# Socioeconomic Differences in Wartime Morbidity and Mortality of Black Union Army Soldiers

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**Abstract**

This paper investigates the patterns of socioeconomic differences in wartime morbidity and mortality of black Union Army soldiers, and compares them with white recruits. Light-skinned soldiers, former slaves who had been engaged in non-field occupations, men from large plantations, and enlistees from urban areas were less likely to contract diseases and/or to die from disease while in service than, respectively, dark-skinned soldiers, filed hands, men from small farms, and enlistees from rural areas. Patterns of disease-specific mortality and timing of death suggests that the differences in development of immunity against diseases and nutritional status prior to enlistment are responsible for the observed mortality differentials. The patterns of wartime mortality of black and white soldiers are generally similar, but the relative effects of the two factors were somewhat different by race. It appears that the health of white recruits was more strongly influenced by the disease environment they were exposed to prior to enlistment. For black soldiers, on the other hand, socioeconomic status, a proxy for nutritional status and general economic wellbeing, was a perhaps more powerful determinant of health. I suggest that the larger occupational differences in wartime mortality among blacks could reflect the differences in health and living conditions of blacks and whites prior to enlistment. The stronger health effect of prior residence in urban areas among whites could be explained by the differences in prior exposure to disease between blacks and whites.

## 1. Introduction

The major purposes of this paper are to investigate the socioeconomic differences in health and mortality of ex-slave Union Army soldiers while in service, and to understand the patterns of the disparities in health of the black population at large. In most studies on U.S. mortality differentials prior to the twentieth century, blacks are compared with whites or the population at large as a single group. Although blacks in the past, especially slaves in the antebellum South, were perhaps a more homogeneous population compared to whites in terms of socioeconomic status, there were considerable variations across slaves in economic wellbeing and ecological environment according to their occupation, skin color, and plantation type. It is possible that the health of slaves significantly differed by personal characteristics and place of residence.

The patterns of health and mortality of the black population in the nineteenth century are not fully understood mainly due to the lack of vital data prior to the twentieth century. An official Death Registration Area consisting of ten states and the District of Columbia was established in 1900, and data collection from all states was not complete until 1933. Even in the early twentieth century, black population is underrepresented in the Death Registration Areas. The currently available mortality statistics for the nineteenth century are based mostly on less systematic sources (Haines 2000, 145-151).

The racial differences in mortality and health are now fairly well established. Available data suggest that the mortality of blacks was considerably higher than that of whites in the mid nineteenth century. The life expectancies at birth circa 1850 for whites and blacks were 39.5 years and 23 years; the numbers of deaths per 1000 infants were 216 and 340, respectively (Haines 2000, 158). More detailed studies of the slave population based on plantation records suggest that the racial differences in the measures of health were primarily due to the early-life malnutrition of slaves. The age profile of height shows that the size of slaves below age five was exceedingly small because of nutritional deficiencies (Steckel 1986). The excess death rates of children under five accounts for nearly all of the racial differences in mortality; mortality of slaves after age 10 was similar to whites. The stunned final height of slaves can also be explained by the early malnutrition.

Slaves were shorter because of the nutritional deficiencies of early childhood but heavier in terms of weight per inch of height. This indicates that late adolescent and adult slaves were probably better nourished than whites (Fogel 1989, chapter 5, Fogel, Galantine, and Manning 1992, #47).

Compared to the black-white differences, much less is known about the differences in health and mortality within the U.S. slave population. Existing evidence suggests that mortality rates on rice plantations exceeded those on cotton plantations. Disparate environmental conditions (such as the effect of population aggregation on the rate of spread of diseases) and the intensity of work according to the type of crop may have played a major role (Fogel 1989, 127). Occupational differences in mortality among slaves have been found, too. Male artisans were less than half as likely to die during a given year as male field hands at the same age. The excess mortality among field hands was perhaps produced by the greater intensity of work and inadequate sanitary conditions for field hands who worked with animal manure during the planting season. The "sanitary condition" hypothesis is supported by the fact that dysentery and tetanus, which are promoted by poor sanitation and hygiene, were two of the leading causes of death (Fogel 1989, 128).

The present study can provide more decisive evidence for the patterns of socioeconomic differences in health of the U.S. slave population than those previously offered in the following several respects. Above all, some special conditions of the army camp during the war provide a unique chance to determine the relationship between socioeconomic background and health. The Civil War brought together a large number of slaves with heterogeneous personal characteristics and ecological backgrounds into an extremely unhealthy environment that caused unusually high rates of disease contraction and consequent mortality. Upon being mustered into the service, they were confined to relatively homogeneous living conditions in terms of the quality of diet, housing, and disease environment. Owing to these features of army life, we are able to identify more clearly the effects of socioeconomic and ecological factors on the degree of susceptibility or resistance to disease. Furthermore, detailed descriptions of disease diagnoses, and cause and date of death while in service, which are contained in the Union Army medical records,

make it possible to examine the patterns of morbidity, cause-specific mortality, and timing of wartime deaths as well as general mortality. Finally, whereas previous evidence on slave mortality was drawn largely from the sources generated in large plantations, the black Union Army sample used in this study covers a wider segment of the slave population. Thus, this study will provide a more general picture of the socioeconomic differences in health among blacks.

The disparities in measures of wellbeing among slaves are one of the less explored aspects of the U.S. slavery. The majority of the studies on the slavery are largely concerned with the average experiences of slaves. The patterns of health differentials offered by this study will deepen our understanding of the slave society in the American South. In addition, by comparing the socioeconomic disparities in health between blacks and whites, this paper will help understand why socioeconomic differences in health differ across times and places.

## 2. Military Service Records of Black Union Army Soldiers

Shortly after the outbreak of the American Civil War, leaders of black community and prominent white abolitionists in the North demanded that black people should be allowed to join the Union Army, expecting that fighting in the war would pave a way toward liberation of slaves and more equal rights for free black people.[2] As the Northern soldiers advanced to southern states, furthermore, many slaves escaped to the territories occupied by the Union Army, providing the Union with a potential pool of military men power. At the early stage of the war, however, Union policy makers were highly reluctant to recruiting black men in spite of its potential military advantages on the grounds that black men's capability of fighting in battles was doubtful and that enlisting black men into the Union Army would enlarge the claims of black people to full citizenship most Northerners refused to concede.

It was some high-rank officers in the army, who felt very strongly about the need to

[2] See Berlin, Reidy, and Rowland (1982, 1998) and Hargrove (1988) for the history of the Colored Troops in the Union Army.

organize black units from among fugitive slaves and freemen, who moved ahead to recruit, organize, and train black regiments. In doing so on their own volition, these generals even faced official censure and possible dismissal from the service in disgrace and well as disapproval from military peers.[3] Only during 1863 black men began to be enlisted into Union ranks on a large scale. Repeated defeats of the Union Army and growing difficulties in recruiting white volunteers were major forces responsible for the turn around of the Union recruitment policy. After the Emancipation Proclamation on January 1, 1863, Northern states started to recruit and organize Colored Regiments. The establishment of the Bureau for Colored Troops on May 22, 1863 finally materialized a coordinated policy for recruitment, organization, administration, and services for the entire black regiments including white officers. During the Civil War, 179,000 black men enlisted in the Union Army of whom 146,000 were from slave states including the border states of Delaware, Maryland, Missouri, and Kentucky.

The present study is based on a sample of 5677 black Union Army soldiers in 51 infantry companies who were linked to their military service records.[4] The service records contain very detailed descriptions of the diseases or wounds that recruits suffered during military service. As soon as a recruit was too ill to report for duty, his condition was noted in morning reports. If his condition required medical attention, it was recorded in the regimental surgeon's report; if he was hospitalized, the diagnosis of the disease was described in the case history together with the ultimate outcomes, such as return to service, discharge for disabilities, or death (U.S. Surgeon General's Office 1870, vol. 1). Information on disease and on date and cause of death in service were gathered from these

[3] The early black regiments that were organized by such pioneers include the South Carolina Regiment by Major General David Hunter, the Kansas Regiment by General James Henry Land, and the Louisiana Native Guard Regiments by Major-General Benjamin Butler and Brigadier-General John Phelps.

[4] This sample has been collected and linked as part of the project titled "Early Indicators of Later Work Levels, Disease, and Death," jointly sponsored by the National Bureau of Economic Research, the National Institutes of Health, the Center for Population Economics at the University of Chicago, and Brigham Young University. See Fogel (1993, 2000a, 2000b, 2001) and Wimmer (2003) for more detailed explanations of the EI Project and data produced from the project. The data sets collected and linked as part of this project can be obtained from the web site of the Center for Population Economics (http://www.cpe.uchicago.edu).

sources. Military service records also provide information on demographic and socioeconomic characteristics of recruits, such as age, occupation at enlistment, place of birth, and height, among other variables, as well as on their military careers, including rank, military duty, company, regiment, change in military status, dates of enlistment and discharge, and so on.

I select ex-slaves from this sample based on the states of birth and enlistment. For many black recruits, the place of enlistment may not have been the true place of residence prior to service. Because of the changes in the principles of recruitment of blacks in the Union Army, many moved to other states to join the Union Army before recruitment was not permitted in their home state. For instance, many blacks in Kentucky had fled to enlist in Northern and Tennessee regiments (Berlin, Reidy, and Rowland 1998). Likewise, blacks in slave states, for whom enlistment was a road to freedom, a large number of slaves moved to Northern states where they could join the Union Army. To make sure that only former slaves are included, I limit the sample to the 4706 men who were born and enlisted in slave states. Previous studies based on samples of white Union Army recruits suggest that the degree of exposure to disease prior to enlistment was an important determinant of the probabilities of contracting disease and death while in service (Lee 1997, 2003). To consider the effect of county-specific ecological environment, I further select a sample of 2264 black soldiers for whom either the county of birth or the county of enlistment were known.

Table 1 compares the medical experiences while in service and selected personal characteristics of the black recruits in these three samples. The entire sample and the sample of ex-slaves are matched fairly well in the wartime mortality from disease, the number of cases per person, the case-fatality rate of wartime diseases. The two samples are also similar in other personal characteristics and military experiences except for the occupational composition. The percentages of white-collar/skilled and other non-farm occupations are somewhat higher for the full sample than for the sample of ex-slaves. The samples of all ex-slaves and those with information on county (cols. 2 and 3) are also generally similar in the wartime medical experiences and other personal characteristics,

although the percentages of non-farm occupations are lower for the latter. Also, early recruits (those enlisted prior to the establishment of the Bureau for Colored Troops in May 1863) are underrepresented in the sample of ex-slaves with information on county. This might indicate that military service records were less completely filled in for black men who joined the army before systematic recruitment of blacks started.

The analyses given below will rely on the sample of ex-slaves and the sample of ex-slaves for whom the county of residence prior to enlistment is known. Even if we cannot preclude the possibility of sample selection bias, Table 1 suggests that the magnitude of the bias should be small. It is likely that the results of this study generally represent the experiences of the entire black Union Army and perhaps the entire male slave population at military service ages during the Civil War.

**3. Socioeconomic Background, Disease, and Mortality**

The wartime casualty caused by disease was much higher for black recruits than for white soldiers. 18 percent of the black servicemen in the sample used in this study were killed by disease whereas 8 percent of the white men in the entire Union Army died from illness while in service. The wartime casualty rates of the sample are well matched to the entire black regiments of 179,000 men of which 33,000 soldiers (18.4 percent) were killed by disease while in service. Disease was by far the predominant cause of wartime mortality of black men, accounting for ten out of every eleven deaths. The ratio of the number of deaths from disease to wound-caused deaths was much higher for blacks compared to white soldiers. I identified the seven most common diseases in army camps, namely, typhoid, smallpox, measles, diarrhea (including dysentery), pneumonia, malaria, and tuberculosis. These diseases are responsible for about two thirds of all deaths caused by illness and half of all disease cases. Of these diseases, diarrhea is the single most important killer, accounting for 20 percent of all deaths caused by disease, followed by pneumonia (14 percent) and typhoid (13 percent).

The unusually high mortality from disease among black soldiers raised considerable concerns among commanding officers of black regiments and medical staffs

of the Union Army. Some attributed the high wartime death rate of blacks to the fact that many black recruits came ill prepared for soldiering in the first place. According to this claim, slavery left black men weak and susceptible to disease and the Union recruitment placed many men under arms who would otherwise have been disqualified. Others blamed poor living conditions that black recruits confronted in the army camps including deficiency of qualified medical personnel, stationing at particularly unhealthy posts, disproportionately more fatigue duty, unbalanced diet, and indifferent treatment of white commanders (Berlin, Reidy, and Rowland 1982, chapter 15).

In the balance of this paper I focus on the issue of how the wartime mortality among black soldiers differed by their socioeconomic characteristics, leaving aside the question of why they were much more likely to be killed by disease than whites. I first calculate the wartime mortality from disease in general ($D$), the mean number of cases per person ($C$), and the case fatality rates ($F$) of all diseases for black recruits according to their age, skin color, height, occupation, average farm size of county, population density of county, and region of residence. The mean number of cases of disease per person-year reflects how susceptible recruits of a particular characteristic were to disease, while the case fatality rates indicate how robust they were in resisting the diseases they contracted. The disease-caused mortality in general ($D$) is determined by these two indexes ($C$ and $F$).[5]

Previous studies suggest that slaves were treated differently according to their skin colors. Planters in Trinidad, for instance, had a strong bias in favor of assigning light-skinned creoles to elite occupations. Light-skinned males were more than twice as likely to be artisans or hold another non-field job as dark-skinned males. A light woman was over six times as likely to be chosen for a domestic as a dark woman. Studies of the New Orleans slave records also show the effect of color on selection for elite jobs, although the effect was much weaker in the United States than in Trinidad (Fogel 1989, 48-50). Although the

[5] In addition, the probabilities of contracting and dying from diseases for a particular demographic group were determined by their average length of service. Unfortunately, the average length of service can be calculated for less than 30 percent of the sample because the information on dates of enlistment or discharge in missing for many soldiers. It is implicitly assumed in Table 2 that the length of military service is the same for each cell composed of particular socioeconomic characteristics.

evidence regarding the effect of skin color is centered on occupational assignment, light-skinned slaves could also have been treated favorably in other aspects if planters had a preference for lighter skin color. I classify skin colors into three categories, (1) dark, (2) brown, and (3) light.

It is widely accepted that adult height is an index of cumulative net nutritional status over the growing ages and a powerful predictor of health at older age (Fogel 1994, Waaler 1984). Because it is inappropriate to compare the height of a recruit at a growing age with those who had already gained their final stature, it is desirable to use an age-standardized measure of height. Accordingly, I construct five dummy variables on height (*Height 1* to *Height 5*), each of which represents a quintile of the height distribution for a particular age. The height distribution by age was obtained from the entire black Union Army sample of 5,677. To all recruits 23 and older, a single height distribution was applied, assuming that height after age 23 remained unchanged.

Occupation is one of the most widely used indicators of socioeconomic status in the nineteenth century United States. I classify their occupations to the following three categories based on the typical job hierarch of slaves: (1) elite occupations such as managers and craftsmen, (2) other non-field occupations and domestics, and (3) field hands. In the antebellum South, it was a common practice that more productive and loyal slaves were promoted to elite occupations. Occupational promotions were used as a reward for hard work and an incentive to elicit more efforts from field workers. In determining a slave's occupation, planters tried to match the slave's human capital and the job requirement as closely as possible (Fogel 1989, Chapter 2). Slaves who were promoted to elite occupations should have enjoyed better diet and housing compared to the majority engaged in field works. The black recruits who had worked on elite occupations presumably had superior health compared to field hands owing to the selective nature of occupational assignment and the privileges associated with their occupations.[6]

The prior exposure to disease was an important determinant of wartime disease and

[6] Slave artisans and drivers (overseers of gang-system) were indeed taller than field hands (Fogel 1989).

mortality of white Union Army soldiers (Lee 1997, 2003). Farmers and rural residents, who were healthier on average prior to enlistment owning to a greater extent of isolation from other people, were more likely to succumb to illness and to be killed by disease than non-farmers and urban dwellers, respectively. The different degree of immunity against pathogens is probably the most important link between the extent of prior exposure to disease and later health. That is, despite the negative consequences for net nutritional status, survivors of unhealthy environments developed better immunity to some of the infectious diseases than were rampant in the army life.

To consider the effect of disease environment of the community, I employ two different measures of population aggregation: the plantation size and the population density. I construct these variables by dividing the sample into five categories of equal size according to the average number of slaves per slave holder and the population density of the county where the recruits had lived prior to enlistment. Recruits from a larger plantation and men from more densely populated county should have had more contacts with disease than, respectively, enlistees from a smaller farm and those from more isolated areas. I also consider the differences between formers slaves from Union slave states and from Southern Confederate states. This regional division is expected to capture the health effects of the differences in crop mix, climate, and ecological environment between the two regions.

The results of the computations are reported in Table 2. Black soldiers with lighter skin colors (either brown or light) were much less likely to die from disease than those with darker skin. The lower disease-caused death rates for brown-skinned men are entirely attributable to the lower probability of contracting disease compared to darker men. On the other hand, the advantages of light-skinned solders over men with darker colors are explained by both lower rates of contraction and case fatality. The effect of height does not stand out clearly.

The men who were formerly engaged in elite occupations were much less likely to die from disease than field hands because their chances of surviving diseases contracted were higher. The mortality from disease for other non-farm occupations was as low as the death rate for elite occupations. But their advantages over field hands resulted exclusively

from their lower probability of contracting diseases.

Ex-slaves from larger plantations appear to have been much less likely to be killed by disease while in service than men from smaller farms. In particular, men who had resided in the top 5$^{th}$ counties in terms of the average plantation size was half as likely to die from disease than those from the bottom 5$^{th}$ counties. The advantages of having resided in large plantation prior to enlistment were due to both the lower probability of contracting diseases and the lower conditional probability of dying from the diseases contracted.

No clear relationship between the population density and the degree of susceptibility of disease, measured by the number of case per person, was observed. On the other hand, recruits from more densely populated counties (that belonged to the top 40 percent of the distribution of the county population density) were more robust in resisting disease they contracted, as indicated by the relatively low case fatality rate.

Lastly, the wartime disease mortality was lower for black men from the border states than those from Confederate states, but not by much. The higher rate of contraction of men enlisted into the border-state regiments was more than offset by their lower case fatality rate. The patterns of mortality differentials for all ages described above are generally true for four age categories.

I conduct logistic regressions to examine the effect of each of the socioeconomic factors, controlling for all other factors at the same time. Three different models are employed. The first and second regressions estimate the effect of each independent variable on the separate probabilities of contracting a disease and dying from a disease (respectively) while in service, based on the entire sample of non-migrants with information on county of residence. For the third regression, the sample is limited to the recruits who had at least one illness while in service. The second regression examines the determinants of the degree of susceptibility to disease while the third is concerned with fatality in case of contraction. The result of the first regression on mortality shows the combined consequence of the differences in susceptibility and lethality.

In addition to the variables on age, skin color, height, occupation, plantation size, population density, and region of residence, of which definitions are explained above,

variables on the year of enlistment and military positions are added. The timing of enlistment could have influenced wartime disease and mortality of black recruits. There were two fundamental changes in the War Department's approach to the recruitment of blacks that should have altered the treatment of black men in the army. Prior to the spring of 1863, as noted above, black soldiers were recruited on ad-hoc basis by individual decisions of Union commanders as Union political leaders hesitated to allow the enlistment of black men. In May 1863, the War Department finally started full-scale enlistment, establishing the Bureau of Colored Troops to regulate and supervise the enlistment of black soldiers and the selection of officers to command black regiments.

Even after black men were officially mustered in the army, they were discriminated against in personnel management in various ways. Black recruits were not permitted to become commissioned officers, and were paid much less than white soldiers. Furthermore, they were much more likely to be assigned to heavy manual duties while white solders were sent to fight in the battlegrounds. In June 1864, Congress passed an act equalizing the pay of black and white soldiers. At the same time, excessive fatigue duty for black troops was banned, too. To consider the effects of these major changes in the rules regarding the treatment of black men, I classify the dates of enlistment into three periods: (1) May 1863 and earlier, (2) June 1863 to June 1864, and (3) after June 1864.

In previous studies on Union Army white recruits I found that military rank and duty had very strong effects on the chances of dying while in service (Lee 1999, 2003). Lee (1999) also shows that military positions were selectively assigned to the newly enlisted according to their socioeconomic backgrounds. Descriptive evidence confirms that the assignments of military positions in black regiments were also selective. Artisans, house servants, and other privileged bondsmen provided the bulk of the noncommissioned officers. Also, black soldiers who had been free led demands for commissioned office and monopolized those ranks after Union policy changed (Berlin, Reidy, and Rowland 1998, 35-36). To control for this potential indirect effect of socioeconomic characteristics on the probability of dying through the assignments of military positions, I include dummy variables on duty (which equals 1 if non-infantrymen and zero otherwise) and rank (equals

1 if higher than private and zero otherwise).

The regression results are presented in Table 3. The estimated parameters for the variables on skin colors, occupation, plantation size, and population density generally confirm the patterns of mortality differentials described above. Brown-skinned men were significantly less likely to contract and to die from diseases. But the favorable effect of light skin is no longer visible once other personal characteristics are held constant. Former white-collar and skilled workers were less likely to contract and to be killed by diseases than were field hands, although the effect of elite occupations on the probability of contracting diseases misses statistical significance by a relatively small margin. Having resided in the top $5^{th}$ counties in the distribution of the plantation size strongly diminished the probabilities of contracting and dying from diseases and the conditional probability of being killed by diseases contracted. Recruits from counties that belong to the top category of population density were much less likely to succumb to and to be killed by disease in case of contraction.

Age had a U-shape relationship with the probability of suffering a disease while in service. The estimated parameters for age and age squared suggest that the probability of contraction first decreased with age, reached the minimum around age 34 and increased with age thereafter. Since few men aged 34 and older entered the army, the effect of age on the probability of contracting diseases was practically negative. The effect of age on the conditional probability of dying from disease in case of contraction was not statistically significant.

It is surprising that the association between height and the probability of contracting disease is positive, not negative. The shortest 20 percent were significantly less likely to be killed by disease while in service. If height is included in the regressions as a continuous variable, it has a strong positive effect on the probabilities of contracting disease and of dying from disease. Height was not systematically related to the conditional probability of dying from disease in case of contraction. One possible explanation for this unexpected outcome is that army recruits received the same amount of food regardless of their stature. If this was the case, a taller solder could have been relatively undernourished

compared to a shorter man because of a greater amount of energy required to maintain a bigger body.

In contrast to the patterns of mortality differentials reported in Table 3, men who enlisted in the Border States were no different from enlistees from Confederate states. The significantly lower conditional probability of dying from disease among the soldiers from the Border States is completely offset by their much higher risks of contracting diseases. Later recruits were much less likely to be killed by disease than earlier enlistees. The relationship between the year of enlistment and the wartime mortality from disease is largely explained by the different average length of military service according to the timing of enlistment. The average number of disease cases per person-year (a measure of probability of contracting disease after being standardized for the length of service) was actually higher for the late enlistees. Furthermore, the case fatality rate was no different between men enlisted in different years. This result implies either or both of the following two cases: (1) the smaller pay or excessively heavy duty of black recruits did not seriously impair their health; (2) the act of June 1864 to equalize the pay of black and white soldiers and to prohibit the excess fatigue duty for blacks was not effectively enforced.

As in the case of white recruits, serving on non-infantry duty significantly diminished the probabilities of suffering and dying from disease. On the other hand, non-commissioned officers had no advantages over privates in black regiments whereas white men at higher ranks enjoyed much lower rates of death and contraction of disease than privates. Unlike white non-commissioned officers who were paid more than were privates, black servicemen received the same pay regardless of their rank. This difference in pay scheme could be responsible for the racial difference in the effect of rank on wartime mortality.

## 4. Nutrition, Immunity, and Wartime Mortality

Previous studies on the experiences of white Union Army solders have suggested two important mechanisms by which socioeconomic backgrounds prior to enlistment affected wartime health (Lee 1997, 2003, Smith 2003). First, a recruit from a healthier

environment had been less exposed to disease and thus had poorer immunity against disease than a man from an unhealthy place. There is a great deal of evidence demonstrating the fragility of isolated population once they come in contact with different disease pool (MaNeill 1976, Curtin 1989, Pritchett and Tunali 1995, Fetter and Kessler 1996, Sköld 1997). It provides a plausible explanation for why farmers and rural residents were more likely to contract diseases and be killed by them than were, respectively non-farmers and city dwellers. Despite the negative consequences for net nutritional status, survivors of unhealthy environments developed better immunity to some of the infectious diseases that were rampant in army life. Second, a person who had been better nourished had advantages over a man with poorer nutritional status in avoiding or resisting some nutritionally-sensitive diseases. This is a possible reason for the negative relationship between household wealth and the probability of contracting some types of diseases among white Union Army recruits (Lee 1997, 2003).

The two potential pathways by which pre-service socioeconomic characteristics determined wartime mortality could be mixed in the regression results reported above. Given that black solders who had been engaged in elite occupations were presumably better nourished than field hands, and some of them probably resided in town, their lower rates of contracting disease and mortality compared to field hands may have resulted from both greater immunity against diseases and superior nutritional status. Servicemen from more densely populated counties should have had more chances to develop immunity against diseases than men from more isolated areas. However, this advantage of urban dwellers could have been offset by their initially poorer nutritional status.

We can examine the relative importance of each of the two links between socioeconomic backgrounds and wartime health by looking at cause-specific morbidity and mortality. According to epidemiological studies, the strength of immunity influence of prior contraction differs from one disease to another. For some diseases, such as measles, smallpox, and typhoid, an attack would confer immunity and thus reduce the probability of contracting or dying from those diseases in the future (such diseases will be called *immunity diseases* below). For other diseases, such as malaria, diarrhea, dysentery, and

pneumonia, a prior contraction has little influence on susceptibility or resistance against a later contraction (this type will be called *non-immunity diseases*).[7] Most diseases are sensitive to nutritional status to some extent, but there are some diseases for which the effect of nutritional status is particularly strong including diarrhea, tuberculosis, most respiratory infections, pertussis, cholera, leprosy, and herpes (Journal of Interdisciplinary History 1983, 506). For non-immunity diseases, the effect of prior nutritional status should be stronger than the effect of immunity. I perform logistic regressions that examine the effects of socioeconomic backgrounds and military experiences on the probabilities of contracting and dying from these two types of diseases employing the same set of variables included in the regressions for all types of diseases. Tables 4 and 5 present the results.

The advantages of light-skinned men in resisting diseases while in service, though marginally insignificant at conventional significance level, were stronger for non-immunity diseases. Since occupational difference between skin colors are taken into account, this indicates that light-skinned slaves were perhaps better nourished and healthier than dark-skinned slaves even within the category of similar occupation. On the other hands, brown-skinned men were less likely to contract both types of diseases. It is uncertain what granted them with stronger immunity against diseases.

Having non-field occupations prior to enlistment significantly diminished the risk of contracting non-immunity diseases while in service. The estimated parameters suggest that, compared to field hands, the probability of suffering this type of diseases was 39 percent lower for the skilled and 23 percent lower for men who had held other non-field occupations, although the effect of working on elite occupations misses statistical significance by a small margin. In sharp contrast, variables on occupation had no significant effects on immunity diseases. This suggests that the advantages of men with elite or non-field occupations over field hands resulted perhaps from their superior nutritional status or general health conditions at the time of enlistment rather than the influence of differential

[7] For the epidemiological characteristics of these and other diseases see May (1958), Steiner (1968, 12-26), Kunitz (1983, 351-53), and Kiple (2003). For more detailed documentation of the history of specific disease see Fetter and Kessler (1996) for measles, Zurbrigg (1997) for malaria, and Sköld (1997) for smallpox.

immunity status. This pattern is clearly different from white recruits for whom the lower wartime mortality of non-farmers compared to farmers largely reflected their better immunity against diseases.

Black soldiers from counties of which average plantation size was large were significantly less likely to die from both types of diseases. But the mechanism by which plantation size affected wartime mortality differed by the type of disease. In case of immunity diseases, the advantages of recruits from large plantations largely come from their lower rate of contracting disease. On the other hand, the major reason for these recruits' lower mortality from non-immunity diseases was the lower probability of dying from non-immunity diseases in case of contraction. Living with a large number of slaves in the same plantation should have provided more chances to contact diseases and thus develop immunity against them. The result also suggests that slaves held in large plantations were probably better nourished than slaves owned by small planters.

Residing in urban counties prior to enlistment strongly lowered the probabilities of contracting and dying from immunity diseases. Recruits from a county that belonged to the top quintile of the population density were 62 percent less likely to suffer immunity diseases, and 75 percent less likely to be killed by those illnesses. For non-immunity diseases, on the other hand, the relationship between the county population density and wartime mortality is much less straightforward. Indeed, recruits from the highest 5$^{th}$ counties in terms of population density were more likely to be succumbed to non-immunity diseases.

The effect of age on wartime morbidity and mortality differ by type of diseases. For immunity diseases, the probability of contracting a disease and the probability of dying from a disease decreased with age through early thirties. Since most recruits were younger than 30 at the time of enlistment, the relationship between age and wartime mortality is practically negative. Perhaps, aged persons had developed stronger immunity against diseases because they had been more exposed to diseases than younger men before they entered the army. For non-immunity diseases, age had no significant effect on the odds of contracting diseases and the conditional probability of dying from the disease contracted.

The regression results for all types of diseases (presented in Table 3) show that the recruits who were enlisted in the Border States were more likely to contract diseases but less likely to die from disease they contracted than those who joined the Union Army in the Confederate states. The regression results for non-immunity diseases (Table 5) are similar to the result for all diseases. In contrast, if only immunity diseases are concerned, enlistees from the Border States were significantly less likely to die from diseases largely due to their lower case fatality rates.

The time pattern of wartime mortality provides another clue by which the influences of prior immunity and nutritional status can be examined. It is documented in the medical histories of the Civil War that the earlier seasoning period in the army was most critical for the survival of recruits. During this period enlistees with limited prior development of immunity were exposed to a pool of various infectious diseases in the army (Steiner 1968). If the differences in wartime mortality between men from countryside and urban areas were mainly caused by the differences in immunity status, most of the differences should have occurred in the early stages of military service when the recruits were not seasoned to the severe disease environment of the army camps. The time pattern of wartime death also offers a hint as to how long the advantages of having a superior nutritional status or generally good health condition at the time of enlistment, as indicated by the recruits' occupation, persisted with the duration of military service.

Table 6 reports the calculated hazard rate of dying from a particular type of disease for each of 180-day intervals from enlistment. The hazard rate for the 181 to 360 days, for example, shows what proportion of the recruits remaining alive in service at the beginning of 181$^{st}$ day died from any illness or some specific type of disease within the following 180 days. If a soldier died from any cause or was discharged alive between enlistment and 180$^{th}$ day, he is removed from the population at risk when the hazard rate of the next time interval (360$^{th}$ to 540$^{th}$ day) is calculated.[8]

[8] To calculate the population at risk at the beginning of each time interval, the number of recruits who were discharged from service should be computed. Unfortunately, the exact timing of discharge can be determined for about 26 percent of the sample because of missing information on the date of discharge. I estimate the number of the discharged for each time interval based on the

The time patterns of wartime mortality are generally consistent with the immunity hypothesis. Hazard rates of dying from disease were higher during the first six months than in subsequent periods, confirming the remarks on the seasoning period given in medical histories of the Civil War. In particular, the mortality for the enlistees from rural areas was extremely high within the first six months and then declined dramatically in subsequent periods. In contrast, the mortality of urban residents was relatively low at the early stage of service and exhibits no clear time pattern. As a consequence, a disproportionately large fraction of the differences between rural and urban residents was made in the first six months in the army.

For recruits who probably lacked immunity against diseases (field hands, rural residents, and men from small farmers), consistent with the prediction of the immunity hypothesis, the mortality from immunity diseases was particularly high during the first six months and dropped sharply thereafter. In contrast, the hazard rates of dying from immunity diseases for men who presumably had better immunity status (non-field occupations, urban residents, ex-slaves from large plantations) do not exhibit a clear time pattern.

However, if non-immunity diseases are concerned, the disease-caused mortality among rural residents was much higher in the first six months than in the following periods. Also, the differences in mortality from non-immunity between urban and rural residents and between men from small and large plantations were particularly high in the first half year. This result suggests that immunity may not be the only explanation for the particularly high mortality from disease among the army recruits. A possible explanation is that as recruits continued to be exposed to disease in the army camp they gained knowledge to avoid contractions. People who had lived in unhealthy circumstances, such as those from urban areas, were more aware of how to avoid contracting disease than those with little experience of disease. According to a qualitative record about white Union Army soldiers, for example, German ate fewer sweets, cooked their food more carefully, and more actively

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assumption that for each type of men (e.g. field hands, non-farm occupation, urban residents, and rural residents) the time patterns of discharge of the entire sample and the recruits for whom the date of the discharge is known are the same.

pursued cleanliness (Hess 1981, 66-67). A number of contemporary accounts suggest that rural residents and farmers were particularly unhygienic and ignorant of child health (Preston and Haines 1991, 38-39). Alternatively, it could be explained by population selections caused by differential mortality; that is, first, individuals who survived an unhealthy environment were on average more robust (that explains why men from urban areas experienced lower mortality than those from rural areas), and, second, less healthy recruits tended to die early, leaving only healthier men in the later stage of military service (that explains why even the hazard of death caused by non-immunity diseases declined with the duration of service).

It is not entirely clear why non-farmers were less likely to be killed by disease than field hands while in service. The skilled and other non-filed workers were perhaps better nourished because of their higher occupations. It may have been the case that non-farmers' overall health, rather than nutritional status, was better than field hands. The effect of differential nutritional status prior to enlistment, if any, should have been stronger in the earlier period in military service. Initially better-nourished recruits would eventually lose their advantage as they continue to face a poorer diet and the fight against disease in the army. Therefore, if the different nutrition as the major story, the difference in mortality from non-immunity diseases between non-farmers and field hands should have been greater in the earlier period in service.

The results in Table 6 only weakly support this "nutrition hypothesis." The mortality differential was the widest in the first six months, and diminished over time. But the advantages of non-farmers persisted throughout the military service, suggesting that different nutritional status may not be the only factor. The results also suggest that the advantages of non-farmers over field hands could be in part attributable to their stronger immunity status. The mortality from immunity diseases within the first six months nearly twice as high for field hands as for men engaged in non-field jobs. The regression results presented in Table 4 (showing no significant effect of occupation on the probability of dying from immunity diseases) fail to capture it because the mortality from immunity diseases in later periods was higher for non-field slaves than for field hands.

## 5. Racial Differences in the Socioeconomic Disparities in Health

The patterns of wartime mortality differentials of black Union Army soldiers are not much different from the features of socioeconomic differences in disease mortality of white recruits suggested in previous studies. Among white soldiers, too, former farmers and men from rural areas were more vulnerable to disease in army camps than, respectively, non-farmers and city-dwellers (Lee 1997, 2003). A notable difference is that height is positively related to the probability of contracting diseases for black enlistees whereas white recruits' health while in service was not significantly affected by their heights.

To compare more accurately the patterns and magnitudes of the wartime mortality differentials between white and black soldiers, I conduct logistic regressions for both races examining the effects of selected personal characteristics and military experiences on the probabilities of dying from all and particular type of diseases. To make the black-white comparison straightforward I modify the classification and redefine several variables used in the regressions for blacks. First, height is included as simple continuous variable instead of age-standardized dummy variables. Occupations of whites are classified according to slaves' occupational hierarchy, including farmers and farm laborers into the category of field hands. The dummy variables on population density are reconstructed reflecting the distribution of county population density of the pooled sample of both whites and blacks. The variables on the average size of plantation are excluded from the analysis because they are relevant only for ex-slaves. Table 7 presents the results.

The results suggest that the occupational differences in wartime mortality were greater for black soldiers than whites. Given that the relative socioeconomic status of white farm owners and tenant farmers was much higher than that of slave field hands, it is not surprising that the disparity between field hands and men with non-field occupations was greater for blacks than for whites. However, the mortality differentials between skilled jobs and unskilled non-farm occupations were also wider for black men than whites. The steeper occupational ingredient in wartime mortality among blacks is entirely attributable to the particularly powerful effect of occupation on the probability of dying from non-immunity

diseases among black soldiers. There were no significant differences across occupational categories in mortality from immunity diseases for blacks. For whites, in contrast, the difference in mortality between farmers and non-farmers is explained largely by the high mortality from immunity diseases among farmers.

The favorable effect residing in urban areas on health while in service was stronger for white soldiers than for blacks. White men from urban counties (top fifth counties in terms of the population density) were more than 30 percent less likely to die from any disease while in service than white enlistees from less densely populated counties. The advantages of residence in urban counties are present for both immunity and non-immunity diseases. In case of black men, on the other hand, the population density had no systematic effect on the probability of dying from any diseases. Different immunity status did matter for blacks, too. Black recruits from the second fifth counties (population density 4) were much less likely to be killed by immunity diseases. For blacks, however, living in urban areas prior to enlistment did no good for their chances of surviving non-immunity diseases, as it did for white soldiers.

These results suggest that, although both socioeconomic status and ecological environment were all important determinants of wartime mortality differentials for both white and black soldiers, the relative effects of the two factors were somewhat different by race. It appears that the health of white recruits was more strongly influenced by the disease environment they were exposed to prior to enlistment. For black soldiers, on the other hand, socioeconomic status, a proxy for nutritional status and general economic wellbeing, was a perhaps more powerful determinant of health.

Some possible explanations can be offered for the differences between white and black men reported above. First, larger occupational differences in wartime mortality among blacks could reflect the differences in health and living conditions of blacks and whites prior to enlistment. It is likely that the marginal effect of a certain determining factor of health (e.g. nutrition and quality of housing) on morbidity or mortality decreases with the size of provision of that factor. If this is the case, socioeconomic differences in health would be smaller for a population enjoying higher standard of living than for a poorer one.

Perhaps, the majority of white soldiers, even men from the lowest social class, were sufficiently healthy and well nourished that their socioeconomic status prior to enlistment had a relatively weak effect on their mortality while in service. Alternatively, the living conditions of black soldiers in the Union Army were much worse than those of white recruits because they were paid less, were assigned more fatigue duty, and received unsuitable food rations. For this reason, higher socioeconomic status prior to enlistment may have provided stronger advantages for blacks than it did for whites.

Second, the stronger health effect of prior residence in urban areas among whites could be explained by the differences in prior exposure to disease between blacks and whites. It is likely that disproportionately large fraction of white soldiers, especially former farmers, came from relatively healthier environments than black recruits. Although the average population density was higher in the North, it was largely due to the presence of many more towns and cities in the region. Slaves in the South, though the majority of them lived in rural areas with a low population density, resided in a larger farm often close to their masters and other slave families. In the South, furthermore, even the rural population may have been exposed to relatively unhealthy environment due to a climate that is more favorable to the development of various infectious diseases. Thus, the majority of white soldiers who resided in isolated farm households in remote rural areas should have had developed less immunity against diseases than blacks before they were confined to the highly unhealthy conditions of the army camps. These differences in the prior exposure to disease might explain why the differences in mortality from immunity diseases between farmers and non-farmers and between rural residents and city dwellers were greater for blacks than for whites. Consistent with this hypothesis, the white men who enlisted in the Border States show very weak relationship between the population size of place of residence and their wartime health (Lee 2003).

## 6. Conclusions

This paper has investigated the patterns of socioeconomic differences in wartime morbidity and mortality of black Union Army soldiers and compared them with white

recruits. Lighter-skinned men were less likely to contract and to die from diseases. Former slaves engaged in non-field occupations were less likely to contract and to be killed by diseases than were field hands. Ex-slaves from large plantations were at much lower risks of contracting and dying from diseases. Residing in urban areas prior to enlistment strongly diminished the chances of suffering and dying from diseases. The relationship between age and the probability of contracting diseases was practically negative.

To my surprise, I found that the association between height and the probability of contracting disease is positive, not negative. A possible explanation for this unexpected outcome is that army recruits received the same amount of food regardless of their stature and therefore a taller solder was relatively undernourished compared to a shorter man. As in the case of white recruits, serving on non-infantry duty significantly diminished the probabilities of suffering and dying from disease. On the other hand, non-commissioned officers had no advantages over privates in black regiments whereas white men at higher ranks enjoyed much lower rates of death and contraction of disease than privates.

Patterns of disease-specific mortality and timing of death suggests that the differences in development of immunity against diseases and nutritional status prior to enlistment are responsible for the observed mortality differentials. The advantages of light-skinned soldiers over darker men and of non-field occupations over field hands perhaps resulted from their superior nutritional status prior to enlistment. The effect of the plantation size on wartime mortality appears to reflect the advantages of men from large plantation in terms of both better-developed immunity and superior nutritional status. Residing in urban counties should have provided more chances to contact diseases and develop immunity against them.

The patterns of wartime mortality of black and white soldiers are generally similar; socioeconomic status and ecological environment were all important determinants of wartime mortality differentials for both races. However, the relative effects of the two factors were somewhat different by race. The results suggest that the occupational differences in wartime mortality were greater for black soldiers than whites. The favorable effect residing in urban areas on health while in service was stronger for white soldiers than

for blacks. It appears that the health of white recruits was more strongly influenced by the disease environment they were exposed to prior to enlistment. For black soldiers, on the other hand, socioeconomic status, a proxy for nutritional status and general economic wellbeing, was a perhaps more powerful determinant of health. I suggest that the larger occupational differences in wartime mortality among blacks could reflect the differences in health and living conditions of blacks and whites prior to enlistment. The stronger health effect of prior residence in urban areas among whites could be explained by the differences in prior exposure to disease between blacks and whites.

The results of this paper suggest that there were substantial disparities in the health of the slave population in the eve of the Civil War. The standard of living and the quality of environment probably differed by skin color, occupation, plantation size, and population aggregation. Light-skinned slaves and those assigned to elite or other non-field occupations appear to have enjoyed better diet, lower work burden, and healthier environment compared to, respectively, dark-skinned slaves and field hands. Slaves in a large-scale plantation were perhaps more exposed to diseases because of higher chances of contacts with other infected people. On the other hand, it appears that the standards of living were higher for slaves held in larger plantations than those in smaller farms. Slaves living in a plantation located in a more densely populated areas were perhaps less healthy than those residing in a isolated farm.

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Table 1
Medical Experiences in Service and Personal Characteristics of Black Union Army Recruits:
A Comparison of Three Samples

| Variables | (1) Entire black Union Army Sample linked to military records N = 5677 | (2) Former slaves (born and enlisted in the slave states) N=4706 | (3) Former slaves with information on county of residence N=2264 |
|---|---|---|---|
| **Number of deaths per 1000 men** | | | |
| All types of illnesses | 180.0 | 189.1 | 171.4 |
| Typhoid | 22.9 | 24.9 | 23.0 |
| Smallpox | 15.6 | 17.8 | 20.7 |
| Measles | 2.6 | 3.0 | 2.7 |
| Diarrhea | 36.1 | 34.4 | 30.5 |
| Pneumonia | 25.0 | 26.6 | 24.3 |
| Malaria | 7.4 | 7.6 | 9.3 |
| Tuberculosis | 6.9 | 7.0 | 6.2 |
| **Number of cases per person** | | | |
| All types of illnesses | 1.712 | 1.632 | 1.544 |
| Typhoid | 0.037 | 0.040 | 0.033 |
| Smallpox | 0.041 | 0.045 | 0.047 |
| Measles | 0.022 | 0.024 | 0.028 |
| Diarrhea | 0.356 | 0.323 | 0.326 |
| Pneumonia | 0.072 | 0.069 | 0.074 |
| Malaria | 0.259 | 0.274 | 0.224 |
| Tuberculosis | 0.020 | 0.020 | 0.018 |
| **Number of deaths per 1000 cases** | | | |
| All types of illnesses | 105.1 | 115.9 | 111.0 |
| Typhoid | 617.3 | 622.5 | 697.0 |
| Smallpox | 378.6 | 395.6 | 440.4 |
| Measles | 117.6 | 125.0 | 96.4 |
| Diarrhea | 101.5 | 106.5 | 93.6 |
| Pneumonia | 345.8 | 385.5 | 328.4 |
| Malaria | 28.2 | 27.7 | 41.5 |
| Tuberculosis | 332.8 | 350.0 | 344.4 |
| **Personal Characteristics** | | | |
| Age at enlistment | 25.5 | 25.5 | 24.9 |
| Height (inch) | 66.5 | 66.5 | 66.4 |
| **Occupational Composition (%)** | | | |
| White-collar and skilled | 5.4 | 3.8 | 3.1 |
| Other non-field | 38.7 | 34.6 | 29.5 |
| Field hands | 55.8 | 61.7 | 67.4 |
| **Year of Enlistment (%)** | | | |
| Prior to May 1863 | 5.5 | 4.5 | 0.8 |
| June 1863-June 1864 | 60.7 | 59.6 | 52.6 |
| July 1864 or later | 33.8 | 35.9 | 46.6 |
| **Military Positions** | | | |
| Percentage of Privates | 94.6 | 94.9 | 94.8 |
| Percentage of infantrymen | 74.7 | 74.8 | 74.5 |

Notes: The county of residence refers to either the county of birth enlistment (for those who provide that information) or the county of enlistment (the rest of the recruits). See text for the definition of the variables.

Table 2
Wartime Morbidity and Mortality from All Types of Diseases by Personal Characteristics

| | All Ages | | | | Ages 17 to 19 | | | | Ages 20 to 24 | | | | Ages 25 to 29 | | | | Ages 30 and Older | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | N | D | C | F | N | D | C | F | N | D | C | F | N | D | C | F | N | D | C | F |
| **Skin color** | | | | | | | | | | | | | | | | | | | | |
| Black | 3321 | 176.8 | 1.520 | 116.3 | 822 | 155.7 | 1.426 | 109.2 | 1146 | 171.9 | 1.573 | 109.3 | 508 | 169.3 | 1.616 | 104.8 | 845 | 208.3 | 1.480 | 140.7 |
| Brown | 278 | 100.7 | 0.799 | 126.0 | 95 | 84.2 | 0.863 | 97.6 | 91 | 76.9 | 0.945 | 81.4 | 32 | 93.8 | 0.813 | 115.4 | 60 | 166.7 | 0.467 | 357.0 |
| Light | 166 | 108.4 | 1.259 | 86.1 | 39 | 102.6 | 0.923 | 111.2 | 76 | 111.8 | 1.289 | 86.7 | 30 | 33.3 | 1.367 | 24.4 | 21 | 190.5 | 1.619 | 117.7 |
| **Height** | | | | | | | | | | | | | | | | | | | | |
| Shortest 5th | 792 | 160.3 | 1.196 | 134.0 | 222 | 153.2 | 1.288 | 118.9 | 287 | 156.8 | 1.184 | 132.4 | 107 | 158.9 | 1.009 | 157.5 | 176 | 176.1 | 1.210 | 145.5 |
| Second 5th | 839 | 158.5 | 1.409 | 112.5 | 178 | 101.1 | 1.157 | 87.4 | 311 | 154.3 | 1.582 | 97.5 | 129 | 170.5 | 1.481 | 115.1 | 221 | 203.6 | 1.326 | 153.5 |
| Third 5th | 704 | 179.0 | 1.723 | 103.9 | 159 | 188.7 | 1.377 | 137.0 | 267 | 172.3 | 1.749 | 98.5 | 98 | 71.4 | 1.959 | 36.4 | 180 | 238.9 | 1.861 | 128.4 |
| Fourth 5th | 928 | 178.9 | 1.605 | 111.5 | 227 | 154.2 | 1.485 | 103.8 | 271 | 169.7 | 1.620 | 104.8 | 172 | 168.6 | 1.907 | 88.4 | 258 | 217.1 | 1.492 | 145.5 |
| Tallest 5th | 673 | 167.9 | 1.489 | 112.8 | 163 | 147.2 | 1.540 | 95.6 | 273 | 157.5 | 1.579 | 99.7 | 96 | 197.9 | 1.177 | 168.1 | 141 | 191.5 | 1.468 | 130.4 |
| **Occupation** | | | | | | | | | | | | | | | | | | | | |
| Skilled | 159 | 138.4 | 1.723 | 80.3 | 17 | 117.6 | 1.294 | 90.9 | 54 | 92.6 | 1.852 | 50.0 | 35 | 171.4 | 1.829 | 93.7 | 53 | 169.8 | 1.660 | 102.3 |
| Non-farm | 1419 | 139.5 | 1.190 | 117.2 | 363 | 137.7 | 1.185 | 116.2 | 537 | 115.5 | 1.207 | 95.7 | 221 | 126.7 | 1.095 | 115.7 | 298 | 194.6 | 1.238 | 157.2 |
| Field hands | 2469 | 185.5 | 1.623 | 114.3 | 655 | 149.6 | 1.467 | 102.0 | 816 | 193.6 | 1.755 | 110.3 | 359 | 175.5 | 1.772 | 99.0 | 639 | 217.5 | 1.534 | 141.8 |
| **Farm size** | | | | | | | | | | | | | | | | | | | | |
| Lowest 5th | 294 | 193.9 | 1.432 | 136.3 | 74 | 135.1 | 1.297 | 104.2 | 97 | 195.9 | 1.619 | 121.0 | 50 | 140.0 | 1.400 | 100.0 | 73 | 287.7 | 1.342 | 214.4 |
| Second 5th | 413 | 181.6 | 1.419 | 128.0 | 129 | 155.0 | 1.155 | 134.2 | 138 | 188.4 | 1.746 | 107.9 | 61 | 147.5 | 1.459 | 101.1 | 85 | 235.3 | 1.259 | 186.9 |
| Third 5th | 491 | 181.3 | 1.621 | 111.8 | 137 | 146.0 | 1.467 | 99.5 | 170 | 217.6 | 1.747 | 124.6 | 70 | 157.1 | 1.729 | 90.9 | 114 | 184.2 | 1.553 | 118.6 |
| Fourth 5th | 350 | 148.6 | 1.283 | 115.8 | 85 | 141.2 | 1.011 | 139.7 | 126 | 150.7 | 1.206 | 125.0 | 47 | 127.7 | 1.511 | 84.5 | 92 | 163.0 | 1.522 | 107.1 |
| Highest 5th | 511 | 99.8 | 1.102 | 90.6 | 130 | 76.9 | 1.523 | 50.5 | 214 | 107.5 | 0.893 | 120.4 | 70 | 57.1 | 0.814 | 70.1 | 97 | 144.3 | 1.206 | 119.7 |
| **Pop density** | | | | | | | | | | | | | | | | | | | | |
| Lowest 5th | 392 | 120.0 | 0.946 | 126.8 | 92 | 108.7 | 0.837 | 129.9 | 140 | 128.6 | 0.986 | 130.4 | 70 | 100.0 | 0.586 | 170.6 | 90 | 133.3 | 1.278 | 104.3 |
| Second 5th | 412 | 138.3 | 1.148 | 120.5 | 103 | 126.2 | 1.262 | 100.0 | 149 | 140.9 | 1.013 | 139.1 | 58 | 120.7 | 1.259 | 95.9 | 102 | 156.9 | 1.167 | 134.4 |
| Third 5th | 483 | 202.9 | 1.557 | 130.3 | 168 | 166.7 | 1.357 | 122.8 | 165 | 212.1 | 1.582 | 134.1 | 57 | 157.9 | 1.965 | 80.4 | 93 | 279.6 | 1.623 | 172.3 |
| Fourth 5th | 439 | 173.1 | 1.747 | 99.1 | 102 | 137.3 | 1.696 | 81.0 | 178 | 174.2 | 1.860 | 93.7 | 66 | 151.5 | 1.924 | 78.7 | 93 | 225.8 | 1.462 | 154.4 |
| Highest 5th | 334 | 137.7 | 1.353 | 101.8 | 90 | 77.8 | 1.356 | 57.4 | 114 | 166.7 | 1.377 | 121.1 | 47 | 85.1 | 1.170 | 72.7 | 83 | 192.8 | 1.422 | 135.6 |
| **Region** | | | | | | | | | | | | | | | | | | | | |
| Confederacy | 2450 | 182.4 | 1.283 | 142.2 | 676 | 168.6 | 1.253 | 134.6 | 781 | 163.9 | 1.353 | 121.1 | 361 | 180.0 | 1.290 | 139.5 | 632 | 221.5 | 1.223 | 181.1 |
| Union slave | 1679 | 149.5 | 1.745 | 85.7 | 374 | 107.0 | 1.564 | 68.4 | 661 | 161.9 | 1.762 | 91.9 | 272 | 125.0 | 1.816 | 68.8 | 372 | 188.2 | 1.847 | 101.9 |

Notes: N = number of recruits; D = number of deaths per 1000 men; C = number of cases per person; F = number of deaths per 1000 cases.

Table 3
Results of Logistic Regressions" Correlates of Probability of Dying from Disease

| Independent Variables | All Recruits | | | | | Recruits Who Contracted Disease | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | (1) Dying from Disease (mean = 0.157) | | (2) Contracting Disease (mean = 0.518) | | Mean | (3) Dying from Disease (mean = 0.291) | |
| | | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value | | $\partial P / \partial x_i$ | P-value |
| Age | 25.231 | -0.033 | 0.3883 | -0.054 | 0.1014 | 25.263 | -0.019 | 0.6773 |
| $Age^2 \times 10^{-1}$ | 70.555 | 0.009 | 0.1337 | 0.008 | 0.1073 | 71.063 | 0.007 | 0.3101 |
| Skin color brown | 0.077 | -0.528 | 0.0326 | -0.579 | 0.0000 | 0.036 | -0.174 | 0.6547 |
| Skin color light | 0.045 | 0.048 | 0.8919 | -0.286 | 0.1627 | 0.043 | 0.140 | 0.7370 |
| Height 1 (shortest $5^{th}$) | 0.210 | -0.353 | 0.0451 | -0.255 | 0.0736 | 0.200 | -0.317 | 0.1198 |
| Height 2 | 0.200 | -0.362 | 0.0437 | -0.259 | 0.0721 | 0.185 | -0.341 | 0.0991 |
| Height 4 | 0.256 | -0.273 | 0.1195 | 0.049 | 0.7644 | 0.166 | -0.350 | 0.0642 |
| Height 5 (tallest $5^{th}$) | 0.173 | -0.209 | 0.2909 | 0.043 | 0.8083 | 0.270 | -0.285 | 0.1825 |
| Unskilled and semi-skilled | 0.300 | -0.309 | 0.0207 | -0.305 | 0.0010 | 0.260 | -0.124 | 0.4599 |
| White-collar and skilled | 0.032 | -0.638 | 0.0965 | -0.290 | 0.2457 | 0.027 | -0.617 | 0.1424 |
| Farm size 1 (lowest $5^{th}$) | 0.131 | 0.188 | 0.4383 | -0.084 | 0.6162 | 0.149 | 0.159 | 0.5518 |
| Farm size 2 | 0.198 | 0.033 | 0.8665 | -0.128 | 0.3688 | 0.209 | 0.103 | 0.6529 |
| Farm size 4 | 0.180 | -0.293 | 0.1138 | 0.000 | 0.9982 | 0.178 | -0.395 | 0.0415 |
| Farm size 5 (highest $5^{th}$) | 0.255 | -0.539 | 0.0007 | -0.277 | 0.0430 | 0.197 | -0.525 | 0.0038 |
| Pop density 1 (lowest $5^{th}$) | 0.199 | -0.350 | 0.0514 | -0.260 | 0.0618 | 0.151 | -0.311 | 0.1295 |
| Pop density 2 | 0.207 | -0.245 | 0.1760 | -0.094 | 0.5248 | 0.195 | -0.267 | 0.1770 |
| Pop density 4 | 0.184 | -0.237 | 0.2158 | -0.424 | 0.0014 | 0.210 | -0.124 | 0.5806 |
| Pop density 5 (highest $5^{th}$) | 0.158 | -0.460 | 0.0060 | -0.400 | 0.0030 | 0.164 | -0.391 | 0.0469 |
| Enlisted in border states | 0.492 | -0.101 | 0.5523 | 1.715 | 0.0000 | 0.597 | -0.516 | 0.0003 |
| Enlisted prior to Mar. 1863 | 0.006 | 4.203 | 0.0112 | 4.401 | 0.0342 | 0.009 | 1.151 | 0.2833 |
| Enlisted after June 64 | 0.517 | -0.145 | 0.2819 | -0.402 | 0.0000 | 0.467 | 0.170 | 0.3371 |
| Higher initial rank | 0.054 | -0.158 | 0.5728 | 0.003 | 0.9892 | 0.060 | -0.179 | 0.5644 |
| Non-infantry duty | 0.245 | -0.723 | 0.0000 | -0.148 | 0.1680 | 0.239 | -0.730 | 0.0000 |
| | | -2LogL = 1589.478<br>Chi-square = 122.054<br>P-value = 0.000 | | -2LogL = 2531.944<br>Chi-square = 194.319<br>P-value = 0.000 | | | -2LogL = 1167.597<br>Chi-square = 96.641<br>P-value = 0.000 | |

Notes: The number of observations is 1887 for regressions (1) and (2), and 998 for regression (3). Dependent variables are dummy variables that equal 1 if a person died from a disease for regressions (1) and (3), if a person contracted a disease for regression (2), and zero otherwise. NI = not included. The omitted categories are (1) black skin color, (2) height $3^{rd}$ quintile, (3) field hands, (4) plantation size $3^{rd}$ quintile, (5) population density $3^{rd}$ quintile, (6) enlisted in the Confederate states, (7) enlisted between March 1863 and June 1864, (8) privates, and (9) infantrymen.

Table 4
Results of Logistic Regressions" Correlates of Probability of Dying from *Immunity Disease*

| Independent Variables | All Recruits | | | | | Recruits Who Contracted Disease | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | (1) Dying from Disease (mean = 0.047) | | (2) Contracting Disease (mean = 0.091) | | Mean | (3) Dying from Disease (mean = 0.304) | |
| | | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value | | $\partial P / \partial x_i$ | P-value |
| Age | 25.231 | -0.159 | 0.0063 | -0.159 | 0.0007 | 23.709 | -0.046 | 0.7286 |
| $Age^2 \times 10^{-1}$ | 70.555 | 0.026 | 0.0033 | 0.023 | 0.0018 | 62.910 | 0.011 | 0.5735 |
| Skin color brown | 0.077 | -0.747 | 0.0621 | -0.418 | 0.1672 | 0.052 | -0.788 | 0.1252 |
| Skin color light | 0.045 | -0.340 | 0.5741 | 0.066 | 0.8785 | 0.047 | -0.708 | 0.1984 |
| Height 1 (shortest 5th) | 0.210 | -0.180 | 0.6280 | -0.228 | 0.3775 | 0.174 | -0.191 | 0.7402 |
| Height 2 | 0.200 | 0.167 | 0.6965 | -0.021 | 0.9403 | 0.180 | 0.167 | 0.8173 |
| Height 4 | 0.256 | 0.198 | 0.6320 | 0.143 | 0.6158 | 0.145 | -0.296 | 0.5746 |
| Height 5 (tallest 5th) | 0.173 | 0.388 | 0.3983 | 0.160 | 0.5978 | 0.285 | 0.064 | 0.9216 |
| Unskilled and semi-skilled | 0.300 | 0.221 | 0.4275 | -0.032 | 0.8612 | 0.215 | 0.877 | 0.1550 |
| White-collar and skilled | 0.032 | <-999.999 | 0.9809 | 0.080 | 0.8869 | 0.703 | <-999.999 | 0.9800 |
| Farm size 1 (lowest 5th) | 0.131 | 1.234 | 0.0352 | 0.175 | 0.5628 | 0.273 | 4.370 | 0.0147 |
| Farm size 2 | 0.198 | -0.045 | 0.8933 | -0.135 | 0.5546 | 0.023 | 0.085 | 0.8859 |
| Farm size 4 | 0.180 | -0.249 | 0.4269 | -0.250 | 0.2672 | 0.157 | 0.291 | 0.6589 |
| Farm size 5 (highest 5th) | 0.255 | -0.537 | 0.0387 | -0.586 | 0.0014 | 0.209 | 0.218 | 0.7603 |
| Pop density 1 (lowest 5th) | 0.199 | -0.223 | 0.4683 | -0.181 | 0.4520 | 0.273 | 0.042 | 0.9468 |
| Pop density 2 | 0.207 | -0.043 | 0.8975 | 0.166 | 0.5186 | 0.192 | -0.015 | 0.9782 |
| Pop density 4 | 0.184 | 0.569 | 0.2572 | -0.349 | 0.1392 | 0.169 | 6.251 | 0.0059 |
| Pop density 5 (highest 5th) | 0.158 | -0.746 | 0.0074 | -0.619 | 0.0019 | 0.174 | -0.598 | 0.2356 |
| Enlisted in border states | 0.492 | -0.664 | 0.0013 | -0.223 | 0.2453 | 0.435 | -0.738 | 0.0088 |
| Enlisted prior to Mar. 1863 | 0.006 | <-999.999 | 0.9923 | <-999.999 | 0.9845 | 0.000 | NI | NI |
| Enlisted after June 1864 | 0.517 | -0.348 | 0.0975 | -0.214 | 0.1854 | 0.459 | -0.379 | 0.2964 |
| Higher initial rank | 0.054 | -0.107 | 0.8379 | 0.133 | 0.7260 | 0.059 | -0.311 | 0.6919 |
| Non-infantry duty | 0.245 | -0.728 | 0.0013 | -0.314 | 0.0806 | 0.174 | -0.802 | 0.0047 |
| | | -2LogL = 693.726<br>Chi-square = 74.036<br>P-value = 0.000 | | -2LogL = 1113.102<br>Chi-square = 58.261<br>P-value = 0.000 | | | -2LogL = 229.908<br>Chi-square = 48.000<br>P-value = 0.001 | |

Notes: The number of observations is 1887 for regressions (1) and (2), and 172 for regression (3). Dependent variables are dummy variables that equal 1 if a person died from an immunity disease for regressions (1) and (3), if a person contracted a disease for regression (2), and zero otherwise. NI = not included. The omitted categories are (1) black skin color, (2) height 3rd quintile, (3) field hands, (4) plantation size 3rd quintile, (5) population density 3rd quintile, (6) enlisted in the Confederate states, (7) enlisted between March 1863 and June 1864, (8) privates, and (9) infantrymen.

Table 5
Results of Logistic Regressions" Correlates of Probability of Dying from *Non-Immunity Disease*

| Independent Variables | All Recruits | | | | | Recruits Who Contracted Disease | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | (1) Dying from Disease (mean = 0.063) | | (2) Contracting Disease (mean = 0.518) | | Mean | (3) Dying from Disease (mean = 0.218) | |
| | | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value | | $\partial P / \partial x_i$ | P-value |
| Age | 25.231 | 0.075 | 0.2121 | -0.003 | 0.9267 | 24.982 | 0.112 | 0.1376 |
| $Age^2 \times 10^{-1}$ | 70.555 | -0.008 | 0.3565 | 0.000 | 0.9753 | 68.927 | -0.012 | 0.2568 |
| Skin color brown | 0.077 | -0.104 | 0.8102 | -0.642 | 0.0005 | 0.026 | 1.411 | 0.1955 |
| Skin color light | 0.045 | -0.784 | 0.1335 | -0.273 | 0.2292 | 0.040 | -0.784 | 0.1471 |
| Height 1 (shortest 5th) | 0.210 | -0.314 | 0.2216 | -0.056 | 0.7460 | 0.200 | -0.371 | 0.2079 |
| Height 2 | 0.200 | -0.427 | 0.0926 | -0.121 | 0.4814 | 0.180 | -0.516 | 0.0652 |
| Height 4 | 0.256 | -0.333 | 0.1715 | 0.309 | 0.1141 | 0.283 | -0.525 | 0.0333 |
| Height 5 (tallest 5th) | 0.173 | -0.265 | 0.3472 | 0.350 | 0.1051 | 0.189 | -0.492 | 0.0821 |
| Unskilled and semi-skilled | 0.300 | -0.345 | 0.0895 | -0.234 | 0.0297 | 0.255 | -0.200 | 0.4363 |
| White-collar and skilled | 0.032 | -0.711 | 0.2274 | -0.391 | 0.1602 | 0.022 | -0.566 | 0.4569 |
| Farm size 1 (lowest 5th) | 0.131 | 0.292 | 0.4093 | -0.116 | 0.5005 | 0.145 | 0.611 | 0.2134 |
| Farm size 2 | 0.198 | 0.089 | 0.7559 | -0.086 | 0.5749 | 0.209 | 0.194 | 0.5759 |
| Farm size 4 | 0.180 | -0.447 | 0.0993 | -0.076 | 0.6575 | 0.161 | -0.541 | 0.0556 |
| Farm size 5 (highest 5th) | 0.255 | -0.460 | 0.0851 | 0.008 | 0.9623 | 0.215 | -0.550 | 0.0508 |
| Pop density 1 (lowest 5th) | 0.199 | -0.524 | 0.0393 | -0.323 | 0.0299 | 0.139 | -0.407 | 0.2017 |
| Pop density 2 | 0.207 | -0.458 | 0.0628 | -0.188 | 0.2144 | 0.183 | -0.398 | 0.1757 |
| Pop density 4 | 0.184 | -0.132 | 0.6361 | -0.199 | 0.1988 | 0.227 | 0.037 | 0.9166 |
| Pop density 5 (highest 5th) | 0.158 | -0.438 | 0.0683 | 0.256 | 0.0992 | 0.163 | -0.417 | 0.1337 |
| Enlisted in border states | 0.492 | 0.160 | 0.5940 | 0.867 | 0.0000 | 0.602 | -0.394 | 0.1378 |
| Enlisted prior to Mar. 1863 | 0.006 | 3.046 | 0.1041 | 1.043 | 0.2544 | 0.009 | 2.108 | 0.2614 |
| Enlisted after June 1864 | 0.517 | 0.200 | 0.4046 | -0.321 | 0.0008 | 0.450 | 0.749 | 0.0288 |
| Higher initial rank | 0.054 | -0.034 | 0.9343 | -0.037 | 0.8722 | 0.057 | 0.085 | 0.8705 |
| Non-infantry duty | 0.245 | -0.778 | 0.0000 | -0.213 | 0.0601 | 0.222 | -0.245 | 0.0002 |
| | | -2LogL = 864.323<br>Chi-square = 73.684<br>P-value = 0.000 | | -2LogL = 2203.726<br>Chi-square = 101.698<br>P-value = 0.000 | | | -2LogL = 557.493<br>Chi-square = 62.541<br>P-value = 0.000 | |

Notes: The number of observations is 1887 for regressions (1) and (2), and 545 for regression (3). Dependent variables are dummy variables that equal 1 if a person died from a non-immunity disease for regressions (1) and (3), if a person contracted a non-immunity disease for regression (2), and zero otherwise. NI = not included. The omitted categories are (1) black skin color, (2) height 3rd quintile, (3) field hands, (4) plantation size 3rd quintile, (5) population density 3rd quintile, (6) enlisted in the Confederate states, (7) enlisted between March 1863 and June 1864, (8) privates, and (9) infantrymen.

Table 6
Hazard Rates of Dying from Disease: Number of Deaths per 1000 Men within 180-Day Intervals

| A. Any illnesses | | | | | | |
|---|---|---|---|---|---|---|
| Days | Field hands | Non-field | Rural | Urban | Small farm | Large farm |
| 0-180 | 74.7 | 64.1 | 71.5 | 35.5 | 71.6 | 48.1 |
| 181-360 | 53.4 | 31.3 | 34.8 | 65.4 | 46.2 | 21.1 |
| 361-540 | 49.0 | 30.8 | 44.5 | 40.8 | 52.8 | 19.2 |
| 541-720 | 32.9 | 33.8 | 37.8 | 25.4 | 37.7 | 31.0 |
| B. Immunity diseases | | | | | | |
| Days | Field hands | Non-field | Rural | Urban | Small farm | Large farm |
| 0-180 | 21.7 | 12.2 | 19.7 | 5.9 | 20.7 | 7.7 |
| 181-360 | 12.9 | 13.1 | 11.6 | 9.8 | 11.9 | 9.4 |
| 361-540 | 10.9 | 6.0 | 18.0 | 0.0 | 16.8 | 9.6 |
| 541-720 | 0.9 | 13.8 | 11.6 | 0.0 | 8.6 | 13.3 |
| C. Non-immunity diseases | | | | | | |
| Days | Field hands | Non-field | Rural | Urban | Small farm | Large farm |
| 0-180 | 29.2 | 17.7 | 32.1 | 17.8 | 33.3 | 19.2 |
| 181-360 | 26.2 | 11.6 | 16.4 | 29.4 | 22.4 | 7.0 |
| 361-540 | 24.5 | 13.9 | 19.1 | 30.6 | 27.6 | 3.2 |
| 541-720 | 19.2 | 7.7 | 14.5 | 16.9 | 15.4 | 13.3 |

Notes: The hazard rates for rural and urban residents and small and large farms are calculated based on the sample of non-immigrants for who the information on county of residence is given. The number of recruits who died from a particular type of disease within each 180-day interval was divided by the number of recruits who remained in service at the beginning of the time interval and then was multiplied by 1,000. If a recruit died from any other cause while in service or discharged alive, he was removed from the pool of population at risk. Since the discharge dates are reported for only a fraction of the recruits, the number of persons who discharged alive within each interval is estimated based on the experiences of those who have that information. For the classification of disease see text.

Table 7
Socioeconomic Backgrounds and Wartime Mortality from Disease: Comparison of White and Black Recruits

| | Dying from any disease | | | | Dying from immunity diseases | | | | Dying from non-immunity diseases | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Whites | | Blacks | | Whites | | Blacks | | Whites | | Blacks | |
| | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value | $\partial P / \partial x_i$ | P-value |
| Age | 0.014 | 0.4791 | -0.068 | 0.0639 | -0.011 | 0.5847 | -0.194 | 0.0004 | 0.057 | 0.0405 | 0.032 | 0.5759 |
| $Age^2 \times 10^{-1}$ | 0.001 | 0.8693 | 0.014 | 0.0129 | 0.002 | 0.7610 | 0.032 | 0.0002 | -0.004 | 0.3450 | -0.003 | 0.7608 |
| Height | 0.004 | 0.6776 | 0.067 | 0.0114 | 0.008 | 0.6653 | 0.093 | 0.0414 | 0.009 | 0.5160 | 0.027 | 0.4764 |
| Non-farm | -0.375 | 0.0000 | -0.393 | 0.0011 | -0.539 | 0.0000 | 0.028 | 0.9070 | -0.274 | 0.0052 | -0.441 | 0.0129 |
| Skilled | -0.389 | 0.0000 | -0.597 | 0.0872 | -0.502 | 0.0000 | 0.000 | 0.9820 | -0.344 | 0.0000 | -0.779 | 0.1390 |
| Pop density 1 | 0.521 | 0.0000 | -0.403 | 0.0252 | 0.431 | 0.0063 | 0.140 | 0.7289 | 0.590 | 0.0000 | -0.624 | 0.0064 |
| Pop density 2 | 0.155 | 0.0772 | -0.014 | 0.9287 | 0.216 | 0.1487 | 0.341 | 0.3042 | 0.118 | 0.3616 | -0.301 | 0.0991 |
| Pop density 4 | 0.010 | 0.9115 | -0.229 | 0.3006 | 0.080 | 0.5990 | -0.735 | 0.0796 | 0.153 | 0.2542 | -0.301 | 0.2944 |
| Pop density 5 | -0.313 | 0.0002 | -0.139 | 0.6934 | -0.576 | 0.0000 | -0.002 | 0.9978 | -0.011 | 0.9369 | -0.085 | 0.8592 |
| Higher initial rank | -0.398 | 0.0000 | -0.026 | 0.9282 | -0.366 | 0.0187 | -0.015 | 0.9781 | -0.396 | 0.0017 | 0.224 | 0.6017 |
| Non-infantry duty | -0.667 | 0.0000 | -0.715 | 0.0000 | -0.752 | 0.0000 | -0.746 | 0.0006 | -0.616 | 0.0000 | -0.705 | 0.0000 |
| Prior to Mar 1863 | 0.422 | 0.0000 | 3.319 | 0.0196 | 1.035 | 0.0000 | 0.000 | 0.9922 | 0.091 | 0.3937 | 2.814 | 0.1044 |
| After June 1864 | -0.507 | 0.0000 | -0.264 | 0.0207 | -0.188 | 0.2779 | -0.462 | 0.0080 | -0.658 | 0.0000 | 0.020 | 0.9191 |