The Heights of American Slaves

New Evidence on Slave Nutrition and Health

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In recent years the nutritional adequacy of the slave diet has received increasing attention from historians. Scholars have analyzed a wide array of sources such as the manuscript censuses of agriculture and population, the ex-slave narratives, diaries, plantation account books, and agricultural and medical journals to shed new light on the quantities, varieties, and nutritional content of foods consumed by slaves (Fogel and Engerman, 1974; Owens, 1976; Sutch, 1975; Kiple and Kiple, 1977; Savitt, 1978; Crawford, 1980; Kahn, 1983). While these studies have yielded considerable information on the average quality of the slave diet in the American South or for slaves in particular localities, relatively little systematic evidence has been available to date on how the level of nutrition varied among different groups in the slave population, and over time.

In this article we examine several bodies of data containing information on the heights of slaves as well as on other personal

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characteristics. As discussed in the introduction to this issue, the work of physiologists has shown that effective indices of the average nutritional status of a population can be constructed from data on height by age. The three data sources are coastwise manifests that provide information on slave height by age for each sex, the muster rolls of the U.S. Colored Troops (1862-1865), and a unique body of slave appraisal records (the latter two drawn from Civil War records) that contain data on height by age for males. Regression analysis is used to examine the variation in adult heights across different groups in the slave population, and over time.

In addition to the data on slaves, we also examine two bodies of data providing information on heights for free blacks: the registers of free Negroes for Fairfax County and for Loudoun County in Virginia. Although the Virginia data are not as rich as the slave data, they do allow at least a tentative comparison of the average nutritional status of the two groups.

SLAVE MANIFEST DATA

Slave height by age data were collected in accordance with the Bill for the Abolition of the Slave Trade (Wesley, 1942). In an effort to prevent slave smuggling after 1807, the bill provided for the identification of slaves involved in the coastwise trade. Duplicate manifests that identified each slave by name, age, sex, height, and skin color were prepared prior to departure. A large number of these manifests are lodged with the National Archives in Record Group 36.

The manifests analyzed in this article include a sample drawn by Marilyn Coopersmith plus the entire collection of manifests lodged with the port of Savannah.[1] The data base contains 10,562 manifests and records of 50,641 slaves. The manifests were prepared between 1811 and 1861 and represent shipments to and from most Atlantic and Gulf ports. The major ports represented in the sample include Baltimore, Norfolk, Richmond, Charleston, Savannah, Jacksonville, Mobile, and New Orleans.

Table 1 Mean, Standard Deviation, Sample Size, and Velocity of Height for Males and Females

	Males				Females			
Age	Mean	Std. dev.	N	Velocity	Mean	Std. dev.	N	Velocity
8	45.12	5.09	280		45.49	5.41	338	
9	47.63	5.11	266	2.51	47.07	4.99	306	1.57
10	49.27	5.78	557	1.64	49.05	5.69	528	1.98
11	51.93	4.72	347	2.66	51.32	4.93	443	2.26
12	53.23	4.96	751	1.30	53.09	4.71	736	1.77
13	55.54	4.77	470	2.31	55.92	4.70	556	2.84
14	57.72	4.49	732	2.18	58.26	4.09	765	2.33
15	60.22	3.90	571	2.50	59.99	3.39	812	1.73
16	62.25	3.68	709	2.03	61.21	3.06	1113	1.22
17	64.26	3.14	655	2.01	61.97	2.82	870	0.76
18	65.23	3.04	1142	0.97	62.21	3.09	1268	0.24
19	66.01	3.18	900	0.78	62.44	3.15	594	0.23
20	66.35	3.00	1527	0.34	62.38	3.04	1264	-0.06
21	67.11	2.91	944	0.76	62.51	3.07	337	0.13
22	67.00	3.00	1374	-0.11	62.58	2.95	664	0.07
23	67.16	2.99	795	0.16	62.50	3.37	404	-0.08
24	66.90	2.94	872	-0.26	62.73	3.05	442	0.23
25-29	67.01	3.02	3610	0.11	62.75	3.06	2100	0.02
30-39	67.29	3.09	3467	0.28	63.02	3.01	2889	0.27
40-49	67.19	3.10	1647	-0.10	62.90	3.16	1756	-0.12
50+	66.89	3.39	901	-0.31	62.57	3.28	1130	-0.33

SOURCE: Slave manifests.

Table 1 shows the average height at each age and age velocity (the change in height between successive ages) of male and female slaves in the sample. Since age represents age as of last birthday, the average age recorded as age n is approximately n + ½. Thus velocity is centered at n. These cross-sectional profiles are similar to those reported in growth studies of modern populations experiencing moderate levels of malnutrition compared to modern

Western European nutritional standards (Eveleth and Tanner, 1976; Tanner et al., 1966; Tanner, this issue). Prior to the adolescent growth spurt, male and female heights are equal. Velocity reaches a prespurt minimum around age 12. The peak of the adolescent growth spurt occurs between 14.5 and 15.5 in males and 12.5 and 13.5 in females. Point estimates of the model age at peak velocity are 14.9 for males and 13.2 for females. Menarche occurs approximately one year after the peak of the female growth spurt (see the discussion and references in Trussell and Steckel, 1978; Steckel, 1979b). Therefore, the average age at menarche was probably no more than 14.5 among U.S. slaves.

Using the 98% criterion (see the editors' introduction), point estimates of the age at which adult height was reached are 19.2 years for males and 16.9 years for females. Mean adult height was 67.1 inches for males (aged 23-49) with a standard deviation of 3.0 inches and 62.8 inches for females (aged 23-49) with a standard deviation of 3.1 inches.[2]

These findings indicate that U.S. slaves reached adult height at a surprisingly early age compared with contemporary European populations, although at a later age than northern native-born whites (Tanner, 1962: 148-149; Baxter, 1875: 19). On average, adult male slaves were slightly more than an inch shorter than northern whites, but appear to have been two to three inches taller than British or Western European adult males in the nineteenth century. Modern studies (Eveleth and Tanner, 1976, Appendix Tables 5, 29, and 44) show that well-fed Americans of African origin reach approximately the same height as Europeans and Americans of European descent, suggesting that variations in genetic potential play a minor role in the above comparisons. In addition, the average age at menarche for female slaves appears to have been at least 2 to 2.5 years earlier than for European women in the nineteenth century (Tanner, 1962: 153).

Regression analysis can be used to explore the correlates of slave height. To facilitate comparisons with the military data, we focus on the heights of adult males, ages 23-49. The available independent variables are manifest size, complexion, port of origin, and date of birth.

The results of the regression are given in Table 2. Slaves appearing on very large manifests (greater than 60 slaves) were

Table 2 Regression of Adult Height for Male Slaves: Manifest Sample[a]

Variable	Coefficient	T-Statistic
Constant	66.95	310.70
Light	0.17	2.24
Manifest Size:		
6-19 slaves	0.11	1.34
20-39 slaves	-0.04	-0.37
40-59 slaves	0.06	0.51
60+ slaves	0.35	3.19
Port of Origin:		
Charleston	-0.40	-2.43
Jacksonville	-0.24	-1.00
Mobile	0.46	2.37
New Orleans	-0.17	-0.77
Norfolk	-0.61	-2.74
Richmond	-0.35	-1.40
Savannah	-0.22	-1.34
Other	0.13	0.74
Born 1790-1800	-0.17	-1.00
Born 1800-1810	0.11	0.70
Born 1810-1820	0.40	2.66
Born 1820-1830	0.38	2.52
Born 1830-1840	0.80	4.48
N	9726	
$\bar{R}^2$	0.01	

a. The intercept refers to a dark-skinned male slave, appearing on a small manifest (fewer than 6 slaves), originating in Baltimore, and born before 1970.
SOURCE: Slave manifests.

taller (0.35 inches) than other slaves. Very large manifests were probably composed mostly of fieldhands while smaller manifests reflected masters traveling with their personal servants. The Civil War data show that servants were relatively short, which would imply a positive association between manifest size and height.

The theory of heterosis (Tanner, 1962: 150-151) suggests that skin color might be related to height. The results show that a light skin was associated with a small (0.16 inches) but statistically significant height advantage. However, it should be noted that preferential treatment may also explain this result.

Adult heights were systematically related to some ports of origin. Relative to slaves shipped from Baltimore, slaves originating in Mobile were significantly taller, while those originating in Norfolk or Charleston were significantly shorter. Caution should be exercised in interpreting the port of origin coefficients since they may reflect differences in environmental conditions, genetic potential, or regional height preferences. Slaves exported from a particular port probably grew up in the surrounding coastal region and the port variables may therefore reflect regional features of diet, disease, or work routine. Since the data do not distinguish between native-born and African-born slaves (except inferentially by date of birth) and African-born slaves were shorter than creole or native-born slaves and there were trivial differences in the heights of Africans, the port of origin variables may also reflect the tribal pattern of imports over time into the region surrounding the port. We use the information on place of birth in the muster rolls to further explore the regional variation in slave height.

Differences in adult height by birth cohort were investigated by a series of dummy variables indicating decade of birth. The coefficients indicate that male slaves born between 1790 and 1800 were slightly shorter as adults than slaves born before 1790, and that slaves born between 1810 and 1830 were significantly taller as adults.[3] The coefficients imply that adult heights increased by 0.4-0.7 inches per generation for post-1810 cohorts, similar to the growth rate observed by Sokoloff and Villaflor (this volume) for colonial Americans between the French and Indian War and the Revolution. Unfortunately, the sample of adult males is not large enough to permit the estimation of a separate set of birth cohort dummies by port of origin. Analysis of the residuals from the regressions together with standard statistical tests suggests, however, that at the present time there is insufficient evidence to

reject the hypothesis that the time profile of slave height differed significantly across ports of origin.

An attempt was also made to estimate nonlinear, continuous time trends in date of birth.[4] A graph of the time profile with variables other than date of birth evaluated at the sample means is given in Figure 1. An F-test indicated that the time profile is statistically significant at the 5% level. Caution should be exercised in identifying turning points, as their precise dating is sensitive to age heaping and differences in sample size per year. Despite these problems, however, the results are similar to the dummy variable method: Adult height rose more or less continuously for cohorts born between 1790 and 1820, flattened out for cohorts of the 1820s, and rose again for slaves born in the early 1830s.[5]

BLACK RECRUITS IN THE UNION ARMY

Free blacks and ex-slaves played a major role in the northern Civil War effort as soldiers. More than 186,000 black adult males were enlisted between October of 1862 and the end of the war (Dyer, 1908: Vol. 1, 11). Part of the enlistment and mustering-out process involved maintaining personnel records for the troops. Called descriptive or muster rolls, these records were used to distribute supplies and salaries, and to identify deserters. For most regiments the following information was recorded: military rank, complexion, eye color, hair color, place of birth and place of enlistment (county and state), height, age, civilian occupation, date of enlistment, term of service, and supplementary military remarks. The rolls analyzed in this article are taken from a sample drawn by John Olson. Virtually all of the recruits were born or enlisted in the slave states; the relatively few soldiers in the sample who were born or enlisted in the North were excluded from the analysis.[6] The final data base contains 8259 recruits from eight regiments.

The distribution of the sample troops by state of birth and of enlistment, the overall distribution of black recruits enlisting in

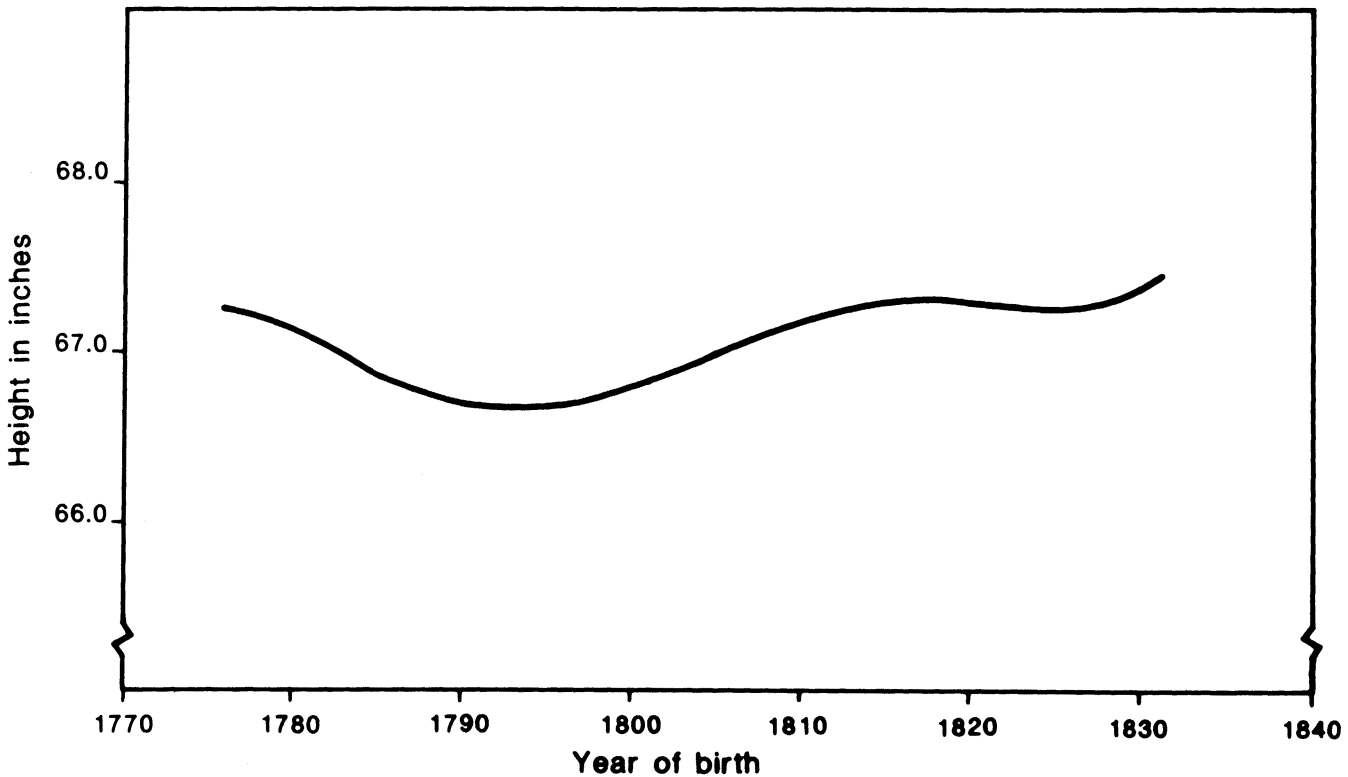

Figure 1: Time Profile of Height of Slave Men Aged 23-49

Table 3 Characteristics of the Olson Sample and All Colored Troops[a]

	Olson Sample Troops			All Colored Troops	
	% by State of Birth	% by State of Enlistment	% of Male Slave Population in 1860	% of State Black Population Enlisting in USCT	% of All Colored Troops Raised in Slave States
Alabama	8.0	2.8	11.3	4.7	3.7
Arkansas	1.8	11.3	3.1	19.4	4.1
Florida	0.1	0.1	1.6	6.8	0.8
Georgia	7.5	5.5	11.4	3.3	2.6
Kentucky	25.8	23.6	6.6	44.1	17.7
Louisiana	1.6	1.2	9.9	24.9	17.9
Maryland	0.5	0.06	2.2	21.9	6.5
Mississippi	4.4	14.6	11.2	17.7	13.3
Missouri	9.6	13.3	2.8	30.9	6.2
N. Carolina	2.8	0.08	7.8	6.4	3.8
S. Carolina	17.5	18.1	9.7	5.9	4.1
Tennessee	14.0	9.3	6.6	32.1	15.0
Texas	0.04	0.0	4.7	0.1	-
Virginia	6.4	0.04	12.3	4.5	4.3

a. Recruits with missing ages or lacking state of birth or enlistment are excluded. Figures may not add to 100 due to rounding. The data set in this table contains 7898 observations.
SOURCE: Olson sample and Metzer (1981).

the slave states, and the distribution of male slaves (aged 15-49) by state of residence in 1860, are given in Table 3. Like all military samples, recruits at younger ages are overrepresented relative to the civilian population. While displaying broad regional coverage within the South, the distribution of the sample by states of enlistment differs from the geographical distribution of the civilian slave population (reflecting the nonrandom spatial and temporal pattern of Union Army recruitment in the South) and of all slave recruits. For further discussions of the characteristics of the Olson sample, see Metzer (1981) or Margo (1983). Because

of the paucity of recruits between the ages of 13 and 17, attention here is restricted to adult heights and the age at which adult height was reached.

Using the 98% criterion, a point estimate of the age at which adult height was reached by the sample recruits is 18.5 years. Mean adult height was 67.1 inches with a standard deviation of 2.6 inches.[7] These results are consistent with the manifest data and provide further support for the finding that slaves were relatively well-fed compared to contemporary Europeans.

As with the manifest data, the correlates of adult height (ages 23-49) can be investigated using regression analysis. The available independent variables are occupation, complexion, place of birth and enlistment, and date of birth. The regression results are shown in Table 4.

The results of the regression indicate that adult height varied across occupations and skin color. Domestics and semi-skilled slaves were approximately 0.4-0.6 inches shorter than skilled slaves or fieldhands. These differences most likely reflect patterns of relative productivity associated with height. Physical strength was one criterion influencing the allocation of slaves to specific tasks, and taller (and hence stronger) slaves would have a comparative advantage in field work and in many skilled occupations (Metzer, 1975: 134). Light-colored slaves were 0.4 inches taller than their darker counterparts. This estimate of the complexion effect is larger than among male slaves in the manifest data, but the difference between the two estimates is not significantly different from zero.

Dummy variables indicating census region of birth (South Atlantic, East South Central, and West South Central) were used to investigate regional variation in slave height. An F-test revealed that the regional dummies were jointly significant at the 1% level. Recruits born in the Upper South Atlantic, Lower East South Central, and Lower West South Central regions were approximately 0.3 inches taller than those born in the Lower South Atlantic region, while recruits born in the Upper East South Central region were 0.5 inches taller; recruits born in the Upper West South Central region were approximately one inch

Table 4 Regression of Adult Height: Civil War Sample

Variable	Coefficient	T-Statistic
Constant[a]	66.53	244.19
Light Skin	0.42	2.83
Occupation:		
Domestic	-0.44	-1.78
Semi-skilled	-0.62	-1.91
Skilled	-0.08	-0.42
Migrant Across State Lines	0.14	1.35
Region of Birth:[b]		
Upper South Atlantic	0.26	1.47
Lower East South Central	0.29	1.71
Upper East South Central	0.54	4.36
Lower West South Central	0.28	0.85
Upper West South Central	1.03	5.66
Year of Birth 1820-1829	0.32	1.43
Year of Birth 1830-1839	0.18	0.85
Year of Birth 1840+	-0.06	-0.24
N=3651		
$\bar{R}^2$	0.02	

a. The intercept refers to a dark-skinned fieldhand, born in the Lower South Atlantic region before 1820, and enlisting in the same state in which he was born.
b. Upper South Atlantic: Virginia, Maryland, North Carolina; Lower East South Central: Alabama, Mississippi; Upper East South Central: Kentucky, Tennessee; Lower West South Central: Louisiana, Texas; Upper West South Central: Arkansas, Missouri (see note 8). Left out region is Lower South Atlantic: Florida, South Carolina, Georgia.

taller than those born in the Lower South Atlantic region. These results are generally consistent with the differences in adult height by port of origin in the manifest data, and, interestingly, with per capita income differences in the South (Easterlin, 1971).[8] One possible explanation for these differences is that factors affecting nutrition and growth such as food supply, disease, or intensity of work varied across regions, specifically across plantation sizes or

crop mix. We use county-level census data from 1850 and 1860 to probe more deeply into the regional differences in adult height.

Data on place of enlistment provide useful insights into the relationship between migration and slave height. The regression results show that slave migrants (slaves enlisting in states other than those in which they were born) were 0.15 inches taller than nonmigrants, similar to Sokoloff and Villaflor's finding (this issue) for native-born whites in the late eighteenth and early nineteenth century. It should be pointed out, however, that the data do not distinguish between true migration and wartime dislocation and that this may be influencing the results.

Differences in adult height by birth cohort were investigated by a series of dummy variables indicating decade of birth. An analysis of the residuals and standard statistical tests failed to detect any statistically significant regional differences in the time dummies overall, although there was some evidence that the regional differences were narrower (with the exception of the Upper South-Lower South difference) for recruits born in the mid-1830s. The apparent reduction in height for 1830s cohorts compared to 1820s cohorts is puzzling in light of our results for the manifests, which show an increase in height for 1830s cohorts. Further analysis not reported here revealed that recruits born in 1835 were unusually short: If attention is restricted to recruits born between 1830 and 1834 (the years over which the two samples coincide) both samples show an increase in height, which implies that recruits born in the late 1830s were shorter as adults.[9] That this drop in height appears to continue among cohorts of the early 1840s raises the intriguing possibility that these cohorts experienced deteriorating nutrition conditions immediately prior to the Civil War. Such an interpretation, however, should be regarded with caution, because our ability to date precisely temporal shifts in height is hampered by the presence of age heaping.

To shed additional light on the regional variation in adult height, we selected the subsample of recruits born between 1833 and 1838 for further study. These recruits were between 12 and 17 years of age in 1850, and since adult height can be sensitive to environmental conditions during the adolescent years, the con-

ditions prevailing in 1850 could have influenced adult height for these cohorts. Using the information on county birth in the muster rolls and the 1850 censuses of agriculture and population, two new explanatory variables were created for each recruit: corn production per capita in the county of birth and an urban dummy (whether the county of birth contained an incorporated place whose population exceeded 2500 in 1850). We also attempted to control for the effects of plantation size by calculating the median slave holding by size of holding in the county of birth in 1860 (this variable is explained in Gray, 1933: 530). Corn production per capita is a crude proxy for the Southern food supply, particularly since there was interregional trade in foodstuffs, but the urban dummy partially controls for this and other urban-specific effects such as higher mortality or morbidity and higher relative prices for food in urban areas. The use of median slave holdings in 1860 is obviously problematic, but this is the earliest census for which published, county-level data are available.

In Table 5 we present the results of two regressions using the 1833-1838 subsample. In the first regression, height is regressed on occupation, complexion, region of birth, migrant status, and dummies indicating year of birth. The urban dummy, median slave holding, and corn per capita (interacted with a quadratic polynomial in date of birth) are added in the second regression.[10]

The three additional variables are jointly significant at the 20% level. The signs of all the coefficients are plausible. Urban birth reduced adult height by about 0.2 inches. Variations in corn per capita had their greatest impact on recruits born between 1835 and 1836, that is, recruits who were in the neighborhood of their spurt in 1850. For these recruits, the elasticity of adult height with respect to corn per capita production (evaluated at the sample mean) was 0.01. Perhaps the most interesting finding is the negative association between height and median slave holding. Although not statistically significant, the sign is consistent with Steckel's (1979b) finding of greater mortality and morbidity on large plantations, a lower quality diet, and a greater intensification of labor that accompanied the use of the gang system.[11] Finally, note that the Upper South-Lower South difference in height is considerably reduced in the second regression, sug-

Table 5 Regressions of Adult Height: 1833-1838 Subsample[a]

Variable	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	66.80	161.33	67.05	94.89
Light Skin	0.51	1.85	0.52	1.88
Occupation:				
Domestic	-0.22	-0.41	-0.18	-0.34
Semi-Skilled	-0.42	-0.65	-0.30	-0.46
Skilled	-0.23	-0.58	-0.25	-0.63
Migrant	0.07	0.31	0.06	0.28
Region of Birth:				
Upper South Atlantic	0.52	1.34	0.33	0.80
Lower East South Central	-0.001	-0.004	-0.20	-0.53
Upper East South Central	0.61	2.45	0.11	0.28
Lower West South Central	-0.15	-1.76	-0.14	-1.47
Upper West South Central	0.93	2.66	0.47	1.05
Born in 1834	-0.24	-0.70	-0.56	-1.24
Born in 1835	-0.62	-1.91	-1.07	-1.76
Born in 1836	-0.16	-0.51	-0.61	-0.86
Born in 1837	0.35	1.55	0.22	0.32
Born in 1838	-0.05	-0.16	0.50	0.78
Corn per capita			-0.002	-0.13
Corn per capita x Data			0.007	1.11
Corn per capita x Date^2			-0.0002	-1.59
Urban			-0.19	-1.20
Median Slave Holding			-0.009	-0.86
N=913				
$\bar{R}^2$	0.04		0.05	

a. Date = (Year of Enlistment - Age - 1832); Urban = 1 if county of birth included at least one urban area (population greater than 2500) in 1860, 0 otherwise; the intercept refers to a dark-skinned field hand born in a rural county in 1833 in the lower South Atlantic region and enlisting in the same state in which he was born. [Author's correction, Data = Date.]

gesting that variations in the food supply and plantation size account for a significant fraction of this difference in adult height.

SLAVE APPRAISAL RECORDS

The final body of slave data we have examined is a unique set of appraisal records for Civil War Mississippi. These records, originally discovered by Armstead Robinson, pertain to contrabands and runaways and were collected by the Union Army after 1863. The following information is given for each individual: name, sex, age, complexion, height, weight (in pounds), and dollar value. The estimates of value appear to have been made by a bonafide slave appraiser. The data base consists of 1213 slaves; because of the very small number of observations on females and adolescents, we have focused our attention on adult males.

The mean adult height of males was 67.4 inches with a standard deviation of 2.8 inches, almost identical to the results obtained for Mississippi-born recruits in the Civil War data discussed above. By approximately 18.3 years 98% of adult height was reached, also consistent with our earlier results. Figure 2 plots mean weight for a given height, along with the regression line of mean weight on height. Depending on height, the predicted weight is between 90% and 98% of the average weight of modern American males. Despite some irregularities due to the small sample size, mean slave weight increased by approximately 3.2 pounds per inch of height.

A regression of adult height on skin color and date of birth was statistically insignificant, possibly because the sample size was quite small. Regressions of weight and value are reported in Table 6. The coefficient of height on weight is different from that in Figure 2, since several other variables affecting weight are being held constant. Light-skinned slaves were slightly heavier at a given height, although the differences are not statistically significant. Weight increased with age up to about age 30.

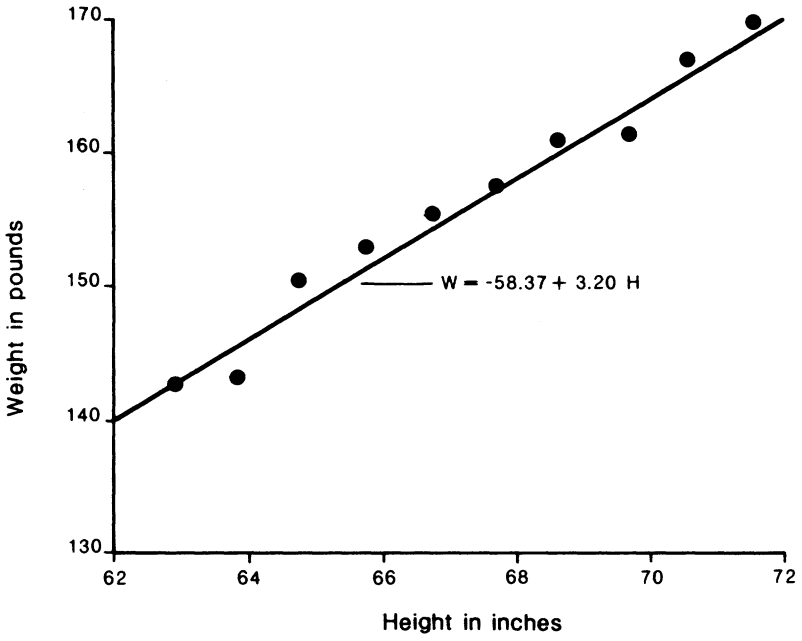

Figure 2: Mean Weight for a Given Height, Adult Males: Mississippi Appraisals

The regression on dollar value shows that taller and heavier slaves commanded significantly higher prices. For example, the increase in value (relative to the mean) associated with an increase in height from one standard deviation below to one standard deviation above the mean height, was 7.7%.[12] A local peak in the age price profile appears between ages 26 and 27, similar to Fogel and Engerman's (1974) finding based on probate records. Although light skin was associated with a slight increase in value, the difference was not statistically significant.

FREE BLACKS

Height-by-age data for free blacks in antebellum Virginia were collected in accordance with a law passed in 1793 by the Virginia

Table 6 Regression of Weight and Value for Adult Males: Mississippi Appraisals[a]

	Weight		Ln (Value)	
Variable	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	-39.45	-2.06	2.73	1.47
Light Skin	2.43	0.76	0.032	0.92
Age	0.61	0.76	0.17	2.22
Age^2	-0.01	-1.04	-0.005	-2.23
Age^3			0.000046	2.10
Height (in.)	2.79	13.82	0.053	2.16
Weight (lbs.)			0.019	1.79
Height x Weight			-0.00027	-1.73
N=523				
$\bar{R}^2$	0.27		0.20	

a. Value is measured in dollars of 1863 and weight in pounds.
SOURCE: Mississippi Appraisal Records.

state legislature (Sweig, 1977). In an effort to prevent slaves from posing as free blacks when hired out and as a general instrument of social control, the statute required every free Negro to register with the clerk of the court in the city or county of residence. The bill also provided for periodic reregistrations every three years in the counties and every year in the cities. By law, the registration specified the name, age, sex, height, complexion, and legal status (whether the individual has been emancipated or was free born) of the registrant, although coverage of this last item appears to have been very spotty. Most of the registrations are no longer extant, and only the registration books for Fairfax and Loudoun counties are available in published form.

Together these two registration books contain information on 833 different individuals over the period from 1782 to 1861. Comparisons of the registration figures with published census data suggest that the registration procedure was quite lax,

particularly at younger and older ages. However, there is no evidence that registration was correlated with stature (controlling for age) and the frequency distribution of adult heights displays no evidence of shortfall or truncation.

Unfortunately, the sample is too small to provide useful information on the adolescent growth spurt since the number of registrants under the age of 16 is very limited. Similarly, the age at which 98% of adult height was reached cannot be calculated precisely, but appears to have been between 17 and 18 years of age for males and 16 and 17 years of age for females. The average height of adult males (ages 23-49) was 67.9 inches with a standard deviation of 2.6 inches and that of adult females (ages 23-49) was 63.0 inches with a standard deviation of 2.6 inches, both of which exceed the adult heights of Virginia slaves in the manifests or Civil War samples. This suggests that at the very least, free blacks in Virginia were as well-fed as Virginia slaves.

Regressions of adult height on the available variables were not statistically significant for males and of marginal significance for females. Although light-skinned free Negroes were taller than their darker counterparts (0.4 inches for males and 0.7 inches for females), the difference was statistically significant only for females. Finally, there was weak evidence of an upward trend in male heights over time: Free blacks born in the 1830s were taller than those born in the 1820s, similar to our finding for slaves. However, this difference was not statistically significant.

CONCLUSIONS

This article has examined several bodies of data bearing on the physiological development of slaves in the antebellum United States. Slaves reached adult height at earlier ages and were taller as adults than members of many nineteenth-century European populations. The average age at menarche among slave women was no more than 14.5 years, approximately 2.5 years earlier than in Western Europe during the first half of the nineteenth century.

Mean weight at a given height for adult males approached modern-day levels.

Regression analysis was used to examine the correlates of slave height. Light-colored slaves were taller and heavier than their darker counterparts, and there were systematic differences in height across occupations and regions, migrant status, and birth cohort. Further analysis employing county-level census data revealed that the regional differences were related to variations in plantation size, crop mix, and food supply. Both height and weight were positively associated with value, consistent with the hypothesis that better-fed, healthier slaves were more productive.

The heights of antebellum free blacks in Virginia were also briefly examined. Free blacks were taller than slaves as adults and appear to have reached adult height at comparable ages. Light-skinned free blacks were taller, as were slaves, and there is some evidence that trends in adult height over time were similar for both groups.

NOTES

1. Subsets of this data base have been analyzed by Engerman (1976), Trussell and Steckel (1978), and Steckel (1979b). The Coopersmith sample was drawn from Mobile and New Orleans records and the sampling procedure emphasized large manifests. The Coopersmith sample is discussed in Steckel (1979b).

2. Beyond age 49 people begin to shrink. Since our evidence suggests that slaves reached 98% of adult height by age 19, age 23 is a conservative upper bound.

3. It should be noted that the 1830 dummy actually refers to slaves born in the first half of the decade. as virtually no slaves in the sample were born after 1835.

Since the manifests do not distinguish between African and American-born slaves, and African-born slaves were shorter than those born in America, some of the apparent decline in adult height for cohorts of the 1790s (relative to other cohorts) may be due to an increase in the proportion of Africans or sons of Africans in the sample. This is consistent with the sharp increase in imports between the end of the Revolution and the abolition of the slave trade. Similarly, some of the increase in height for subsequent cohorts may be due to a decreased proportion of Africans and their descendants following the abolition of the slave trade.

4. The exact form of the trend was a fifth-degree polynomial in date of birth. Experiments with terms of higher order had little effect on the trend. The profile differs slightly from the male profile reported in Steckel (1979b). The earlier time trend was based entirely on the Coopersmith sample (see note 1) which, unlike the current sample, contains very few observations pertaining to Charleston or Savannah. In addition, the fraction of

slaves in the Coopersmith sample born after 1830 is small and drawn chiefly from Mobile and minor ports, while in the current sample observations drawn from Charleston and Savannah predominate among the 1830s cohorts. Analysis of three-year moving averages of mean heights by year of birth for Charleston and Savannah suggests that the earlier 1830s cohorts were taller, while the reverse was true for Mobile cohorts of the 1830s. Unfortunately, the number of slaves shipped from Mobile born in the early 1830s is too small to allow us to conclude on the basis of standard statistical criterion that the time profile of slave heights differed across ports of origin (hence the conclusion reached in the text), although the matter warrants further investigation.

5. We also examined the time profile of heights for adolescent males. The time dummies follow the same overall pattern as for adult males, although there is some evidence of cycles. For example, slaves born between 1790 and 1810 were between 0.5 and 1.0 inches shorter as adolescents than slaves born prior to 1790, but were approximately the same height as adults. This suggests that catch-up growth may have played an important role among slaves in the early nineteenth century.

6. Unfortunately, the Civil War data do not allow us to distinguish between free blacks and ex-slaves at enlistment. However, it is unlikely that this problem influences our analysis significantly because the number of free blacks in the slave states eligible for military service relative to the eligible slave population was very small.

7. The estimate of mean height was calculated using the Quantile Bend method (Wachter, 1981), although it is worth noting that in this case, the adjustment is very small. This is because minimum height restrictions did not apply to volunteer organizations such as the U.S. Colored Troops. Estimation of the age at which adult height was reached is complicated by pronounced heaping at age 18. In calculating the estimate we assumed that the average heights of 17 and 19 year old recruits were unbiased, and then found the age at which 98% of adult height was reached by linearly interpolating between the two ages.

Although the mean heights are nearly identical in the manifests and the Civil War samples, the standard deviation of height is larger in the manifest data. While there is no evidence of shortfall or truncation in the manifests (and, indeed, no reason to suspect any), there is substantial heaping of heights below the mean on even inches, and at 60 inches in particular. Asymmetrical heaping of this sort can bias the standard deviation: several different methods of adjusting for the bias reduced the estimated standard deviation of height in the manifests from 3.0 to 2.8 inches, which does not differ statistically from the estimate for the muster rolls (2.6 inches). Details of the adjustment methods are available from the authors upon request.

8. The states included in each region are given in Table 4. For the purposes of this analysis, Missouri was included in the Upper West South Central region. Almost all of the manifest sample is drawn from ports located in the South Atlantic region, making regional comparisons difficult. Furthermore, slaves in the manifest sample were probably drawn disproportionately from coastal areas, while the Civil War recruits were drawn from the entire South. Nevertheless, some comparisons are possible. Slaves shipped from Mobile or New Orleans (both in the Lower East South Central region) were taller than slaves shipped from Lower South Atlantic ports. Slaves shipped from Charleston or Savannah, both in the Lower South Atlantic region, were shorter than slaves shipped from Baltimore, which is in the Upper South Atlantic region, although they were taller than slaves shipped from Virginia ports. Unfortunately, the number of recruits in the Civil War sample born in Virginia is too small to make the appropriate disaggregated comparisons. However, this discrepancy between the two samples suggests that variations in height within states, particularly between coastal and inland areas, deserves further study. For an analysis between the relation between height and per capita income see Steckel (1982).

9. Since date of birth was calculated as year of enlistment minus age, recruits enlisting in 1864 or 1865 and reporting their age as 30 years would have been assigned to the 1834-1835 birth cohorts. This assignment would be incorrect for some recruits given the age heaping in the sample. Depending on the degree of age heaping and the correlation between age heaping and height, the estimated mean heights of recruits born after 1835 could be biased upward. Unfortunately, we cannot compare the manifests and Civil War samples for post-1835 cohorts since virtually no slaves appearing in the manifests fall into that category. A related problem is that recruits born in the Lower South Atlantic region in the mid-1820s (between 1823 and 1826) were unusually tall: The mean height for these cohorts was over 2 inches greater than the mean for the decade as a whole. If these recruits are eliminated from the sample, then recruits born in the early 1830s were approximately 0.3 inches taller than recruits born in the early 1820s, which is similar in magnitude to the increase observed in the manifests.

10. The rationale behind interacting corn per capita with a quadratic polynomial in date of birth is to see if the effect of variations in the food supply depended on the age reached in 1850. Nutritional conditions are particularly influential in the neighborhood of the adolescent growth spurt which we estimated earlier as falling between 14.5 and 15.5 years for male slaves. Precise dating of the effect, however, is complicated by misreporting of age (see note 9).

11. Based on a quantitative analysis of the ex-slave narratives, Crawford (1980: 114) concluded that slaves on large (50+) plantations tended to be worse off in terms of diet than slaves on smaller holdings (fewer than 50 slaves).

The low t-statistic on median slave holding is more a reflection of multicollinearity in the sample than of lack of statistical significance, since most of the variation in plantation size was between regions (held constant in the regression). If the regional dummies are omitted, the coefficient remains negative and is statistically significant at the 10% level.

12. Assuming that the appraised values were unbiased estimates of prices that would have obtained in a competitive market, this figure can be taken as a direct estimate of the increased productivity associated with the increase in height (and weight) given in the text. The estimate exceeds the pure productivity effects associated with stature, however, since slaves engaged in some skilled jobs and as drivers were taller than those in fieldwork, and taller slaves probably had a longer life expectancy than did shorter slaves (see the article by Friedman in this issue). Both factors were associated with higher prices but could not be entered into the regression.

In any case, the estimate should be viewed with caution because the data pertain to an unusual period in American history. The optimal weight and height (in terms of maximizing value) was 196 lbs. and 70.4 inches. Curiously, Taubman (1975: 60) found that the optimal weight for modern-day American males (in terms of maximizing earnings) was 198 lbs.

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