Death is the final event in the life of a person, but what structures its timing is not just the characteristics of the individual. Until the last few decades, studies of socioeconomic differentials in mortality depended on data collected for populations located in geographic units. Thus when nineteenth-century English investigators commented on the high mortality of the poor, they had to rely on correlations among registration districts in the incidence of the poor and the death rate. A skeptic might charge that this conclusion rested on an ecological fallacy as the evidence did not reveal who actually died within each district.

Although based on necessity and dependent on published data, this approach is conceptually not entirely fallacious. Family reconstitution studies of early modern village populations suggest that socioeconomic differences in mortality of people living in an area tended to be small or non-existent, whereas differences between areas, particularly cities and rural areas, tended to be very large (Smith 1982). The risk of death faced by individuals in the past was one that they partially shared with their neighbors. In a mortality regime dominated by infectious diseases, people living in proximity were exposed to the common dangers lurking in the food, water, and air. On the other hand, such influences shared by people living closely together are certainly not the entire story. Over and over again, for example, demographers have shown that death rates vary systematically with age.

Data sets constructed recently, such as the one detailing the life and death experience of Union Army enlisted men serving in the Civil War and after (Fogel 1991), represent a major advance beyond studies constrained by published tabulations. First, multiple and overlapping

factors associated with the incidence of death can be assessed simultaneously. Second, variation in the risk of death can be examined over time.

Paradoxically, the pioneering analyst of disease mortality of individual soldiers that is recorded in this unique data set found that factors beyond the individual were important. Variations between urban and rural areas and between rural farmers and non-farmers, indices interpreted as tapping the incidence of prior exposure to disease, were a major determinant of the risk of acquiring and dying from disease in the army. Childhood nutrition and health, inferred from height, did not matter. Economic resources, indexed by property wealth recorded in the federal census of 1860 may have had an influence only for diseases related to nutrition among residents of metropolitan counties. (Lee 1997; 2000). It was not just the economists who might or should be surprised by these results. Historical demographers are confident that death rates for adults steadily increase with age, even among young men who served in the army. Yet this routinely-observed pattern only appears for non-farmers and for men enlisting in metropolitan counties (Lee 2000).

These results contain three paradoxes. First, the healthier, the wealthier and large groups of the younger were not unambiguously more likely to live than the less healthy, poorer, and older. Second, the analysis of a unique individual-level data set uncovered the importance of a factor—prior exposure to disease—whose source was collective. Third, the orientation of discipline of epidemiology (or sociology) seems to be more relevant for understanding these result than those of economics and demography.

## EXPOSURE TO RISK AT PLACE OF ORIGIN: URBANIZATION & MORTALITY

Given their importance, more needs to be known about the definition, scope, and functioning, of disease environments. Building on Lee's work, this paper combines both individual- and aggregate-level data and attempts to specific several of the correlates of disease mortality at a finer level of detail. An investigation of the incidence and timing of disease mortality among Union Army enlisted men in companies from New York state is placed in the context of a parallel study of mortality of regiments and other units of army volunteers that were organized in the Empire State.

New York is the focus primarily because of a uniquely detailed published tabulation of outcomes of military service regiments. Its author was Frederick Phisterer (1912, v. I, 288-303), a pioneering statistician of the Northern military effort during the Civil War (1907).[1] For officers and enlisted men, he reported the numbers killed in action, died of or recovered from wounds received in action, died of disease, and died of six other known causes and one unknown cause that were less frequent. He also tabulated these data separately for those who became prisoners of war and those who were never captured. Contemporaries and historians of the Civil War have highlighted the horrendous conditions and high death rates in prisoner-of- war camps. Since the fraction of a regiment that fell into enemy hands varied considerably depending on circumstances (the median percentage was 5.35 while the mean was 7.96 and the standard deviation 11.38), this adjustment is useful.

Among the 267 New York units, there were 183 regiments of infantry, 33 of cavalry, 3 of engineers, and 48 regiments, battalions, or batteries of artillery. Unlike most of the compilers of

[1] Born in Germany in 1836, Phisterer served in the regular army, entering as a private in the artillery in 1855 and leaving as a sergeant in 1861. Re-enlisting in the U.S. army in July 1861, he was discharged as captain in 1870. From 1877 onward he was active in the National Guard, rising to the rank of Brevet Major-General and the position of Adjutant-General of the New York National Guard. Living in Albany, between 1890 and 1908, he

other state reports, Phisterer provides an approximation of the population at risk. However the column headed by the phrase "the number of men in organization among whom losses occurred." misleads. The heading in the recapitulation replaces "men" with "enlistments," indicating that those who re-enlisted were counted more than once. In either case, the available proxy for the population at risk does not take account of other causes of attrition—transfer, desertion, discharge, etc.[2] Finally, Phisterer provides a detailed summary of the history of the unit, including the dates it was mustered in and out and places where it served. The former allows the calculation of death indices by duration, and the latter information can be translated into regional disease environments.

In the nineteenth century, urbanization was closely related to health and mortality. Contemporaries certainly believed that men in large cities were less healthy than men from the countryside. A medical examiner of draftees and recruits for a New York City district noted, among other comments, that "congestive diseases, as apoplexy, delirium tremens, &c, dependent on causes too palpably incident to a large, crowded, immoral, and ill-cleaned city to need specification, are numerously met with" (Roberts, June 28, 1865, p. 264). Another city medical examiner, Dr. W.H. Thompson, reported on the unhealthy conditions in his district, especially for the Irish. He was also "struck with number of persons among the better classes, and native Americans, with weak constitution, deficient girth of chest, and slender physique, especially among the younger men. The contrast, in this respect, with what I had noted in American country-recruits in 1862 is so marked that I have been led to consider city-life in New York as exerting an

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published three editions of a five-volume survey totaling 4,499 pages on the New York men and units who fought in the Civil War.

[2] Since the population at risk cannot be precisely captured, these measures are referred to as death indices rather than rates.

unfavorable influence on physical development, especially in children" (Thompson June 28, 1865, vol. I, p. 252).

There were other towns and cities in the state outside of New York City. Further, factors other than urbanization, such as residence along the Erie Canal, could be associated with exposure to disease. Data from New York state allow a subtler isolation of ecological variables that theoretically are associated with the extent of prior exposure to disease than is possible by merely characterizing counties as urban or rural. Two sources were used to index the disease environment among counties within the state of New York. Three censuses—the 1850 federal and the 1845 and 1855 state returns—yielded a relative index, however underestimated, of the crude death rate in each county. Township-level data from the 1845 census were also used to calculate the proportion in each county that resided in places 2,500 and larger and 5,000 and larger.

Although men in regiments and especially companies were recruited locally, they did all come from the same county. A rather elaborate procedure was used to index the disease environment of recruits in the various military units. Based on reports from the families to which they belonged, the 1865 state census tabulated, for each regiment or other unit, the number of living New York-resident soldiers who were from each county (New York Secretary of State 1867, 637-48). The four counties with the largest share of troops in the 278 units included on average 74% of the men. In the 192 infantry regiments, the figure was 77%. The estimated death and urbanization index for each regiment was the average, weighted by the share of each county and the residual in the totals of living soldiers reported for each unit, of crude death rates and urbanization rates in these four counties and the residual.

The data from the New York state census of 1845 indicate (see Table 1) that the urbanization effect on mortality is continuous rather than dichotomous. Crude death rates increased from a rate of 11.4 per 1,000 in townships under 1,000 in population to a rate of 15.7 per 1,000 for places between 7,500 and 60,000 in size. The rate for New York City was even higher—16.9 per 1,000.[3] Although the town rather than the county appears to be a better unit to isolate the disease environment in childhood, practical considerations limited my refinement of the urbanization effect to the level of the county.

The published results of examinations for military service during the last half of the war provided estimates of the fraction of draftees, and of recruits and substitutes rejected for service of those presumably examined medically (Baxter 1875, vol. I, pp. 637-767; Fry 1866, 165-213 ).[4] Since recruits and substitutes sought to join the army, their rejection rate is more likely than that for draftees to reflect actual health status (Smith 2000a).[5] These data are reported for 31 registration districts whose boundaries were those of to Congressional districts. The rate for the registration district was assigned to each county it included. As before, the rate for the regiment is imputed by the weights derived from the distribution among counties reported in the 1865 state census.

As Table 2 shows, the imputed background urbanization and death rates for regiments and other units correlate with the deaths from disease during the Civil War. Regiments whose recruits came from counties that were more rural and that had lower crude death rate experienced higher

[3] In his studies, Lee operationalized the effect of prior exposure to disease with a rural-urban dichotomy, based on having a city over 10,000 in Ohio, or in a metropolitan area in 1860 for troops from the entire North. Six counties—Albany, Erie, Kings, New York, Richmond, Rensselaer—of the sixty in New York in 1860 1860 were classified as urban. It is quite plausible that men who enlisted in the 54 non-urban counties had not, on average, been exposed to disease to the extent of those joining in the six urban counties.

[4] These estimates assume that draftees rejected for non-medical reasons were never medically examined and that recruits and substitutes rejected because they were too old or too young were also not examined (Smith 2000).

mortality during the war. Regiments whose men were from counties that were part of Congressional districts where fewer recruits and substitutes failed their medical examinations in the final two years of the war also had higher disease mortality during the war.

The relationship between imputed county of origin characteristics to mortality during the war is not as linear or continuous as the relationship between town size and the crude death rate in 1845 (Table 1). Further, there was substantial variation not accounted for by the different classifications (see the $Eta^2$ statistics in Table 2) . The plan to develop a background mortality index that would complement the urbanization effect failed. Instead a methodological mountain has yielded something of a substantive mole hill. Since the background urbanization and mortality indices were highly correlated (0.7 to 0.9), only one can be employed as a predictor of the wartime disease mortality index.

## DISEASE MORTALITY AND SHARED VS. DISTINCT DISEASE ENVIRONMENTS OF MEN AND REGIMENTS

In addition to throwing men together from diverse disease environments, soldiering during the Civil War sent men into regions of the country with a range and variable intensity of disease patterns. The aggregated results tabulated by Phisterer permit some insight into the scope of disease environments in the Union Army. Usually ten companies, originally composed of approximately 100 men each comprised an army infantry regiment. Although companies were sometimes detached from their regiments for special service, usually they did not. Companies in regiments in which the other companies had higher disease death indices also suffered a higher

[5] In the calculation, those excluded because they were under- or over-age were excluded from the denominator,

incidence of fatalities from disease. A one percent increase in the disease death index of the men in all other companies in the regiment is associated with nearly a one percent increase in death index for companies in the New York regiments that experienced a high rate of combat-related deaths.(Fox 1974; orig. pub. 1898, 183-241).[6] While common regional origin within New York is also relevant, the regression equation below also points to an effect from the region of service during the war:[7]

**Company Disease Index = 7.87 + (0.881) x (Other Men in Regiment Disease Index)**

**F=233.3; Slope Standard Error = (0.058) N=443 companies; Adjusted $R^2$=0.346**

Officers who led army companies obviously shared geographic locales with the men they led. Each company typically had three officers—a captain, a first lieutenant, and a second lieutenant and thus each regiment typically included only 30 line officers and nine staff officers (Shannon 1928, vol. II, 270). As the size of companies and regiments shrank through attrition, officers were more likely to be replaced than were men. The best estimate is that just over 5% of men in New York units in the Union Army were officers.[8] In just over a quarter of the regiments, no officers died from disease outside of prison, and nearly 80% of the regiments had two or fewer disease deaths among officers. Given the small numbers in the base population of officers, it is not surprising that the correlation of the disease death index of officers and men within regiments is

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as it was assumed that they never had a medical examination.

[6] Included in this analysis are the 39 "fighting regiments" that had more than 130 men killed or died from wounds or, if in a smaller unit, had a high percentage of such combat deaths.

[7] This relationship could be spurious to the extent that the compiler William Fox had more complete coverage of either the deaths or the numbers enrolled in a unit.

[8] In his detailed assessment, Phisterer (1907, vol. I, 186, estimated that there were 16,000 officers and 294,000 enlisted men in New York volunteer units. Officers thus comprised 5.16% of the total strength, the figure used in dividing the figure for the total in the organization..

weak. On average, a 1% increment in the disease index for enlisted men increased the officer index by only a sixth of one percent.

**Officer Disease Index = 10.35 + (0.172) x (Enlisted Men Disease Index)**

**F=21.46; Slope Standard Error = (0.037) N=228 regiments Adjusted $R^2$=0.083**

Any novelty in destination of service could be dangerous, as the two exceptional units that stayed home hint. The 925 men in the 20th and 28th artillery batteries, originally part of Anthon's Battalion, which was organized in late 1862 in New York City, served throughout the entire course of the war in Forts Schuyler and Columbus that guarded New York harbor. Only twelve of these men died of disease giving them a death index of 5 per 1,000 man-years, a mere fifth of the overall average for soldiers from the state.

Most New York regiments served only in the Eastern Theatre of Operations and there mostly in the ninety miles between Richmond, Virginia and Washington, D.C. Categorizing the units by a distinctive other region of service, Table 3 suggests that being sent to Louisiana or to along the Gulf of Mexico was the most hazardous. The lower Mississippi seems to have lived up to its reputation as a deadly region. However, experience in North or South Carolina, which was limited to the coastal area until the very end of the war, did not yield remarkably higher mortality indices.

There was, however, marked variation in the incidence of disease within regions.[9] This variability is to be expected. At some point, as the incidence of sickness increases, a "tipping

[9] Many of the regiments that had some experience outside of the Eastern Theatre also spent time within that area. Employing analysis of variance for both four- and five-category regional classifications shows that the difference between regions was significant only at the 0.1 level.

point" may be reached, after which the number of cases and fatalities accelerates in a way not predictable by objective conditions. Such an epidemic occurred in the five regiments of the Vermont brigade in the fall of 1861, units whose living and sanitary conditions were, according to investigators, no more miserable than regiments in which the incidence of sickness was quite low (Benedict 1886, 237-40). Even without such an accelerent, clustering of deaths within particular companies and regiments is to be expected. These units encountered particular circumstances or their members had special characteristics that are not known or knowable to an investigator nearly a century and a half later.

Officers and men in the same regiment may have advanced (or failed to advance) through the South together, but they did not share entirely the smaller disease milieu of the camp. Phisterer's tabulations are especially valuable here in suggesting the boundaries of disease environments. Overall, enlisted men were three times as likely to die from disease as were officers (see Table 3). While the CPE sample is restricted to enlisted men, limited evidence indicates that officers were taller, more likely to be native-born, and more frequently drawn from the ranks of the middle class than enlisted men. As noted, these attributes are not associated with a lower death rate from disease. Whether officers were more likely to come from cities and larger towns than enlisted men is uncertain.

Officers and men did not live in immediate proximity. According to regulations, privates in an army camp were grouped by company with a street in between. At one end, perpendicular to the street of enlisted men, were rows: first, non-commissioned officers, then the commissioned officers of the companies, and finally that of the staff and commander of the regiment who were located in front of the baggage train. Behind the baggage train were the latrines for the officers,

while the soldiers relieved themselves in latrines at the opposite end of the camp (Wiley 1952, 55 and note 45, p. 373). Officers and men also ate at separate messes, and officers used their own funds to purchase food. The leaders and the led shared geographically-defined disease environments (e.g., malarial regions) but not what might be called the micro-microbe-disease space.

The four-fold ratio of the mortality indices between officers and enlisted men incarcerated in prisoner of war camps also illustrates the importance of the environment in which those in the Union Army served. With rare exceptions, Union officers were imprisoned in camps apart from captured enlisted men (Marvel 1994, 293). Imprisoned officers died more frequently than those who were never captured (and at much higher rate if duration of exposure could be calculated), but conditions for captured officers sometimes were not harsh (Mitchell 1988, note 64, p. 221). Nearly one in six captured New York enlisted men died in Confederate prisons compared to one in twenty-five officers.

A common circumstance—being wounded in action—yielded quite similar mortality outcomes for officers and enlisted men. Indeed, a slightly higher percentage of wounded officers died (13.6%) than wounded men (12.2%). Possible explanations of this similarity are that the distribution of severity of the wounds was not radically different for men and officers and that post-wound infections were a great leveler. All else equal, officers should have had a lower wound case fatality rate. Because they were salaried and paid for their food, wounded officers were not hospitalized with enlisted men. If the wounds were minor, they were cared for in their own quarters by an orderly. Other options for wounded officers included care in a private hospital or sick-leave at home (Adams 1952, 171-72). The smaller disparity between the mortality indices

among officers and men prisoners of war due to wounds and other causes (19.5 and 32.7 per 1,000) compared to disease (39.8 and 156.6) leads to the speculation that officers were, on average, more severely wounded than men.

## MEASURING LENGTH OF OBSERVATION AND DEATHS OF INDIVIDUAL ENLISTED MEN IN NEW YORK SAMPLED COMPANIES

Key to demographic analysis is the concept of population at risk. The rich detail in the sample of Union Army enlisted men can be exploited to capture when men first came under observation and when they no longer were. To do so required a variety of assumptions. In the version of the data set used in this paper, there were 7617 enlisted men. For 208 (2.73%), there were no dates except that for enlistment recorded on the descriptive roll of the company, the original source of the data. With the assumption that no military service record could be located, these men were dropped from the analysis; the implicit assumption here is that their mortality experience in the army was identical to those whose entry and exit dates could be determined.

Accepting the enlistment date provided in the descriptive rolls as the appropriate date of entry into observation was the most critical assumption. Other sources, presumably the military service records, provided up to three separate enlistment dates. Of these, some 7.5% came six or more months before the enlistment date on the descriptive roll and 5.4% came a year or more earlier. In all, 13.6% had an earlier date of enlistments, but very short intervals can be attributed to slight variants in recording the same date or as the result of men who served previously for three months under Lincoln's original call of April 15, 1861 for 75,00 men. New York provided 13,906 men in this instance. The longer intervals may be attributed to those enlisting in a sampled company

after serving two years under the second call of 1861 in other company or regiment. New York provided the only troops (30,950) enlisting for two years under this call (Phisterer 1907 ,3-4). Whatever the reason for the discrepancy between the enlistment date recorded on the descriptive roll and the enlistment dates appearing on other records, the former must be correct from a demographic perspective. The soldier is not at risk to die before joining one of the companies that were sampled at the beginning of the project. However, for 2.7% of the cases missing information on the date of enlistment in the descriptive roll an enlistment date from other records was taken as the date of entry into observation.

Some ambiguity exists with respect to the date the soldier was last under observation during the war. On the assumption that the date of death was an important and definitive event, and given that there are not variant records of this date, it was accepted as correct. Of those who died of disease before 1866, 6.9% had some other occurrence in their lives recorded as taking place **after** they had died. For 3.5% of these deaths this unnatural event occurred more than three months after they had died. Since the timing of this post-mortem event was found by computing the maximum date among all of the many events recorded by date in the data—discharge, military court action, release from hospital, etc.—the procedure is sensitive to errors in the original records or in the data entry.

If no death during the war era was recorded, the men were regarded as being under continuous observation in the first period until the date of the latest event recorded unless there was a definitive break of more than 0.25 years between a seeming date of departure and a subsequent date of re-entry. The working assumption here was that a soldier was really under continuous observation until proven otherwise, a conjecture that by expanding the period at risk tends to

minimize the measured mortality rate. For example, someone who deserted but later returned was treated as never having left. It would be possible to make better judgments, on a case by case basis, as to whether someone was really under observation at every point. Using assumptions that maximized the apparent length of the first period that the solider was under continuous scrutiny, the goal was to minimize the complexity of the data set.. Only if there was a gap of more than 0.25 years between a date of discharge and a date of re-enlistment was the first period terminated by the discharge date. In this paper, the relatively few second and ever fewer subsequent observation spells that began with re-enlistments were excluded from the analysis.

Limiting this study to one state, even one as large as New York, sharply reduces the number of events to be analyzed. To maximize that number, 619 deaths from all specified non-combat causes are included. While death from disease was not rare by the standards of nineteenth-century civilian experience, only 8.3% of sampled soldiers died from these causes. Almost half of the deaths were due to two causes: diarrhea (27.5%) and typhoid (22.3%). Other relatively numerous killers were fevers of various types (6.8%), dysentery (4.5%), tuberculosis (3.7%), pneumonia (3.2%), scurvy (2.6%), and starvation (2.6%). A handful of deaths probably incident to wounds (gangrene, erysipelas, and possibly some of the unspecified diseases) are included.

## SEASONING AND THE EFFECT OF DURATION OF SERVICE

Seasoning—the elevation of disease and death from disease that occurred as a consequence of movement—is a pervasive phenomenon in the literature of historical demography. Whether moving to cities in the early modern era, to the Chesapeake region from Britain in the

seventeenth century, or into the Union Army from rural Ohio, arrivals did poorly during their initial exposure to the new disease environment. As Table 4 demonstrates for enlisted infantry men in units organized in New York state, death from disease declined with the length of time served. The overall death rate from disease was 46.0 per 1,000 man-years. In the first year of observation the rate was 55.6 compared to 41.8 for the second year. For those under observation longer than two years, the rate was 34.8 per 1,000 from that duration until the time of exit.

As was the case for Ohio troops (Lee 1997 ,42), the chances of death peaked well into the first year of service. In New York, the death rate for the first six months was lower (45.2 per 1,000 man-years) than in the second six months (69.2). The risk of death from disease continued to decrease after the first year of service. Possibly due to the small sample of deaths in later six-month intervals, the decrease was not monotonic. Lee also found a second peak toward the end of the second year of service in his analysis of Ohio troops.

The seasoning effect is intertwined with the destination of service. If most of the service in a region were concentrated into the first segment of a company's tour of duty, then the apparent effect of serving in that region would be exaggerated. Table 5 divides the sample into the first and all other subsequent geographic locations of service. The results concur with the finding in the regimental-level data (Table 3) that service in the Louisiana and Gulf Region was most hazardous to life. However, these data, tabulated throughout by the region of first service, suggest that the apparent higher mortality in Louisiana and the Gulf is elevated because of the high rate of New York men sent there at the beginning of their time in the army. Puzzlingly, initial service in the Carolinas was not less deadly than soldiering elsewhere in the South.

Many factors significantly relate to the incidence of disease death of New York enlisted infantry men. For each of these variables, the third column of Table 6 reports the index per 1,000 men of dying from disease while they were in the Union Army. (The percentage of men in each category appears in the second column.). Overall, 8.36% of those who enlisted died from disease while they were in the army.

Three variables—year of enlistment, term of service, and birth cohort—should be regarded as controls. These indicators have statistical but not substantive relevance. The first two affect the proportion ever dying of disease by altering the potential period at risk. It is not surprising, for example, that only 2.3% enlisting in 1865 died of disease while in the army. Age, of course, bears a substantive relationship to the risk of death, but this relationship is so well known that it lacks much interest. That only the oldest age group—those born before 1830—had a higher fraction die of disease may be attributed mostly to the fact that men born before 1830 were much older than the birth cohort of the 1830s. They were 38.6 years old at the time of enlistment compared to 26.6 for those born in the 1830s and 19.8 for those born in 1840 or after. Depending on location or status, infantrymen differed in average age. For example, natives were three years younger than the foreign born, those enlisting in New York City were 1.1 years older and farmers were 1.3 years younger than the overall average. Such differences in age-distribution potentially can obscure or distort the relationships that are of more genuine interpretive interest. Hence age needs to be included as a separate variable in the analysis.

Three of the indicators reflect different wartime circumstances. Not surprisingly, ever being a prisoner of war of the Confederates was particularly deadly. No less than one-third of captured New York infantrymen died of disease. In addition, first serving beyond the Atlantic coast—either

in the Western Theatre or in the Louisiana-Gulf of Mexico region—elevated the disease death index.

Of particular interest are those attributes characterizing the soldiers at or before the time of enlistment in one of the sample companies. Those who had not previously served in the army (8.6%), farmers (12.0%), the native-born (10.3%)[10], those who enlisted in upstate New York outside of the areas of New York City and the Erie Canal (10.8%), and those who were of over 69 inches in height (10.4%) were notably more likely to die from disease in the army.

Additionally, men who enlisted in counties that had a lower rate of medical rejections for service of recruits and substitutes in the last two years of the war (r= -0.07), that were less urban in 1845 (r= -.07), and that had lower crude death rates in 1855 (r= -.08) were also modestly, but statistically-significantly, more likely to die from disease in the Union Army. As was shown by Lee (1997 2000), seemingly healthier men from apparently healthier environments were particularly like to succumb to disease during the war. Both the categorical and interval-level variables mentioned above have a plausible theoretical relationship to the extent of prior exposure to disease.

To deal with the influence of a range of interrelated variables requires, of course, a multivariate approach. Exhibiting a relatively simple approach to complexity, Table 6 uses logistic regression analysis to estimate the odds of death from disease over the entire period the soldier was in observation (Column 4).[11] Not unexpectedly, the statistical significance of many of the background variables disappears in this assessment, including height and all of the three covariates

[10] Based on what turned out not to be an insightful historian's judgment that the foreign-born in the mid-nineteenth century were a heterogeneous group both in terms of socioecnomic status and geographic location (especially the urban Irish and the rural Germans), effects for separate foreign nationalities were analyzed.
[11] Again, this index differs from a true cohort death probability since it does not account for varying lengths of time that the soldier was in the army before exiting via death from combat, desertion, discharge, etc.

characterizing the county of enlistment as well as the variable detailing the geographic region of enlistment within the state. Everything considered, farmers were more likely, and those born in Canada and Germany among the foreign-born were less likely to die from disease. Interpretation should follow the Seussian objection to identifying specific importance of any variable with "how many *** ("stars upon thars"). The level of statistical significance depends on how the variable was measured and categorized and the number of other similar indicators included in the analysis.[12] Recall that Table 1 suggested that a continuous relationship existed between the size of a town and the crude death rate. The county of enlistment is, of course, larger than the town of enlistment. Further, soldiers tended to enlist in central places—towns towns and cities that were larger than the place where they actually lived. Given the rates of geographic mobility in nineteenth-century America, the town of residence could often differ from the place he spent his childhood and youth. A safe conclusion is that prior exposure to disease did, all else considered, did increase the risk of death from disease while serving in the Union Army rather than it was farm background that *really* mattered..

To isolate the impact of seasoning, separate logistic regression analyses were undertaken of disease mortality during the first year (Column 5 of Table 6) and the interval following the conclusion of the initial year of service (Column 6). The logic here is that factors that affect seasoning should be much stronger in the first year than thereafter. Certain background factors that may be interpreted as having to do the prior exposure to disease, e.g. farm occupation, wane in magnitude after the first year. The results, however, are not entirely clear. Some of absence of

[12] As told by Dr. Seuss (Geisel 1961, 3-4), the Plain Belly Sneeches had "none upon upon thars."
"But, because they had stars, all the Star-Belly Sneetches
Would brag, We're the best kind of Sneetch on the beaches.".

clarity is due to the shrinkage of the sample. In the first year, some 302 disease deaths occurred to an original 6,786 enlistments. After the first year, there were only 265 deaths caused by disease among the 3,887 soldiers who were still in the army at the beginning of the second year of service. Thus, some of the odds ratios diverge after the first year, even though they are less likely to pass a test of statistical significance. In this regard, the possibly higher mortality of enlistees in New York and the counties contiguous to New York is suggestive when compared to the opposite relationship extant when no other variables are considered. Two of the factors related to wartime experience—being a prisoner of war, and the region of first service—increase in importance after the first year.

Even after taking into account both background and wartime factors, an indicator that relates to sharing of more particular mortality environments and/or the process of contagion also must be incorporated into the analysis. This indicator--the fraction of men who died from disease in a sampled regiment, other than the individual soldier—represents an attempt to operationalize the clustering in mortality experience associated with soldiering together that cannot be attributed to the broad geographic regions of service.[13] (Other than reporting the bivariate correlation, this indicator is omitted from the analyses in Table 6.)

Table 7 shows the impact of this indicator of within-regiment clustering of mortality. An increment of 10 per 1,000 in the disease death index of the other men in a regiment increased the death index of the individual within a regiment by 4.08 per 1,000. Its effect on the other variables shows up only in the attenuation of the impact of location of first service. Both location and the

[13] For example, consider a regiment with 100 infantry men that experienced eight deaths from disease. In this case, the clustering index for a soldier who died of wartime disease was 7/99, and 8/99 for a man who did not.

clustering of death within regiments are indicators measured at the level of the regiment rather than the individual. This clustering of death within regiments is an independent dimension of the structuring of disease mortality.[14]

This paper has demonstrated that a multiplicity of factors need to be considered to understand variation in death from disease of soldiers from New York during the Civil War. Background factors such as occupation and type of residence, sensibly viewed as related to the extent of prior exposure to disease, mattered. Once in the army, the risk of death varied depending on how long the soldier had served and whether he had prior military service. The background factors only mattered to any great extent during the initial year of experience in the army. Experience in the army also helped to determine disease mortality. If the soldier found himself in a more dangerous disease environment—along the lower Mississippi or the Gulf of Mexico, or, most drastically, in a prisoner-of-war camp—he was more likely to die from disease. Finally, the soldier shared mortality risks with those men whom he was in close contact with—the other enlisted men in his company and regiment. With the troops but not intermingled with them and the micro-organisms the embodied, officers were much less likely to succumb to disease.

Why did so many Union Army soldiers die of disease during the Civil War? Perhaps because the sources of mortality were so diverse.

[14] Without the addition of other variables, the ordinary least squares estimate is that an increase of 10 per 1,000 in the death index of other men in a regiment would increase the individual index by 5.6 per 1,000.

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Table 1.—Township Population Size and Census Crude Death Rate, New York 1845

| Population of Township | Crude Death Rate | ---Town Population--- Total | Percent | Number of Townships |
|---|---|---|---|---|
| Under 1000 | 11.4 | 60,792 | 2.3 | 94 |
| 1000-1499 | 12.5 | 159,255 | 6.1 | 124 |
| 1500-1999 | 12.5 | 325,197 | 12.5 | 184 |
| 2000-2499 | 12.9 | 343,542 | 13.2 | 153 |
| 2500-4999 | 13.1 | 825,108 | 31.7 | 247 |
| 5000-7499 | 14.2 | 231,129 | 8.9 | 39 |
| 7500-19999 | 15.6 | 107,478 | 4.1 | 10 |
| 20000-60000 | 15.8 | 177,460 | 6.8 | 5 |
| New York City | 16.9 | 371,223 | 14.3 | 1 |
| Total | 13.86 | 2,601,184 | ----- | 857 |

Source: Calculated from New York. Secretary of State, 1846.

Table 2.—Correlates of disease death indices for New York Regiments.

| Classification and Categories | Disease Death Index | Number of Regiments |
|---|---|---|
| Inferred crude death rate in 1845 | 69.4 | 258 |
| Under 11 per 1,000 | 94.8 | 7 |
| 12 per 1,000 | 82.3 | 52 |
| 13 per 1,000 | 80.9 | 86 |
| 14 per 1,000 | 55.1 | 69 |
| 15 per 1,000 and higher | 51.6 | 64 |
| $Eta^2$ and F-value | .023 | 1.50 |
| Inferred crude death rate in 1855 | 69.4 | 258 |
| Under 11 per 1,000 | 105.1 | 72 |
| 12 per 1,000 | 65.3 | 43 |
| 13 per 1,000 | 60.2 | 53 |
| 14 per 1,000 | 46.9 | 37 |
| 15 per 1,000 and higher | 49.0 | 53 |
| $Eta^2$ and F-value | .058 | 3.90** |
| Inferred share of population over 5,000 in 1845 | 69.4 | 258 |
| Under 20% | 98.8 | 48 |
| 20-30% | 89.8 | 72 |
| 30-50% | 50.3 | 64 |
| 50-70% | 47.4 | 44 |
| 70% and higher | 46.3 | 30 |

| | | |
|---|---|---|
| $Eta^2$ and F-value | .056 | 3.74** |
| Inferred share of population over 2,500 in 1845 | 69.4 | 258 |
| Under 60% | 105.8 | 73 |
| 60-70% | 60.1 | 74 |
| 70-80% | 53.5 | 54 |
| 80% and higher | 50.1 | 57 |
| $Eta^2$ and F-value | .058 | 5.19** |

Table 2.--continued.

| Classification and Categories | Disease Death Index | Number of Regiments |
|---|---|---|
| Inferred recruit medical rejection rate, 1863-65 | 69.4 | 258 |
| Under 215 per 1,000 examined | 106.2 | 61 |
| 215-300 per 1,000 | 67.9 | 97 |
| 300-350 per 1,000 | 45.6 | 35 |
| 350 and above per 1,000 | 49.9 | 65 |
| $Eta^2$ and F-value | .054 | 4.81** |
| Actual region of organization of regiment | 69.5 | 257 |
| New York County | 47.8 | 81 |
| County contiguous to New York County | 53.9 | 30 |
| County on Erie Canal | 71.7 | 60 |
| Elsewhere in state | 93.8 | 86 |
| $Eta^2$ and F-value | .039 | 3.59* |

Notes: *Signficant at .05; **Significant at 0.01.

Table 3.-- Disease Death Indices for New York Regiments and Other Units by Rank, Cause and Distinctive Region of Service, for Prisoners and Non-Prisoners.

| Region of Service of Regiment or Other Unit | -Disease Death Indices- Per 1,000 Man-Years | Per 1,000 Men | -----Number of----- Men | Units |
|---|---|---|---|---|
| Totals for Region of Service | 24.7 | 64.0 | 303,662 | 249 |
| Only in Eastern Theatre | 22.1 | 54.0 | 204,239 | 164 |
| -----Only in New York | 5.0 | 13.0 | 925 | 2 |
| Ever in Louisiana or Gulf Region | 41.8 | 110.5 | 30,229 | 28 |
| Ever in the Carolinas | 24.2 | 71.3 | 48,924 | 38 |
| Ever in Western Theatre | 27.0 | 77.4 | 20,270 | 19 |
| ----With Sherman to the Sea | 32.7 | 90.7 | 13,220 | 12 |
| ----Not with Sherman | 16.2 | 52.3 | 7,050 | 7 |
| By Military Rank | | 63.2 | 317,340 | 264 |
| --Enlisted Men | | 65.4 | 288,719 | 264 |
| --Officers | | 23.0 | 15,713 | 264 |
| After Being Wounded | | 123.2 | 55,442 | 267 |

| | | | | |
|---|---|---|---|---|
| --Enlisted Men | 122.2 | 52,245 | 267 | |
| --Officers | 136.1 | 3,197 | 267 | |
| Prisoners of War (Disease) | 153.0 | 31,066 | 267 | |
| ---Enlisted Men | 156.6 | 30,112 | 267 | |
| ---Officers | 39.8 | 954 | 267 | |
| Prisoners of War (Wounds and Other) | 32.3 | 31,066 | 267 | |
| ---Enlisted Men | 32.7 | 954 | 267 | |
| ---Officers | 19.9 | 30,112 | 267 | |

Notes: The denominator of the index based on men-years is the "number of men in organization among whom losses occurred" multiplied by the difference between date the regiment or other unit was mustered in and the date it was mustered out. Ideally, the denominator should be the average number of men in the unit over the duration of its service.

Source: Phisterer (1907), vol. I, pp. 80-91; 288-303.

Table 4.—Death Rates by Duration of Exposure, New York Union Army Enlisted Men

| Period of Exposure | Death Rate per 1,000 | Number of Deaths | Man-Years at Risk | Starting Cohort Size |
|---|---|---|---|---|
| Enlistment until exit | 46.0 | 613 | 13,325 | 7,548 |
| Enlistment to end 1st year | 55.6 | 330 | 5,928 | 7,548 |
| Start year 2 to end year 2 | 41.8 | 147 | 3,514 | 4,338 |
| Start year 3 until exit | 34.8 | 136 | 3,883 | 2,721 |
| First 6 months | 45.2 | 151 | 3,343 | |
| Second 6 months | 69.2 | 179 | 2,585 | |
| Third 6 months | 47.7 | 94 | 1,968 | |
| Fourth 6 months | 34.2 | 53 | 1,545 | |

| | | | | |
|---|---|---|---|---|
| Fifth 6 months | 50.3 | 62 | 1,232 | |
| After 2.5 years to exit | 27.9 | 74 | 2,652 | 2,283 |

Table 5.—Death Rates by Geographic Location of Service

| Region of Service | Death Rate per 1,000 | Number of Deaths | Man-Years at Risk |
|---|---|---|---|
| First Service Region Total | 50.0 | 458 | 9,152 |
| Eastern Theatre | 49.8 | 365 | 7,325 |
| Louisiana & Gulf | 71.2 | 61 | 856 |
| Carolinas | 26.6 | 24 | 903 |
| Western Theatre | 119.4 | 8 | 67 |
| For Second Geographic Region of Service | | | |
| First Service Region Total | 36.8 | 154 | 4,186 |
| Eastern Theatre | 32.2 | 95 | 2,947 |
| Louisiana & Gulf | 43.6 | 21 | 481 |
| Carolinas | 45.2 | 28 | 620 |
| Western Theatre | 71.9 | 10 | 139 |

| | | | |
|---|---|---|---|
| For Both First and Second Geographic Regions | | | |
| First Service Region Total | 45.9 | 612 | 13,338 |
| Eastern Theatre | 44.8 | 460 | 10,272 |
| Louisiana & Gulf | 65.9 | 82 | 1,337 |
| Carolinas | 34.1 | 52 | 1,523 |
| Western Theatre | 87.4 | 18 | 206 |

Table 6.—Logistic Regression of Longitudinal Disease Mortality Index by Timing of Death.

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| | Bivariate Results | | Entire Sample | Death in First Year | Death After First Year |
| Variables and Categories | Pct. | Index | Odds Ratio | Odds Ratio | Odds Ratio |
| Height**** | | | Group (n.s.) | Group (n.s.) | Group (n.s.) |
| Under 65 Inches | 16.3 | 71 | 1.02 | 0.97 | 1.08 |
| 65-66 Inches | 27.6 | 66 | 0.76* | 0.69* | 0.86 |
| 67-68 Inches | 28.7 | 88 | Ref. | Ref. | Ref. |
| 69 Inches or Taller | 27.4 | 104 | 1.05 | 1.01 | 1.13 |
| Inferred Previous Enlistment** | | | | | |
| (Before Date in Descriptive Roll) | | | Group** | Group* | Group (n.s.) |
| No discrepancy | 87.6 | 85 | Ref. | Ref. | Ref. |
| Gap under 1 Year | 8.3 | 96 | 1.01 | 1.09 | 0.93 |
| Gap greater than 1 Year | 4.1 | 25 | 0.26*** | 0.31** | 0.12* |
| Region of County of Enlistment**** | | | Group (n.s) | Group (n.s.) | Group (n.s.) |

| | | | | | |
|---|---|---|---|---|---|
| New York County | 26.5 | 60 | 1.05 | 0.49 | 2.24 |
| Contiguous to New York | 13.7 | 57 | 0.97 | 0.51 | 2.03 |
| On Erie Canal 20.0 | 85 | 0.95 | 0.77 | 1.19 | |
| Elsewhere in State | 39.8 | 108 | Ref. | Ref. | Ref. |
| | | | | | |
| Occupational Group**** | | | Group* | Group* | Group (n.s.) |
| Professionals & Proprietors | 7.9 | 50 | 0.80 | 0.54 | 1.12 |
| Unclassified & Missing | 3.6 | 65 | 0.95 | 0.73 | 1.20 |
| Farmers | 31.2 | 120 | 1.37** | 1.39* | 1.16 |
| Workers | 57.3 | 70 | Ref. | Ref. | Ref. |
| | | | | | |
| Country of Birth**** | | | Group* | Group (n.s.) | Group (n.s.) |
| USA | 53.5 | 103 | Ref. | Ref. | Ref. |
| Canada | 7.0 | 61 | 0.60* | 0.68 | 0.55 |
| England | 4.4 | 71 | 0.85 | 0.82 | 0.94 |
| Ireland | 19.4 | 66 | 0.76 | 0.65* | 0.84 |
| Germany | 10.7 | 48 | 0.57** | 0.65 | 0.60 |
| Other Foreign Country | 5.0 | 59 | 0.64 | 0.58 | 0.71 |
| | | | | | |
| Year of Enlistment**** | 100.0 | 83.6 | Group* | Group**** | Group (n.s.) |
| 1861 | 26.4 | 83 | 0.99 | 0.51** | 1.48 |
| 1862 | 32.5 | 107 | 1.08 | 0.64 | 1.61 |
| 1863 | 9.7 | 99 | Ref. | Ref. | Ref. |
| 1864 | 20.6 | 72 | 1.04 | 1.36 | 0.75 |
| 1865 | 10.8 | 23 | 0.41** | 0.61 | 0.04 |

Table 6.—Longitudinal Disease Mortality Index by Timing of Death (continued).

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| | Bivariate Results | | Entire Sample | Death in First Year | Death After First Year |
| Variables and Categories | Pct. | Index | Odds Ratio | Odds Ratio | Odds Ratio |
| | | | | | |
| Birth Cohort**** | | | Group**** | Group**** | Group**** |
| Before 1830 | 20.6 | 124 | 1.97**** | 1.80*** | 2.41**** |
| 1830-1839 | 35.3 | 71 | 0.96 | 0.88 | 1.11 |
| 1840 and After | 44.1 | 75 | Ref. | Ref. | Ref. |
| | | | | | |
| Location of 1st Distant Service in Field**** | | | Group** | Group (n.s.) | Group** |
| Eastern Theatre | 78.0 | 80 | Ref. | Ref. | Ref. |
| Louisiana or Gulf | 8.9 | 133 | 1.72*** | 1.24 | 2.01*** |
| Carolinas | 11.1 | 61 | 1.10 | 0.51* | 1.50 |
| Western Theatre | 2.0 | 133 | 1.50 | 1.23 | 0.97 |

| | | | | | |
|---|---|---|---|---|---|
| Ever a Prisoner of War**** | | | Group**** | Group*** | Group**** |
| Yes | 3.0 | 332 | 6.33**** | 2.55*** | 8.72**** |
| No | 97.0 | 76 | Ref. | Ref. | Ref. |
| Length of Term*** | | | Group (n.s) | Group (n.s) | Group (n.s.) |
| Under 3 Years | 14.5 | 54 | 0.79 | 0.89 | 0.30 |
| 3 Years or More | 85.8 | 89 | Ref. | Ref. | Ref. |
| Interval-level Covariates (Bivariate Pearson Correlations)[a] | | | | | |
| Medical Rejections | | | -.072*** | -.088*** | -.014 (n.s) |
| Urbanization 1845 | | | -.071*** | -.061*** | -.032 (n.s.) |
| CDR 1855 | | | -.083*** | -.085*** | -.031* |
| Regimental clustering[b] | | | .1210*** | .088*** | .072*** |
| Intercept and standard error | | | -1.90 (.38)**** | -2.09(.49)**** | -2.66(.58)**** |
| Initial -2 Log Likelihood | | | 3900.0 | 2469.9 | 1934.8 |
| Improvement with Model | | | 309.7**** | 170.3**** | 165.8**** |

*Sig. at .05 **Sig. at .01; ***Sig. at .001; ****Sig. at .0001

[a] Definitions of Interval-level covariates. In the logistic regressions, none of the fist three below were significant:
Medical Rejections of Recruits, 1863-65
Pct over 5,000 in 1845 in County of Enlistment
Crude Death Rate 1855 in County of Enlistment
[b] Proportion Dying of Disease of Others in the Regiment (not entered into the regression)

Table 7.—Logistic Regression of Longitudinal Disease Mortality Index with Regimental Clustering.

| | Unadjusted | With Cluster Variable |
|---|---|---|
| | Entire Sample | Entire Sample |
| Variables and Categories | Odds Ratio | Odds Ratio |
| Year of Enlistment | Group* | Group* |
| 1861 | 0.99 | 1.04 |
| 1862 | 1.08 | 1.01 |
| 1863 | Ref. | Ref. |
| 1864 | 1.04 | 1.10 |
| 1865 | 0.41** | 0.47* |

| | | |
|---|---|---|
| Ever a Prisoner of War | Group**** | Group**** |
| Yes | 6.33**** | 5.70**** |
| No | Ref. | Ref. |
| Length of Term | Group (n.s) | Group (n.s) |
| Under 3 Years | 0.79 | 0.89 |
| 3 Years or More | Ref. | Ref. |
| Birth Cohort | Group**** | Group**** |
| Before 1830 | 1.97**** | 1.98**** |
| 1830-1839 | 0.96 | 0.75 |
| 1840 and After | Ref. | Ref. |
| Height | Group (n.s.) | Group (n.s.) |
| Under 65 Inches | 1.02 | 1.02 |
| 65-66 Inches | 0.76* | 0.76* |
| 67-68 Inches | Ref. | Ref. |
| 69 Inches or Taller | 1.05 | 1.04 |
| Location of 1st Distant Service | Group** | Group* |
| Eastern Theatre | Ref. | Ref. |
| Louisiana or Gulf | 1.72*** | 1.44* |
| Carolinas | 1.10 | 1.13 |
| Western Theatre | 1.50 | 0.74 |
| Occupational Group | Group* | Group* |
| Professionals & Proprietors | 0.80 | 0.79 |
| Unclassified & Missing | 0.95 | 0.95 |
| Farmers | 1.37** | 1.35** |
| Workers | Ref. | Ref. |

Table 7.—Disease Mortality Death (continued).

| Variables and Categories | Unadjusted Entire Sample Odds Ratio | Cluster Variable Entire Sample Odds Ratio |
|---|---|---|
| Country of Birth | Group* | Group* |
| USA | Ref. | Ref. |
| Canada | 0.60* | 0.60 |

| | | |
|---|---|---|
| England | 0.85 | 0.87 |
| Ireland | 0.76 | 0.75 |
| Germany | 0.57** | 0.62* |
| Other Foreign Country | 0.64 | 0.68 |
| | | |
| Inferred Previous Enlistment | | |
| (Before Date in Descriptive Roll) | Group** | Group** |
| No discrepancy | Ref. | Ref. |
| Gap under 1 Year | 1.01 | 0.96 |
| Gap greater than 1 Year | 0.26*** | 0.27*** |
| | | |
| Region of County of Enlistment | Group (n.s) | Group (n.s.) |
| New York County | 1.05 | 1.13 |
| Contiguous to New York | 0.97 | 0.93 |
| On Erie Canal | 0.95 | 0.94 |
| Elsewhere in State | Ref. | Ref. |
| | | |
| Other Covariates | | |
| **Disease Death Rate of Others in Regiment** | | **1.408****** |
| | | |
| Medical Rejections of Recruits, 1863-65 | 0.9978 (n.s.) | 0.9965 (n.s.) |
| Pct over 5,000 in 1845 in Enlist. County | 1.0009 (n.s.) | 0.9998 (n.s.) |
| Crude Death Rate 1855 in Enlist. County | 0.9530 (n.s.) | 0.9674 (n.s) |
| | | |
| Intercept and standard error | -1.90 (.38)**** | -2.36 (.40)**** |
| Initial -2 Log Likelihood | 3900.0 | 3900.0 |
| Improvement with Model | 309.7**** | 330.9**** |

*Sig. at .05 **Sig. at .01; ***Sig. at .001; ****Sig. at .0001