular colony, especially in the earlier war.

Finally, we understand that regional boundaries may in some instances play a greater role in migration than political boundaries; in the South and the Middle Atlantic regions, these do not coincide. The more interesting divisions may have been between the coastal, piedmont, and mountain areas--geographic rather than political distinctions, and considerably more cumbersome to investigate. Shifts in population within each colony for the most part escape our scrutiny also.

Traditional accounts of inter-colonial migration trace the shift in population from the original coastal settlements inland, pushing the frontiers back, and place particular emphasis on the flow from New England southward and westward, down the Appalachian valleys. Studies of migration typically find the activity to be gradual--most people do not move very far from home. The first descriptions of inter-colonial migration in America, however, sketched a prominent role for New Englanders in the settlement of the frontiers in the mid-18th Century. Little evidence existed to aid the historian in determining exactly how far these typical pioneers pushed away from their origins.[23]

Our results provide some mild contradictions to some of these traditional views. Tables 9 and 10 categorize residents of nine colonies according to birthplace. Each resulting cell is further described, where appropriate, by two

measures, corresponding to the two possible points of view in examining this issue. The first--row (a), the proportion of all enlistees that originated in a particular colony--simply tells where residents of an area came from. The second measure--row (b)--is slightly more complicated. Its purpose is to focus on the place of birth and indicate what destinations, among those colonies surveyed, claimed men born in some colony. The column headed "Pennsylvania," for instance, distributes all men born in that colony by eventual residence. The statistic described here tells that, in the case of recruits in the Revolutionary army in the colonies we surveyed, half of those born in Pennsylvania remained in Pennsylvania, 8% moved to Maryland, 24% to Virginia, and 15% ended up in the Carolinas. These are not simple percentages, because sample sizes vary greatly between colonies, and the populations of the colonies themselves differ. For instance, the column underneath the heading "New Jersey" in Table 9 seems to suggest at first glance that by far the most New Jersey-born French and Indian War recruits went to New York. Weighting the numbers by population and sample size, however, reveals that proportionately far more New Jersey natives migrated to Pennsylvania than to New York. For more information on the weights used to derive this statistic, see "Notes to Tables 9-11"; this note also contains admonitions on the limitations of these numbers and suggestions for their interpretation.

These warnings aside, what do these data inform us about patterns of intercolonial migration? A glance at Tables 9 and 10 reveals nothing startling; they tend rather to reinforce the traditional accounts of the direction of flow. Certain conclusions stand out, however. First, no great shift in direction of flows occurred between the two wars (magnitudes are not comparable). The observed patterns are very clearly discernible; almost all movement was southward, or in some cases westward. Such large numbers of migrants appear on the muster rolls that the colonial American population (or at least that segment of the population enlisting in the military) must have been extremely mobile.

TABLE 9

DISTRIBUTION OF RESIDENCE BY NATIVITY: NATIVE-BORN SOLDIERS

Colony of Birth

Place of Enlistment		New Eng.	N.Y.	N.J.	PA	MD	VA	CAROLINAS	TOTAL
New York		1017	2417	222	116	21	18	10	3859
	a)	.26	.63	.06	.03	.01	-	-	
	b)	.83	.98	.28	.03	-	-	.29	
Pennsylvania		6	1	22	164	6	4	0	203
	a)	.03	-	.11	.81	.03	.02	-	
	b)	.09	.01	.50	.85	.02	.01	-	
Maryland		0	0	0	0	36	3	0	39
	a)	-	-	-	-	.92	.08	-	
	b)	-	-	-	-	.89	.05	-	
Virginia		4	1	7	16	21	372	1	422
	a)	.01	-	.02	.04	.05	.88	-	
	b)	.08	.01	.22	.11	.09	.95	.71	
TOTAL		1027	2419	251	296	84	398	12	4525

a) Proportion of row total

b) Weighted proportion of column total; see "Notes to Tables 9-11"

TABLE 10

DISTRIBUTION OF RESIDENCE BY NATIVITY: NATIVE-BORN SOLDIERS

AMERICAN REVOLUTION

Colony of Birth

Place of Enlistment		New-Eng.	N.Y.	N.J.	PA	DE	MD	VA	NC	SC	TOTAL
Massachusetts		866	12	1	2	0	1	2	3	0	887
	a)	.98	.01	-	-	-	-	-	-	-	
	b)	.48	.02	.01	-	-	-	-	-	-	
Connecticut		74	2	0	0	0	0	0	0	0	76
	a)	.97	.03	-	-	-	-	-	-	-	
	b)	.41	.03	-	-	-	-	-	-	-	
New York		102	312	11	0	0	2	0	0	0	427
	a)	.24	.73	.03	-	-	-	-	-	-	
	b)	.10	.92	.16	-	-	.01	-	-	-	
Pennsylvania		3	1	22	92	2	11	0	1	0	132
	a)	.02	-	.17	.70	.01	.08	-	-	-	
	b)	-	-	.46	.48	.06	.05	-	.01	-	
Delaware		1	0	3	12	51	6	1	0	0	74
	a)	.01	-	.04	.16	.70	.08	.01	-	-	
	b)	-	-	.04	.04	.87	.02	-	-	-	
Maryland		0	0	4	17	0	154	3	0	2	180
	a)	-	-	.02	.09	-	.86	.02	-	.01	
	b)	-	-	.08	.08	-	.67	-	-	.03	
Virginia		2	2	6	25	0	18	320	0	0	373
	a)	.01	.01	.02	.07	-	.05	.86	-	-	
	b)	.01	.02	.23	.24	-	.16	.72	-	-	
North Carolina		1	0	0	3	1	2	41	102	1	151
	a)	.01	-	-	.02	.01	.01	.27	.68	.01	
	b)	-	-	-	.04	.08	.02	.13	.90	.05	
South Carolina		0	1	1	20	0	15	107	26	48	218
	a)	-	-		.09	-	.07	.49	.12	.22	
	b)	-	-	.05	.11	-	.08	.14	.10	.92	
TOTAL		1049	330	48	171	54	209	474	132	51	2518

a) Proportion of row total

b) Weighted proportion of col. total; see "Notes to Tables 9-11"

Notes to Tables 9-11

The weights above consist of each sample's size divided by the population of the colony in the appropriate year. ("Sample" refers to enlistments in an individual colony's militia.) This weight is then divided into the numbers in each row.

If N_{ij} is the number of militiamen enlisting in colony i born in colony j, then dividing the weight into this number will give

$$P_i \cdot N_{ij} / N_i = X_{ij}$$

(where N_i is the sample size and P_i is the population of the colony). If N_{ij}/N_i is an unbiased estimate of the nativity of the population, then X_{ij} would represent the number of people in all of colony i born in colony j. Of course, we have reasons to expect that N_{ij}/N_i, since it describes characteristics of a distinct subset of the population--young, male, probably not representative of the class, occupational, and ethnic structure of that population--would not be unbiased. Hence we have reversed the focus of this number by weighting all elements in column j so that they sum to one:

$$X_{ij} / \sum_i X_{ij} = Y_{ij}, \quad \sum_j Y_{ij} = 1$$

The use of P_i in this measure standardizes all elements of the column by assuming that the militias of each colony represent roughly similar proportions of the populations of those colonies.

The results are then to be interpreted as follows: The number in row (a) tells, of all militiamen born in column j who eventually ended up in one of the colonies listed along the side, what proportion went to each. Because not all colonies are sampled, yet every column sums to one, these numbers are not comparable across rows but only down columns, since they depend so heavily on the particular subset of colonies included in each sample. If the column heading is also a row heading, the cell at the intersection of the two can of course be expected to dominate the column, if more men remained in their home state than moved on. If, on the other hand, no row corresponds to a particular column, then the percentages here described express, of men born in that colony who emigrated to those places listed on the rows, the proportions who ended up in each.

This statistic is a trifle veiled, and should be handled with some skepticism lest by its very existence as a concrete number it gain undue authority. It becomes less useful the fewer the colonies listed on the rows, since likely destinations are thereby excluded.

TABLE 11

WEIGHTS FOR TABLES 9 & 10

French & Indian War (based on 1760 population)		American Revolution (based on 1780 population	
N.Y.*	.0619270,.0622514	Mass.*	.0039162,.0044523
Penn.	.0034131	Conn.	.0003870
Va.	.0024696	N.Y.	.0022513
Md.	.0004129	Penn.	.0015643,.0017018
		Del.	.0026641
		Md.	.0016865,.0020613
		Va.	.0008494
		N.C.	.0006034
		S.C.	.0014444,.0014500

*Where two weights are listed, the second was used for the tables of foreign born; in several colonies, large numbers of native born whose colony of birth was unknown had to be excluded from the calculation.

Source: U.S. Historical Statistics, Colonial Times to 1957

During the French and Indian War, geographically the more limited of the two samples, the only significant movement that shows up is southward. New Englanders reached New York; occasionally some passed through to Pennsylvania and Virginia. It is conceivable, though we would consider it unlikely, that New Yorkers could have moved back into New England, undetected in our sample; what appears here, however, implies that they were more likely to have remained within their home state, by the time they enlisted, than their neighbors the Pennsylvanians. New Jerseyites moved west into Pennsylvania, and Pennsylvanians and Marylanders moved south into Virginia. We cannot tell whether Virginians were also moving south, but we know there was no significant northward movement. Looked at from the other point of view, New York was populated by a large minority of New Englanders, Pennsylvania mostly by Pennsylvanians (excluding consideration of foreigners) and Virginia by a minority of migrants from Middle Atlantic colonies.

A more complete picture is suggested by the Revolutionary sample. The proportion enlisting in the colony of birth is still slightly over-estimated (because of the three missing colonies) although this error is no doubt small. In any case, the surprising fact is how small this proportion turns out to be in several colonies. Pennsylvania, in particular, kept a hold on only half the colonial militiamen born within its borders. In contrast, 92% of those born in New York remained to enlist there.

Some of the differences in mobility between colonies can be explained by the direction of migration. The muster rolls clearly indicate that the man who travelled north was a rare individual, with the exception of the few Marylanders landing in Pennsylvania. (This is indicated in the matrix presented in Table 10 by the many empty cells lying above the diagonal.) New Englanders moved to New York. A few New Yorkers reversed this flow, but interestingly none showed up in Pennsylvania; mostly, they didn't leave the colony. New Jersey natives again moved south and west. Pennsylvania natives, not only the most mobile, appeared the farthest from home of any sizable group in the sample. Delaware natives were exceptional in the region in their attachment to the home colony. As we proceed south, the proportions not migrating from the colony of their birth increase. This is expected, given that this is the region gaining native-born migrants, and at the "end of the line" along the migratory route.

Certainly there is little justification for projecting the numbers of migrating militiamen onto the total colonial population. However, beyond the surprisingly high rates of migration that they imply, they indicate interesting regional variations. The colonies lying between Pennsylvania and Virginia seem separated from those to the north, although they mixed populations thoroughly with those to the south. (The exception to this is the isolation of Delaware.) Although New England appeared to be losing population into New York, natives of these

colonies did not play the role often attributed to them in tales of colonial settlement. It was rather the natives of the mid-Atlantic region who opened the South. Further investigation might probe migration within colonies--at least for New York and Pennsylvania--for clues to the greatly different propensities to emigrate that these colonies engendered in their populations. The suggestion that New Yorkers directed their settlement into upstate areas seems dubious in this period of hostilities that inhibited expansion of the northwest frontier. Our regression results, which calculate a greater average height for New Yorkers than for Pennsylvanians (almost as tall, in fact, as southerners) suggests that the economic differentials that might have attracted New Yorkers to make the move did not exist. One further possibility is that the greater flow of new immigrants from abroad into Pennsylvania pushed more residents of that state to seek open areas to the south.

A breakdown of migrants into age groups allows us to search for a typical age of migration. Although militiamen were predominantly young, we have a number of observations of men in their early fifties, making it possible for us to correlate age and mobility. The results indicate that most of those who would eventually leave their home colonies did so by the age of 20. A simple average shows that about a third of the total native born became migrants; about a fifth of the 15-to-17-year-olds and a quarter of the 18 and 19-year-olds had already moved; by the 25-30 age group, the proportion of migrants exceeds that of the average, indicating that almost all the migrating took place before the age of 25. This holds for both wars, although French and Indian migrants seem to have waited one or two years longer than their Revolutionary counterparts before moving.

When foreigners are sorted similarly, their proportion remains constant beginning with the 25-30 age group. Although accounting for half the enlistees in the earlier war, they comprise only a third of the youngest age group

but 70% of the oldest. (The pattern is the same but the percentages lower for the Revolution.) If immigrants were arriving beyond the age of 30, they apparently were not enlisting. Another possibility is that higher mortality rates among the foreign born, compared to the natives, disguised further immigration.

One interesting fact that emerges from the age-mobility correlation is that those emigrants that proceeded in the typical direction (west and south) were in general younger than the few going against the predominate flow. This latter group also differed from the mainstream in that they were more likely to be sailors and not at all likely to be farmers.

In Table 12, we report the occupational structure of the recruits from each colony. As is immediately evident, there is a substantial increase in the socio-economic status of the enlisted men between the two wars. In the aggregate, 14.9% and 24.7% of the Revolutionary soldiers, native born and foreign born respectively, were laborers, as opposed to 43.6% and 40.2% of these groups during the earlier period. Although these percentages vary somewhat over colonies, and thus the precise figures are sensitive to the geographical balance, the evidence does not appear to sustain the view of a Revolutionary army dominated by lower class individuals. Considering that laborers constituted a significant proportion of the agricultural labor force, that many artisans farmed part-time, and that the data refer to the bottom ranks of the military, the number of laborers seems small.

It should not be surprising that the foreign born were less likely than the native born to be farmers and more likely to be artisans and laborers. Even after adjusting for urban residence, their occupational status is lower. They appear to have had difficulty in immediately acquiring land, because they were disproportionately represented among the urban residents, and this foreign-born urban population was somewhat younger than the foreigners in rural areas. Of the four nationalities represented in large numbers (Irish, English, Germans, and Scots) only Scots show a significant number of farmers among their

Table 12*

THE DISTRIBUTION OF SOLDIERS BY OCCUPATIONAL CLASS

AMERICAN REVOLUTION

	Artisans	Farmers	Laborers	Professionals	Seamen	Unknown Occupation	TOTAL
New England							
Native Born	259	529	198	3	44	166	1199
	25.1%	51.2%	19.2%	0.3%	4.3%		
Foreign Born	43	20	23	-	12	71	169
	43.9%	20.4%	23.5%	-	12.2%		
Middle Atlantic							
Native Born	261	236	96	-	5	442	1040
	43.6%	39.5%	16.1%	-	0.8%		
Foreign Born	218	60	119	5	6	303	711
	53.4%	14.7%	29.2%	1.2%	1.5%		
South							
Native Born	101	270	6	-	4	366	747
	26.5%	70.9%	1.6%	-	1.0%		
Foreign Born	34	31	-	-	4	64	133
	49.3%	44.9%	-	-	5.8%		
TOTAL							
Native Born	621	1035	300	3	53	974	2986
	30.1%	51.4%	14.9%	0.1%	2.6%		
Foreign Born	295	111	142	5	22	438	1013
	51.3%	19.3%	24.7%	0.9%	3.8%		

* The percentage terms indicate the percentage of those recruits whose occupations are known, within a row category, who belong to a particular occupational class. Some of the recruits whose places of birth are unreported are included among the native born.

Table 12a

THE DISTRIBUTION OF SOLDIERS BY
OCCUPATIONAL CLASS

FRENCH AND INDIAN WAR

	Artisans	Farmers	Laborers	Professionals	Seamen	Unknown Occupation	TOTAL
New York, Pennsylvania							
Native Born	1567 40.4%	462 11.4%	1927 47.7%	3 0.1%	83 2.1%	204	4246
Foreign Born	1507 41.3%	124 3.4%	1601 43.9%	32 0.9%	384 10.5%	206	3854
Maryland, North Carolina, Virginia							
Native Born	153 36.6%	241 57.8%	16 3.8%	5 1.2%	3 0.7%	47	465
Foreign Born	193 46.1%	146 34.8%	35 8.4%	8 1.9%	37 8.8%	26	445
TOTAL							
Native Born	1720 38.6%	703 15.8%	1943 43.6%	8 0.2%	86 1.9%	251	4711
Foreign Born	1700 41.8%	270 6.6%	1636 40.2%	40 1.0%	421 10.4%	232	4299

ranks (just under a fifth, in both wars). Artisans and laborers account for about 80% of the total in each of the other three groups, split evenly between the two classes in the aggregate; the English were found more heavily among the artisans and the Irish and Germans among the laborers. A wide variety of European countries is found in the list of the remaining countries that contributed to the colonial militias, although the four mentioned above accounted for over 90% of the foreign born enlistees. Many of the other 10% hailed from either Mediterranean or Scandinavian countries, and of these roughly two-thirds of each group were seamen and the remaining third laborers. This implies that for residents of countries other than those in which a history of immigration to America had established a network of information and ensured a continual stream, the most common way to end up in the New World was to be exposed through travel.

Of the native born, laborers and seamen were more likely to have left their colony of birth, whereas farmers and artisans tended to remain. In Virginia, for instance, 81% of artisans and 87% of farmers enlisting in that colony were born there, compared to only 38% of the laborers. One possible interpretation of this is also that, whatever the original occupation, migrants became laborers in their new homes.

An intriguing picture emerges from the simple sorting of enlistees into rural and urban categories. If the patterns observed in the militias held among the population at large, the cities maintained large congregations of foreign immigrants, while losing much of the population born in the city to the countryside. 30% of the foreign born during the first war and 24% in the later war listed a city (with population of 3,000 or more) as residence. In contrast, only 9% and 3% of the native born in the respective wars were city-dwellers. Among the latter, about two-thirds of those born in American cities moved to rural areas, while only a very small fraction (7% and 2%) of the natives of rural

areas moved into cities. In both periods the number moving out of the cities exceed the number moving in from rural areas, if only slightly.

The fraction of the American population dwelling in urban areas did not increase during this era,[24] but the total population was growing. Since it is difficult to argue higher rates of natural increase in urban areas the deficit must have been filled by foreigners. One pictures the immigrants arriving in colonial ports, replacing natives who were streaming out into the countryside. Most foreign immigrants also sojourned in the cities only a short time, if at all; their children probably contributed to the out-migration of the natives.

Although the scenario suggested here is vividly demonstrated in the militia data, there is a possibility that it is spurious. The major ports of New England's coast emptied drastically during the Revolution; Boston's population fell by about 13,000 between 1770 and 1776. If militia recruits living in Boston, Newport, or Providence before the British blockade re-settled inland and then enlisted, giving their new homes as their place of residence, then both the movement out of the cities and the suppressed migration into the cities would have been an artifact of this aberrant decade. However, no such population shifts could be invoked to explain the similar pattern observed in the French and Indian War. Together, the two samples present a rather convincing story of urban-rural migration.

Migration studies typically explain direction and extent of flows by relating them to differences in per capita income. Since we lack such information and since the the first part of this paper is concerned with calculation of heights for different subset of the population, it might prove interesting to compare the findings of the two sections. Intercolonial immigration correlates rather well with differences in average heights between colonies. Those areas receiving migrants net--New York and especially the South--registered the tallest recruits. New England and the Middle Atlantic colonies, most of which were net losers of native-born population,

averaged significantly shorter. With respect to foreign immigration, this pattern disappears. The colonies receiving the lion's share of Europeans were those in the "shorter" Middle Atlantic region.

It is tempting to conclude that correlation between average heights and native mobility implies that heights are proxying for per capita income levels, and to assume that foreigners lacked enough information to choose their destinations on this basis. However, there is another possibility that may explain part of this. The Middle Atlantic region received the largest inundation of foreigners, and all foreigners averaged an inch or two shorter than native Americans. If nutritional effects carry through to a subsequent generation (as there is some evidence they may), immigrant parents may have been responsible for a generation of short children, even if diets were similar across colonies. An equally plausible alternative is that the foreign immigrants in that region produced smaller children because, due to their own lack of resources (not to a poor choice of place of settlement), they earned low incomes.

TABLE 13

URBAN-RURAL CLASSIFICATIONS OF MILITIA RECRUITS

FRENCH & INDIAN WAR

		Foreign Born	Native Born Rural	Native Born Urban	Total Reporting Nativity	Unknown Nativity
Rural		2273	3215	272	5760	177
Residence	a)	39%	56%	5%		
	b)	71%	93%	74%		
Urban		938	255	98	1291	7
Residence	a)	73%	20%	8%		
	b)	29%	7%	27%		
Total Reporting Residence		3211	3470	370	7051	
Unknown Residence		1067	657	50		

a) Percentage of row total, excluding "Unknown"

b) Percentage of column total, excluding "Unknown"

TABLE 14

URBAN-RURAL CLASSIFICATIONS OF MILITIA RECRUITS

		Foreign Born	Native Born Rural	Native Born Urban	Total Reporting Nativity	Unknown Nativity
Rural Residence		365	2130	56	2551	157
	a)	14%	84%	2%		
	b)	76%	97%	63%		
Urban Residence		114	52	32	198	13
	a)	58%	26%	1%		
	b)	24%	2%	36%		
Total Reporting Residence		479	2182	88	2749	
Unknown Residence		534	543	15		

a) Percentage of row total, excluding "Unknown"

b) Percentage of column total, excluding "Unknown"

Conclusions

It should be evident that the muster rolls are a valuable source of evidence for the study of colonial America. The information they contain can be employed to investigate a variety of issues beyond the obvious questions related to the composition of the military. There may be some problems concerning the representativeness of those serving in the military, or of our sample, but they are not so severe as to render the information unusable. They can be handled effectively by utilizing prior knowledge and careful consideration of which variables might be affected by the potential biases.

There is now a substantial physiological literature, encompassing both the descriptive and experimental schools, that implies that height-by-age data can provide a rather accurate index of the "average nutritional status" of populations. If such inferences are valid, the pattern or systematic variation in height across places of birth and residence has potentially exciting implications. The issue of what these apparent differences in nutritional status reveal about relative income levels is especially intriguing. At the stage of economic development which characterized colonial America, one might expect that the consumption of food would be a good indicator of the standard of living. However, even if one disregards the possibility of dissimilar tastes, different conditions of food supply, reflected in relative prices, might provide an alternative explanation.

If one was simply comparing the heights of two populations at a single point in time, one might argue that a difference in terminal heights, and the implied disparity in nutrition, had little to do with relative income levels. In the case of the North and the South, for example, the obvious differences between the agricultural sectors of the region, such as in crop mix or seasonal patterns, might generate some discrepancies in nutrition apart from income.

In addition, there are other factors which could influence the demand for food in specific areas and thus affect the nutritional status of the populations involved. One of many candidates for such an agent is climate; in the South, warmer temperatures may have encouraged greater consumption of meat or protein. Another possibility is that amidst the virulent disease pool of the South, individuals with a taste for highly nourishing diets would have lower mortality, biasing the mean terminal height upward as an estimate of the general population's level of nutrition, and, if such tastes were conveyed to the next generation, natural selection would promote the evolution of a new set of preferences toward food.

Fortunately, we have information on the heights of the northern and southern populations over time. Not only are the mean heights of the regions changing, but they are changing at different rates. Although interpretations that emphasize differences in tastes or relative prices might predict a wedge between the heights of the regions, this class of arguments does not seem to adequately account for significant increases in height, over a short period, within one area. Similarly, they don't seem to offer a plausible alternative to at least part of the substantial discrepancy between northern and southern rates of increase of final height being attributable to change in relative income levels. This conclusion is bolstered by the observation that there were no significant changes in the relative prices of relevant commodities during the inter-war period.

In our view, the growth in American final heights between the wars is well established, and has implications for the controversy on the extent of colonial economic growth. That the southern rate of increase was so much greater than that of the North, and was impressive by any standard, suggests

that this region may have been prospering during this period. That the northern rate, including all areas, was small and positive, perhaps a bit smaller than that of Britain, provides some support to those who perceive economic stagnation in New England during these years. Urban populations seem to be doing worse than any other segment of the society. This latter finding might conceivably be a product of changes in the patterns of migration. A final possibility is that the stature of the Revolutionary recruits (those near age 25) in the sample may have picked up some of the effects of the economic hardship which accompanied the early stages of the War, and was felt most severely in northern urban areas.

The levels of nutrition in the two regions have substantial implications for the study of mortality during this era. The eighteenth and early nineteenth centuries were characterized by the narrowing of sharp interregional differences in mortality rates between New England and the South.[25] Crude mortality rates in Massachusetts appear to have persisted in the 15 to 25 per thousand range throughout this period, while the rates for whites in the South declined from roughly 50 per thousand to the vicinity of 25 per thousand.[26] The higher mean terminal heights in the South would tend to dispel the notion that the higher southern mortality rates were linked to lower levels of nutrition in that area. The data raise the possibility that improvements in nutrition between the wars may have worked to close the gap between the regional death rates by counteracting some of the factors which contributed to producing higher mortality in the South (disease pool, climate, etc.). One might also consider the significance of the evidently high level of nutrition in the colonies as a whole. Together with the regional patterns discussed above, this piece of evidence would seem to support the hypothesis that other factors besides nutrition were important in accounting for the dramatic

decline of national mortality rates during the nineteenth century. However, the apparently superior levels of nutrition may provide a partial explanation of the high fertility rates and low mortality rates, relative to Europe, which characterized the early U.S. demographic experience.

Footnotes

1. Fred Anderson is currently engaged in studying the Massachusetts muster rolls from the French and Indian War period. He has generously shared his findings on patterns of migration with us, and they appear to be similar to the results from our sample. A. T. Steegman, a biological anthropologist, is also utilizing the colonial and revolutionary muster rolls to study height-by-age profiles.

2. The only quantitative estimate that we have located is contained in Adam Seybert, Statistical Annals, Philadelphia, 1816, p. 631.

3. There have been several attempts at estimating the size of the American army during the War, but their range is wide and none of them is without problems. In 1790, Henry Knox, the Secretary of War, reported that there had been 396,000 total enlistments in the Continental Army and state militias during the War. This figure is recognized as grossly overinflated as a measure of the number of individuals involved because of multiple enlistments and the practice of meeting recruitment quotas by entering imaginary citizens on the rolls. The 184,000 - 250,000 estimate compiled by the Department of Defense, and cited by Historical Statistics, was intended to apply to the number of different individuals who served in the "army, navy, and marine corps." Assuming that the state militias are included in this estimate, the inclusion of naval and marine forces may make the Department of Defense numbers inappropriate for our purpose of determining the number in the militia or Continental Army. Two scholars, Howard Peckham and Don Higginbotham, have studied this question in some depth, and characterize the Department of Defense figures as too high. Since the methods by which the estimate was calculated are not shown, their criticisms are based on inferences about what the total enlistment of individuals could reasonably have been, given the size of the population. Both Peckham and Higginbotham (see Chapter 15 of Higginbotham, The War of American Independence, (New York, 1971), and Peckham, The War for Independence, (Chicago, 1958), p. 200.

acknowledge the lack of reliable information about the American colonial population. They begin their treatments with the 1790 census figure of 3,000,000 and the British American Department estimate of 2,500,000. Peckham notes the adjustments and deductions that are implied by the age distribution, the numbers of blacks and women, loyalists, etc., and concludes that only about 100,000 different individuals served in any of the militias or the Continental Army. He supports this claim with the argument that there were never more than 30,000 in arms at any one time. Higginbotham seems to offer a qualified endorsement to Peckham's estimate, but also indicates that the true number could conceivably range as high as 250,000.

The lack of information about the Department of Defense estimate is unsettling, but the 100,000 figure of Peckham's might seem low. A conservative accounting of the Massachusetts Soldiers and Sailors of the Revolutionary War, (Boston, 1896-1908) volumes would indicate somewhere between 100,000 and 140,000 individuals in Massachusetts alone with many recruits being drawn from Maine and New Hampshire. It is unlikely that adjustment for the number of sailors, as well as other upward biases in counting, could reduce the total figure significantly below 90,000. A 90,000 figure would seem quite plausible as estimates of the Massachusetts population during the Revolution are in the 290,000 - 307,000 range, with the inclusion of Maine increasing the total by 50,000. In an essay appearing in Legacies of the American Revolution, edited by Larry R. Gerlach et al., John Shy cites an unpublished estimate by Theodore J. Crackel as the best estimate he is aware of. Crackel produced a figure, calculated with conservative assumptions, of 185,000 individuals who served for at least six months in the American forces.

4. Herman Freudenberger and Gaylord Cummins, "Health, Work, and Leisure Before the Industrial Revolution," Explorations In Economic History, 13 (January, 1976), p. 1-12.

5. Thomas McKeown, R.G. Brown and R.G. Record, "An Interpretation of the Modern Rise of Population In Europe," Population Studies, 26 (November, 1972), p. 345-382. P.E. Razzell,"An Interpretation of the Modern Rise of Population In Europe - A Critique," Population Studies, 28 (March, 1974), p. 5-17. Robert Higgs,"Mortality In Rural America, 1870-1920: Estimates and Conjectures," Explorations In Economic History, 10 (Winter, 1973), p. 177-195. Andrew Appleby, "Nutrition and Disease: The Case of London, 1550-1750," Journal of Interdisciplinary History, 8 (Summer, 1975), p. 1-22.

6. The study of human growth, utilizing height-by-age data, can be traced back to the early nineteenth century. Many of the scholars of this period linked differences in height-by-age profiles to socio-economic factors. See, for example, A. Quetelet, Sur l'homme et le developpement de ses facultes, ou: Essai de physique social; Paris, 1835. M. Dunant, De la taille moyenne des habitants du canton de Geneve; Geneve, 1867.

7. Phyllis Eveleth and James Tanner, Worldwide Variation In Human Growth; London, 1976. James Tanner,"Growth at Adolescence," Blackwell Scientific Publications; Oxford, 1962. James Tanner, Fetus Into Man: Physical Growth From Conception To Maturity; Cambridge, MA, 1978. J.G. Fleagle, K.W. Samonds, and D.M. Hegsted,"Physical Growth of Cebus Monkeys, cebus albifrons, During Protein and Calorie Malnutrition," American Journal of Clinical Nutrition, 28 (1975), p. 246-253. M.F. Elias and F.W. Samonds,"Protein and Calorie Malnutrition In Infant Cebus Monkeys: Growth and Behavioral Development During Deprivation and Rehabilitation", American Journal of Clinical Nutrition, 30 (1977), p. 355-366.

8. There are several well documented cases of rather continuous secular increases in final heights. See J.C. Van Wieringen,"Secular Growth Changes," Human Growth, vol. 1, eds. F. Falkner and J.M. Tanner; New York, 1978. However, there is some evidence that the long-term record of change in U.S. heights

manifests cycles of substantial duration. See Robert W. Fogel et. al.,"The Economic and Demographic Significance of Secular Changes In Human Stature: The U.S. 1750-1960," Unpublished manuscript, 1979.

9. There are some differences between ethnic groups in height-by-age profiles, but the relative importance of genetic and environmental factors remains in dispute. Although the differences, between well-fed blacks and whites, in the tempo of growth are substantial, the two groups have essentially the same mean final height. Although Orientals seem to have lower final heights than Africans or Europeans, the difference has diminished in recent years. See Eveleth and Tanner, Worldwide Variations In Human Growth.

10. F.S. Hulse,"The Breakdown of Isolates and Hybrid Vigor Among the Italian Swiss," Proceedings of Twelfth International Congress of Genetics, 2 (1977), Tokyo: Science Council of Japan.

11. There are two different sources of height-by-age data for northern Civil War recruits that we have consulted. Both imply, or have already calculated, a mean terminal height of 68.2 inches. See J.H. Baxter, Statistics, Medical and Anthropological, of the Provost Marshal General's Bureau..., U.S. War Department, 2 vol.; Washington D.C., 1875. and B.A. Gould, Investigations In the Military and Anthropological Statistics of American Soldiers; Cambridge, MA, 1869.

12. The World War II mean terminal height was computed as 68.2 inches in Fogel et. al.,"The Economic and Demographic Significance of Secular Changes In Human Stature".

13. From the theory of genetics, one would expect terminal height to be normally distributed within a population, the members of which had experienced the same environmental conditions. Quetelet, Tanner, and Van Wieringen, among many scholars, have noted the empirical regularity of distributions of terminal height being approximately normal. See James Tanner,"Boas's Contributions to Knowledge of Human Growth and Form," American Anthropologist, 1, no. 5, Part II, 1959.

14. For a discussion of the possible biases, and several methods of

dealing with them, see the Statistical Appendix in Fogel et. al. In the method we utilized, the loglinear three-moment estimator, the bias in the sample mean is estimated from the sample mean, the standard deviation, and the coefficient of skewness.

15. "Professor Gwatkin...On the Manners of the Virginians, c. 1770," William and Mary Quarterly, 10 (1953), p. 84. James Henretta also cites this quotation, but argues that the relative scarcity of livestock increased over the course of the 18th Century. He further implies that this scarcity was most severe in New England. Although it is a reasonable hypothesis, the evidence he offers in support of the former contention is highly sensitive to the selection of the base year. See his The Evolution of American Society, 1700-1815; Lexington, MA, 1973, p. 20.

16. A potential bias of serious magnitude is the possibility that the recruits, or some subset of them, were measured with their shoes on. Although there is no evidence that any measurements were made in this manner, the problem is, nevertheless, deserving of attention. Unfortunately, while military manuals with instructions that measurements should be taken with shoes off have been discovered for later periods, none has been located for the French and Indian or the Revolutionary War. Although evidence of this nature would be reassuring, an examination of the data leads to a discounting of the seriousness of the problem. Comparisons of the heights of foreign-born and black soldiers in our sample to those reported in other sources available for these groups, suggest that the muster roll measurements are extremely unlikely to have been made with the shoes on. Inferences can also be made from the heights of recruits who migrated across colonial borders. Only in South Carolina were such individuals, after allowing for the greater stature of migrants in general, significantly taller than their counterparts who had remained in the home colony. In this case, there is a considerable amount of impressionistic material describing the superior diet of the citizens of South Carolina; thus, the discrepancy in

heights can be explained without resorting to shoes. As South Carolinians were only marginally taller than New Yorkers and North Carolinians, and shorter than Virginians, the proposition that the former group was unique in being measured with shoes on is not persuasive.

17. Lionel Chalmers, An Account of the Weather and Diseases of South Carolina; London, 1776, p. 37.

18. Our understanding of the geographical pattern of wealth holdings is based on the work of Alice Hanson Jones. For a summary of these findings, see U.S. Bureau of the Census, Historical Statistics of the U.S., Colonial Times To 1970; Washington D.C., 1978, Series Z 169-191. The work of Terry L. Anderson on the apparent economic stagnation of New England during this period offers additional support to such a view. See his article, "Economic Growth In Colonial New England: 'Statistical Renaissance'," Journal of Economic History, 39 (March, 1979), p. 243.

19. Benjamin Gould, The Military and Anthropological Statistics of American Soldiers.

20. The rate of increase of British final heights, during the period 1760-1779, has been estimated as 0.8 inches per generation. See Fogel et. al..

21. The difference in average year of enlistment between the two samples is 19 years. We are thus comparing members of the same age group two decades apart.

22. We originally drew together as much information as we could find in standard, secondary sources on the ethnic composition of the colonial American population, and derived some estimates of the probably magnitudes of the different populations. These are available in an appendix to this paper.

23. Early works on inter-colonial migration include Stella Sutherland, Population Distribution in Colonial America; New York, 1936; and Lois Mathews, The Expansion of New England; Boston, 1909, Both espouse this standard view. More recent work, especially by historical geographers such as Robert Mitchell, tend to examine quite limited geographical areas, or particular subsets of the

population. See for example, "The Shenandoah Valley Frontier," Annals of the Association of American Geographers, 62 (Sept., 1972), p. 461-486, and "The Presbyterian Church As an Indicator of Westward Expansion In 18th-Century America," The Professional Geographer, 18 (Sept., 1966), p. 293-299.

24. See W. Rossiter, U.S. Bureau of the Census, A Century of Population Growth; Washington D.C., 1909; and Herman R. Friis, "A Series of Population Maps of the Colonies and the United States, 1625-1790," Geographical Review, 30 (July, 1940), p. 463-470.

25. Maris Vinovskis, "Mortality Rates and Trends In Massachusetts Before 1860," Journal of Economic History, 32 (March, 1972), p. 184-213.

26. Robert Fogel et. al., "The Economics of Mortality In North America, 1650-1910: A Description of a Research Project," Historical Methods, 11 (Spring, 1978), p. 75-108.