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UNDERSTANDING THE TWENTIETH CENTURY DECLINE IN CHRONIC CONDITIONS AMONG OLDER MEN

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ABSTRACT

I use a sample of Union Army veterans to trace the impact of a high infant mortality rate in area of enlistment, such infectious disease as acute respiratory infections, measles, typhoid fever, tuberculosis, rheumatic fever, diarrhea, and malaria while in the army, occupation at enlistment, and occupation at older ages on chronic respiratory problems, various heart conditions, and joint and back problems at older ages. I find that between 1900 and the present the prevalence of respiratory conditions at older ages fell by 70 percent, that of arrhythmias, murmurs, and valvular heart disease by 90 percent, atherosclerosis by 60 percent, and joint and back problems by 30 percent. Occupational shifts accounted for 15 percent of the decline in joint problems, over 75 percent of the decline in back problems, and 25 percent of the decline in respiratory difficulties. Reduced exposure to infectious disease accounted for at least 10 to 25 percent of the decline in chronic conditions. I also find that the duration of chronic conditions has remained unchanged since the early 1900s but that if disability is measured by difficulty in walking, men with chronic conditions are now less disabled than they were in the past.

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The improvement in the health of the elderly in the United States during the twentieth century has been remarkable. Costa (1998) finds that in the 1930s rates of blindness among those aged 65 to 84 were four times as high as in the 1990s. Fogel and Costa (1997) find that men older than 64 in 1910 were much more likely to suffer from heart, respiratory, musculoskeletal, and digestive disorders than their counterparts today. Costa and Steckel (1997) document the increase in weight adjusted for height for older men from dangerously low levels at the turn of the century. This improvement in health has not necessarily been continuous. Costa and Steckel (1997) report that chronic disease rates at older ages were higher for cohorts born between 1840 and 1849 than for those born between 1820 and 1829. There may be cycles in more recent years as well. Although clinician reports document continuous improvements in health since the 1970s (Waidmann, Bound, and Schoebaum 1995), self-reported health declined during the 1970s but increased during the 1980s (Verbrugge 1984; Crimmins 1990; Colvez and Blanchet 1981; Chirikos 1986; Poterba and Summers 1987; Cutler and Richardson, forthcoming).[1] Nonetheless, the overall trend appears to be one of improving health.

Several environmental factors may account for the long-term decline in chronic disease rates among older Americans and for cycles in health. Although the increased efficacy of medical procedures may improve health, it may do so only for those who would have survived in any event while simultaneously keeping alive those who would have died in a poor state of health. The latter effect may even offset or overwhelm the former effect. Life style changes such as the cessation of smoking or the switch to a low fat diet may account for some of the recent improvements; however, the initial increase in smoking probably contributed to increased morbidity rates. Other factors that could explain the long-run decline include reductions in occupational injuries, a decline in

[1] Self-reported health measures may be misleading because they depend upon public and private efforts at disease prevention and upon the availability of disability insurance. However, clinician reports may fail to capture the functional implications of many health conditions.

atherogenic viruses in the food supply, increases in nutritional intake during the growing years, and declines in childhood infectious diseases. As pointed out by Preston (1993) those who reached ninety in 1992 were born in 1902 when life expectancy at birth was only 49 years and the burden of infectious disease was exceptionally heavy. An ongoing series of studies by Barker and his colleagues (Barker 1992, 1994) linking many of the degenerative conditions of old age to exposure to infectious disease, malnutrition, and other types of biomedical and socioeconomic stress in utero and in the first year of life argues that the focus of research should be shifted from an emphasis on such adult risk factors as obesity, smoking, and lack of exercise to early childhood factors. These studies, however, have been criticized on several grounds, including the confounding of stress at birth and in early infancy with stress at young and late adult ages because of the persistence of biomedical and socioeconomic risk factors (Paneth and Susser 1995).

This paper investigates the risk factors of heart disease, respiratory disorders, and musculoskeletal problems among the first cohort to reach age 65 in the twentieth century by using a longitudinal data set on Union Army veterans. In many ways the data are ideally suited to a study of the impact of environmental stress throughout life. Because infant mortality varied greatly across United States counties during the early childhood of this cohort, this variation allows me to investigate the impact of the disease environment in the county of enlistment. Because these men were exposed to a variety of stresses while in the army as young adults, particularly from infectious diseases, I can investigate the impact of exposure to disease at young adult ages on later life outcomes. I can also investigate the impact of socioeconomic factors at young adult and older ages on chronic disease rates at older ages. Because medical care in the past was ineffective at best, I will be able to examine whether there is any evidence that in the past marginal survivors who may be kept alive today died and that men with specific chronic conditions were less disabled than their counterparts today. Riley (1989) has argued that while incidence rates for specific conditions may have fallen, conditional on having a disease those with the disease may now be more disabled than they were one hundred years ago. In contrast, Cutler and Richardson (forthcoming) find that since the late 1970s self-reported health of those with specific chronic conditions has improved.

The findings will help us understand why the health of different cohorts has been changing in the United States and therefore improve our forecasts of health trends. These forecasts will permit us to assess policies to postpone the normal age of retirement for Social Security and to reduce the fiscal deficits in Medicare and Medicaid. The findings will also help us formulate public policies for countries undergoing an epidemiological transition. The infectious diseases that were prevalent in the United States in the nineteenth century are still common, and as deadly, in many developing countries today. Controlling infectious disease may therefore be the appropriate health response to lower chronic disease rates. Furthermore, if ill-health among older populations arises from their experiences in early childhood or as young adults, then these years may the appropriate ages at which to target health interventions.

The findings also have implications for theories of the epidemiological transition (Omran 1971; Fries 1980). If infectious diseases contribute to chronic disease then the link between infectious and chronic diseases may be much closer than previously thought. Although life style changes and improved medical care allow for the compression of morbidity in these theories, chronic diseases are generally viewed as part of the natural process of aging and thus as limits to life expectancy, a limit which is now generally set at age 85 (Fries 1989). Recent research, however, finds little evidence for a genetically endowed life span, or, at the very least, suggests that such a limit would be well above age 85 (McGue, Vaupel, and Holm 1993; Wilmoth and Lundström 1995). Manton, Stallard, and Tolley's (1991) predictions suggest that if people changed their health behaviors in optimal ways then life expectancies might reach the 90s or the 100s. Reductions in other risk factors for chronic disease, such as exposure to infectious disease, may therefore play a role in extending life expectancy and may explain the declines in older age mortality observed since the 1970s.

The paper begins with a discussion of the relationship between early life conditions and chronic disease. It then proceeds to describe the data and to present some results on trends in chronic conditions. The paper then examines the relationship between early life conditions and the probabilty of chronic disease, how life expectancy for individuals with particular diseases has changed over the course of the century, and whether there is any evidence that those with a given chronic condition are now more disabled than they were in the past. The paper ends with a discussion of the implications of the findings.

1 Early Life Conditions and Chronic Disease

The medical and epidemiological literature provides many examples of the possible linkages between early life conditions and the three major chronic disease categories examined in this paper – heart, respiratory, and musculoskeletal disorders. These are briefly reviewed in this section.[2]

The link between infectious disease and rheumatic heart disease, a form of heart disease common in most developing countries and in the United States at the beginning of the century, is particularly well-established. Acute rheumatic fever involves the joints and the heart and subcutaneous tissue and results in damage to the heart valves. Today acute rheumatic fever most frequently occurs in children 6-15 years of age following group A streptococcal upper respiratory tract infection whereas in the nineteenth century it occurred more frequently among older persons, with 25 percent of first attacks occuring between ages 20-25 and 49 percent between ages 30-39 (Kiple 1993: 971). Individuals who have had acute rheumatic fever become particularly likely to

[2]See Elo and Preston (1992) and (Stein *et al*. 1990) for more thorough discussions.

experience recurrences of attacks following the streptococcal infection. Crowding associated with poor living conditions is the major predisposing condition for the increased risk of streptococcal infection and acute rheumatic fever.

Other infectious diseases that can affect cardiac functioning include late stage syphilis, measles, and typhoid fever. In a sample of typhoid patients, electrocardiogram assessments showed that 12 percent had cardiac involvement (Khosla 1981). Electocardiogram assessments of Nigerian children with measles showed that 35 percent had some electrocardiogram abnormality (Olowu and Taiwo 1990).

The link between infectious disease and atherosclerosis is less well-established. Buck and Simpson (1982) found a high correlation in the United States between atherosclerotic heart disease at older ages and diarrheal deaths from birth to age 20 and speculated that infection facilitates the production of autoimmune complexes that promote the later development of atherosclerotic lesions. The fatty streaks that are the precursors of these lesions may already be present in children by age 10.

Infectious disease is not the only early life factor that may affect heart functioning. Barker (1992, 1994) finds in longitudinal data that undernutrition in utero and in the first year of life, as proxied by anthropometric measures of the child, increase risk of coronary heart disease and stroke.

Chronic obstructive lung disease is another important cause of adult morbidity and mortality in developing countries. Researchers have hypothesized that lower respiratory tract infections in childhood may aid in the development of chronic obstructive lung disease in later life, particularly during early infancy when childrens' lungs are undergoing developmental change. In a longitudinal study of British men, Barker (1992, 1994) found that bronchitis, pneumonia, and whooping cough before age 5 are associated with reduced lung function at ages 59 to 70. Follow-ups of disadvantaged children in South Africa revealed that lung function abnormalities persisted years after the contraction of pneumonia (Wesley 1991). In this group of children, and in most developing countries, measles is a major cause of acute lower respiratory infection (Markowitz and Nieburg 1991). Autopsies and radiographs show that measles bronchopneumonia results in bronchiolar obstruction, airways distension, and a thickening of the peri-bronchial walls (Jean et al 1981). Among Civil War soldiers measles was followed by such complications as chronic bronchitis, pneumonia, pleurisy, chronic diarrhea, and general debility (Cliff, Haggett, and Smallman-Raynor 1993: 105). Previous tuberculous disease may also lead to respiratory abnormalities from cavities. One third of typhoid fever patients also suffer from cough, suggesting that typhoid fever may also be a likely candidate for respiratory distress problems in later life. Other viral infections, such as pulmonary syphilis, might also play a role.

Lung diseases and respiratory symptoms resulting from occupational exposure to dust, fumes, or gases include asthma, chronic bronchitis, chronic airflow limitation, and tuberculosis. Workers in mining, steel foundries, tool grinding, glass making, metal casting, and stone polishing are particularly prone to occupational lung disease. Farmers are also affected because of inhalation of organic dust from moldy plant materials and animal waste, hair, and feathers.

Joint and back pains remain common afflictions in developed countries and are increasingly being recognized as substantial burdens in developing countries (Muirden 1995). Although rheumatic fever, particularly in adults, is often accompanied by arthritis, this manifestation is generally considered to be of relatively short duration, benign in children, but painful in adults. However in rare instances a residual nonprogressive athropathy develops (Katz 1977). Musculoskeletal symptoms are common with many viral infections, as well as syphilis and malaria. Although in most cases these symptoms fade away after a short period, permanent joint damage can occur for a series of diseases such as tuberculosis, vaccinia, and gonorrhea, among others (Hartmann 1974). In addition to disease, occupational stress is another important determinant of musculoskeletal capacity, which even in modern, developed country populations is not only lower among men in physical rather than mental or mixed work, but the rate of deterioration in musculoskeletal capacity among men in physical work is greater (Nygård *et al*. 1988).

Thus far I have stressed the positive relationship between early life conditions and chronic disease at older ages, but the relationship could be negative as well. If genetic susceptibility to death from infectious disease or other insults at young ages is positively correlated with genetic susceptibilty to develop chronic disease at older ages, then, because fewer genetically "frail" individuals survive to old age, the morbidity rate of such a cohort may be lower relative to a cohort in which more genetically frail individuals survive. Additionally, cohorts who survive infectious disease may acquire partial or complete immunity and therefore may have lower mortality rates.

2 Data

The data used in this paper are drawn from the records of the Union Army pension program.[3] This pension program was the most widespread form of assistance to the elderly prior to Social Security, covering 85 percent of all Union Army veterans by 1900 and 90 percent by 1910 and benefitting an estimated 25 percent of the population older than 64 whether as a couple consisting of the former soldier and his wife, the single or widowed veteran, or the widows of veterans (Costa 1998: 160). The program began in 1862 when Congress established the basic system of pension laws, known as the General Law pension system, to provide pensions to both regular and volunteer recruits who were severely disabled as a direct result of military service.[4] The Union Army pension program became a universal disability and old-age pension program for veterans

[3]The data can be obtained from Professor Robert Fogel, University of Chicago, Graduate School of Business, Center for Population Economics, 1101 E. 58th Street, Chicago IL 60637.

[4]See Costa (1998: 197-212) for a history of the Union Army pension program.

with the passage of the Act of June 27, 1890 which specified that any disability entitled the veteran to a pension. Even though old age was not recognized by statute law as sufficient cause to quality for a pension until 1907, the Pension Bureau instructed the examining surgeons in 1890 to grant a minimum pension to all men at least 65 years of age unless they were unusually vigorous.

Copious records were generated by the Union Army pension program. Pension applications included detailed medical examinations both for men whose pension application or bid for a pension increase was rejected and for men whose applications were accepted. These records are currently being collected and linked to the 1900 and 1910 censuses and to military service records. The 1900 and 1910 censuses provide occupational information and the military service records information on stress at young adult ages such as prisoner of war status, whether the soldier was ever discharged for disability, and such illnesses as measles, diarrhea, tuberculosis, typhoid, rheumatism, acute respiratory infections (e.g. pneumonia, bronchitis), malaria, and war injuries. Infant mortality rates in county of enlistment are available from the 1850 United States Census of Mortality and from the 1855 New York State Census of Mortality.[5]

The records used in this paper represent a 49 percent sample of the final sample that will be available and consist of men in 45 Ohio companies, 51 New York Companies, 37 Illinois Companies, and 28 Pennsylvania companies. The sample is restricted to native-born men linked to the 1900 census and aged 50 to 64 in 1900.[6] About 10 percent of these men were not yet collecting a pension in 1900, either because their applications had been rejected or because they had not yet applied for a pension. A surgeons' exam is available for 93 percent of all men who had a pension in 1900. Men for whom a surgeons' exam is missing tended to be men who entered

[5]The mortality rates are from Fogel (1998) and New York State (1857). They are self-reported and are therefore biased downwards. However, the bias is unlikely to differ markedly across counties.

[6]These restrictions were made to ensure the availability of occupational information for all men circa 1900 and the availability of epidemiological information on the county they were raised in. Observable characteristics do not predict linkage to the 1900 census.

at a late age and received a pension on the basis of age. Although I assume that these men did not have the specific chronic condition that I examine, the results are virtually identical when these men are omitted from the sample.

Men who entered the Union Army were probably healthier than the population as a whole. An examination of men who were rejected for military service suggests that mean height for the population was about 0.18 inches less than the mean of the recruits. Once men entered the service, rural farmers, who were the better nourished segment of society, were more likely to die because they lacked immunities to such common camp diseases as measles and typhoid (Lee 1997). However, men who survived the war (regardless of occupation) were only 0.02 inches shorter than all recruits at enlistment, suggesting that the war itself induced minimal survivorship selection on the basis of height and hence on early net nutritional status. Increased exposure to disease probably left men in worse health than when they entered the army, but by age 50 even men who had grown up in rural areas and had not served had probably been exposed to as many infectious diseases as veterans because of increased migration.[7] Several tests indicate that this sample is representative of the general population in terms of mortality experience and wealth.[8]

The records of the examining surgeons give height, weight, pulse rate, respiration, and temperature at every examination. The physicians also noted general appearance, including gait and ability to walk. The examining surgeons described each condition and if a surgeon ever noted a respiratory, heart, or musculoskeletal condition, this detailed information is used in the

[7]For example, malaria increased in the north following the Civil War even among women, probably because of the return of large numbers of soldiers who had been infected with the plasmodium while serving in the south (Akernecht 1945; Boyd 1941).

[8]Among all adult males age 20 and over in the households to which recruits were linked in the 1860 census, mean wealth was similar to that found in a random sample. Cohort life expectancies of veterans who reached age 60 between 1901 and 1910 resemble the cohort life expectancies found in genealogies and the distribution of deaths from specific causes for all veterans who died between 1905 and 1915 does not differ significantly from the distribution of expected number of deaths from those causes in the death registration states in 1910 (Costa 1998: 197-212).

analysis. Thus for heart disease the physician described pulse rate characteristics; whether a murmur was present and its timing, type, and location and which valves were involved; whether the murmur was accompanied by a thrill; whether there was enlargement, oedema, cyanosis, dyspnoea, atherosclerosis, or impaired circulation. Respiratory examinations included reports of respiratory sounds such as murmurs, rales, crepitus, vocal fremitus, and ronchae and reports of decreased breath. Descriptions of rheumatism included where the rheumatism was located and whether pain, tenderness, swelling, or crepitation was associated with the joint. Because the surgeons did not base their diagnoses upon a recruit's wartime experiences the correlation between illness while in the army and a chronic condition at later ages is unlikely to be spurious.[9] Disease rates are based upon an examining surgeon ever having noted a condition.[10] Prevalence rates for 1910 may be underestimated because men who qualified for a pension on the basis of age alone, as many did in 1910, have fewer surgeons' exams than their counterparts who qualified on the basis of health.

The Union Army data are compared with random samples of the non-institutionalized, white population drawn from the 1959 to 1962 National Health Examination Survey and the 1971-1975, 1976-1980, and 1988-1994 National Health and Nutritional Examination Surveys.[11] These surveys included medical exams, which, while not strictly comparable across all years, yield diagnoses that can be compared with those of physicians working under contract from the Pension Bureau. The symptoms and conditions that I examine did not require any diagnostic equipment

[9]The same correlations between chronic disease at older ages and illness while in the army are found for men who claimed that their disabilities were traceable to the war and for men who did not make this claim. Unfortunately the sample of men who had been examined and whose claim for a pension was rejected was too small to be used in an analysis.

[10]I assume that a veteran has a condition unless an examining surgeon specifically states that he does not or gives him either a disease specific rating of zero or a total rating of zero.

[11]The bias introduced from an examination of non-institutionalized men only should be small. In 1900 institutionalization rates for men older than 64 were just under 3 percent and by 1990 were just under 4 percent. Increases in institutionalization rates for women were much higher (Costa 1998: 113).

that was unavailable to late nineteenth century physicians. These symptoms and conditions are valvular heart disease (murmurs involving the mitral and aortal valves); congestive heart failure (contemporaneous occurrence of oedema, cyanosis, and dyspnoea); atherosclerosis (detected by feeling whether the arteries had hardened); irregular pulse; adventitious sounds (murmurs, rales, crepitus, vocal fremitus, and ronchae) or decreased breath; dullness of chest on percussion; joint problems; and back problems.

3 Trends

Table 1 gives prevalence rates for Union Army veterans aged 50-64 in 1900 and for the same men aged 65-74 10 years later and point prevalence rates for white men in the same age groups in recent health surveys. The prevalence of respiratory conditions fell by 67 to 71 percent, and would have fallen by more if not for the increase in smoking. The prevalence of irregular pulse rates, murmurs, and valvular heart disease fell by 90 percent and of atherosclerosis by 53 to 72 percent. Joint and back problems declined by 20 to 44 percent. The prevalence of respiratory conditions and atherosclerosis increased more sharply with age at the beginning of the century than it does today.

How reliable are these estimates of declines in prevalence rates? Certainly part of the decline in irregular pulse rates and murmurs may reflect the more careful examinations of surgeons accustomed to direct observation. Furthermore, cumulative prevalence rates calculated from the Union Army sample are not strictly comparable to the point prevalence rates estimated from recent surveys both because a condition would be more likely to be noticed in multiple examinations and because men would be more likely to develop a condition between the time of the last exam and either 1900 or 1910. However, if the latter is true then prevalence rates in the Union Army sample will be underestimated, but even if the former were true, it seems unlikely

Table 1: Prevalence Rates Among Cohort of White Men Aged 50-64 in 1900 and 60-74 in 1910, and Cohorts Aged 50-64 and 60-74 in 1959-196, 1971-1981, and 1988-1994

	1900/1910	1959-1962	1971-80	1988-94
Ages 50-64				
Decreased breath or adventitious sounds	23.7		7.6	7.8
Never smoked				3.5
Former smoker				4.0
Current smoker				19.3
Dullness chest	9.3			
Joint problem	48.2			
Pain/tenderness/swelling specified	43.2		24.3	
Back problem	40.4		29.1	
Irregular pulse	30.0		3.6	4.3
Murmur	29.1	3.4	4.2	1.9
Thrill	0.7	0.9	0.5	
Valvular heart disease				
(mitral or aortic origin murmurs)	19.2		1.7	
Congestive heart failure				
(oedema, cyanosis, and dyspnoea)	3.1			
Atherosclerosis/arteriosclerosis	1.9		0.9	
Ages 60-74				
Decreased breath or adventitious sounds	37.8		12.0	11.1
Never smoked				3.3
Former smoker				9.2
Current smoker				26.7
Dullness chest	11.3			
Joint problem	59.1			
Pain/tenderness/swelling specified	55.0		30.8	43.1
Back problem	49.5		39.5	
Irregular pulse	42.0		7.7	6.7
Murmur	39.2	7.7	7.8	4.2
Thrill	1.2	1.0	0.4	
Valvular heart disease				
(mitral or aortic origin murmurs)	26.9		3.6	
Congestive heart failure	10.0			
(oedema, cyanosis, and dyspnoea)				
Atherosclerosis/arteriosclerosis	8.2		2.3	

Note. See the discussion in the text on the comparability of prevalence rates between 1900/1910 and later years. Prevalence rates for 1900/1910 are for atherosclerosis and for 1971-1980 for arteriosclerosis. All prevalence rates are weighted by the age distribution in 1900/1910. Prevalence rates are calculated from the Union Army data, the 1959-1962 National Health Examination Survey, and the 1971-1975, 1976-1980, and 1988-1994 National Health and Nutrition Examination Surveys. Questions on arthritis are not comparable across all years. In 1971-1975 and 1976-1980 physicians were asked to note tenderness, swelling, deformity, and pain on motion in the shoulder, elbow, wrist, metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints, ankle, feet, knees, and hips. In 1988-1994 the examiners were instructed to report only on the wrist, each finger of the hand, the toes, and the knee for those older than 59. This procedure appears to have increased overall finding rates.

that such a large decline in prevalence rates could be explained by definitional biases alone. Thus while the estimated prevalence rates may not be precise indicators of true prevalence rates, it is still probably true that the prevalence rates in the Union Army sample were much higher than they are today.

The high prevalence rates for joint and back problems are confirmed by analyses of skeletal remains. For example, Larsen et al. (1995) report that in a mid-nineteenth century frontier cemetery in the Midwest 8 out of 11 adult skeletons exhibited one or more skeletal pathologies relating to general activity, including degenerative joint disease (osteoarthritis), nonarthritic joint changes resulting from habitual postures, and fractures arising from traumas.

The declining disease rates seen in Table 1 are readily reconciled with changes in cause of death patterns observed during epidemiological transitions. Cause of death information may simply be a poor indicator of morbidity rates in a regime in which infectious diseases are dominant. Fifty-two percent of Union Army veterans aged 50 to 64 in 1900 with valvular heart disease died of heart disease, as did 52 percent of those with an arrhythmia and 56 percent of those with atherosclerosis. In contrast, 67 percent of men of the same age with valvular heart disease in the 1971-1975 survey died of heart disease, 69 percent of those with an arrhythmia, and 75 percent of those with atherosclerosis. Had 9 percent of Union Army veterans not died from pneumonia, bronchitis, and influenza, 4 percent from infectious disease, and 13 percent from genito-urinary disorders, cause of death patterns may well have been more similar to those observed today.[12]

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[12]Men who died during the influenza epidemic were excluded from these numbers.

4 Determinants of Chronic Conditions

I estimate the impact of early and late life stress on chronic conditions among native-born Union Army veterans aged 50 to 64 in 1900 and 60 to 74 in 1910 by a series of probit equations in which the dependent variables are equal to one if the veteran had one of the following specific chronic conditions: decreased breath or adventitious sounds; dullness of chest upon percussion; joint problems; back problems; valvular heart disease; congestive heart failure; and atherosclerosis.[13] The typical probit equation that is then estimated is

$$Prob(I = 1) = Prob(\epsilon < X'\beta) = \Phi(X'\beta)$$

where $I = 1$ if a veteran had the specific chronic condition, $\Phi()$ is a standard normal cumulative distribution function, and X is a vector of control variables.[14] The effect of a unit change in one of the independent variables on the probability of having a given chronic condition is given by the partial derivative of the probit function P with respect to that independent variable. For example, if the dependent variable were whether a veteran had decreased breath or adventitious sounds a value of $\frac{\partial P}{\partial x}$ of 0.096 for wartime respiratory infection implies that having had a respiratory infection during the war increases the probability of decreased breath or adventitious sounds by 0.096.

The control variables are derived from the 1900 census, the pension records, and the military service records. They consist of variables proxying for environmental stress prior to

[13] I also investigated the use of alternative specifications. In particular, I conditioned on all man who were examined in a given year and did not have a specific condition and investigated what determined the probability of developing that specific chronic disease by a given year. This did not yield materially different point estimates. However, the sample size was much smaller and the standard errors much larger.

[14] I use a probit rather a logit model because the logistic distribution tends to give larger probabilities to $y = 0$ when $\beta' x$ is extremely small (and larger probabilities to $y = 0$ when $\beta' x$ is very large). However, probit, logit, and linear probability models yielded similar results.

joining the army such as dummy variables indicating size of city of enlistment and whether the infant mortality rate in county of enlistment was high.[15] They also consist of such dummy variables as whether the veteran ever suffered from measles, typhoid fever, diarrhea, tuberculosis, acute respiratory infections (e.g. pneumonia, bronchitis), malaria, and rheumatism while in the army.[16] Very few men are specifically identified as having suffered from rheumatic fever while in the army, so rheumatism while in the army may be indicative of either an underlying chronic condition, traumatic arthritis, or of a viral infection accompanied by rheumatic symptoms. The reports submitted by camp doctors to the Surgeon General distinguish between acute and chronic rheumatism and these suggest that 40 percent of all cases of rheumatism were acute and were mainly caused by rheumatic fever. However some of the chronic cases may have been prolonged acute rheumatic fever (Bollet 1991). Other measures of stress while in the army are whether the veteran was ever injured, was ever discharged for disability, or was ever a prisoner of war.

Several potential biases are likely to be introduced from the use of wartime measures of stress. Infectious diseases acquired in the army may have been more severe than those acquired in civilian life (because repeated rapid passage increased the virulence of infectious agents). Contemporary observors noted that measles among Civil War troops was a much severer infection than that witnessed in the civilian population (Cliff, Haggett, Smallman-Raynor 1993: 106). However, if survival rates among Civil War soldiers with infectious diseases were lower

[15] A dummy variable rather than a continuous variable for infant mortality fit the specification better, perhaps because the measure is noisy. Infant mortality rates tended to be highest in urban areas and in areas along the Ohio River. About 19 percent of infant deaths were from infectious and parasitic diseases, 14 percent from respiratory diseases, 17 percent from such symptoms and ill-defined conditions as fever, and 26 percent were uncodable. The regressions that I present do not include height at enlistment as a coefficient, largely because sample size would fall sharply if I were to restrict the sample to men beyond their growing years. When I included height as an explanatory variable in the regressions, in most cases height was a small and insignificant predictor of chronic disease. However, height was a positive, but small, and significant predictor of back problems, dullness of chest, and irregular pulse.

[16] Interaction effects between disease dummies are not reported because the coefficients on these interaction terms were small and insignificant.

than in the civilian population, the impact of infectious disease on older age chronic disease rates will be underestimated.[17] Furthermore, the effect of infectious disease will be underestimated because many men undoubtedly had experienced infectious disease either before they entered the army or after they left it.[18] If men who caught infectious diseases while in the army were inherently frailer (an unlikely supposition given the rates of exposure in army camps), then I will be overestimating the impact of infectious disease on later morbidity. However, because I am observing survivors, and therefore perhaps the hardiest men, this may lead to me to underestimate the effect of infectious disease. A different type of bias is likely to arise in the case of the war injured. Men who were injured in the war tended to be taller (suggesting better net nutritional status during their growing years) and they also tended to be from urban areas (suggesting that they had been exposed to many infectious diseases already). Despite their longer years of army service, they were less likely to develop tuberculosis, a disease likely to strike those of poor net nutritional status. If men who had been injured in the war were initially healthier and remained healthier because they had been exposed to milder forms of infectious disease rather than the severe camp forms, then being injured in the war might well be a negative predictor of chronic disease.

Additional control variables are occupation at enlistment and occupation circa 1900 (derived from the 1900 census for men in the labor force and from the pension records for men out of the labor force) which proxy for socioeconomic status at younger and at older ages, respectively. Occupations are grouped into professional or proprietor, farmer, artisan, and laborer. Size of city of residence in 1900 proxies for exposure to infectious disease at older ages. Because

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[17]The findings will also underestimate the impact of infectious disease in a modern population in which survival rates of men with infectious disease are higher.

[18]For example, malaria was *the* United States disease of the late nineteenth century, prevalent throughout the Mississippi Valley and as far up as Canada (Kiple 1993: 526).

mid-size cities had not yet initiated sanitary reforms whereas large cities had, exposure to disease in mid-size cities should be greater (Preston and Haines 1991: 98). State of enlistment, age, marital status, state of enlistment dummies, and regiment dummies, are also control variables. These two sets of dummy variables are included to control for omitted state characteristics and such omitted regimental experiences as battlefield stress. However, because regiments were drawn from the same geographic areas, regiment fixed effects may reflect county of enlistment fixed effects.

The marginal effects for probits for respiratory conditions for 1900 and 1910 are given in Tables 2 and 3. For both dullness of chest and decreased breath or adventitious sounds statistically significant positive predictors in all four regressions were an acute respiratory condition, tuberculosis, and measles while in the army. The impact of these infectious diseases was substantial; having had just one of these diseases raised the probability of respiratory problems by about 0.1. Syphilis while in the army was a statistically significant and substantial positive predictor of these two chronic symptoms as well. A high infant mortality rate in county of enlistment increased the probability of dullness of chest in 1900 by 0.04 when regiment fixed effects are excluded from the regression, and, when state of enlistment fixed effects were excluded as well, was a significant, positive predictor of decreased breath or adventitious sounds.

Men who had been farmers and laborers at enlistment were more likely to suffer from respiratory difficulties both in 1900 and in 1910. By 1910 men who had been artisans and laborers in 1900 were more likely to exhibit decreased breath or adventitious sounds. Artisans who were millers, carpenters, and painters, all occupations with exposure to dust and fumes, had higher rates of respiratory disorders than artisans who were blacksmiths, machinists, or coopers. Prevalence rates for dullness of chest would have been 31 percent lower in 1900 and 57 percent lower in 1910 if the occupational distribution circa 1900 had been that of older men in 1990 and the occupational distribution at enlistment had been that of younger men in 1940. Prevalence rates for decreased

Table 2: Marginal Effects for Probits for Respiratory Conditions, Men Aged 50-64 in 1900, Dependent Variable is Equal to One if Condition by 1900

		Dullness chest				Decreased breath/ Adventitious sounds			
	Mean	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dullness chest	0.093	.		.		.			
Decreased breath/ adventitious sounds	0.237	.		.		.			
High infant mortality county	0.121	0.035†	0.019	0.029	0.020	0.040	0.027	0.052*	0.019
City enlistment $\geq$ 50,000		.		.					
$<$ 50,000 and $\geq$ 2,500	0.321	0.048†	0.024	0.037	0.025	0.041	0.037	0.037	0.025
$<$ 2,500	0.610	0.007	0.022	-0.003	0.023	-0.016	0.037	-0.003	0.023
Wartime diarrhea	0.320	-0.021†	0.010	-0.020†	0.010	0.004	0.017	0.006	0.018
respiratory infection	0.120	0.069‡	0.019	0.067‡	0.019	0.096‡	0.268	0.096‡	0.028
tuberculosis	0.020	0.137‡	0.054	0.131‡	0.054	0.134†	0.064	0.147†	0.066
measles	0.070	0.114‡	0.028	0.108‡	0.027	0.118‡	0.035	0.111‡	0.035
typhoid	0.068	0.030	0.022	0.033*	0.022	0.043	0.033	0.061*	0.034
malaria	0.036	-0.005	0.025	-0.007	0.023	0.031	0.043	0.026	0.043
syphilis	0.013	0.125‡	0.064	0.137‡	0.068	0.134*	0.080	0.110	0.076
rheumatism	0.123	0.007	0.015	0.005	0.014	0.035	0.025	0.036	0.025
injury	0.330	-0.008	0.010	-0.102	0.010	-0.049‡	0.017	-0.055‡	0.017
Prisoner of war	0.106	0.007	0.017	-0.001	0.016	0.050*	0.028	0.048*	0.028
Discharged for disability	0.197	0.006	0.013	0.006	0.012	0.017	0.021	0.017	0.021
Lives in top ten city, 1900	0.046	-0.038	0.020	-0.036	0.019	-0.086†	0.034	-0.088†	0.034
Lives in medium size city, 1900	0.109	-0.011	0.015	-0.011	0.014	0.006	0.026	-0.001	0.026
Lives in small city/noncity, 1900		.		.					
Professional/proprietor c. 1900		.		.					
Farmer c. 1900	0.410	0.005	0.014	0.005	0.013	0.031	0.023	0.036	0.023
Artisan c. 1900	0.148	0.004	0.018	-0.007	0.017	0.011	0.028	0.007	0.028
Laborer c. 1900	0.230	-0.007	0.015	-0.008	0.014	0.022	0.025	0.021	0.026
Professional/proprietor at enlistment		.		.					
Farmer at enlistment	0.629	0.047†	0.022	0.005	0.013	0.080†	0.034	0.074†	0.034
Artisan at enlistment	0.144	0.019	0.031	-0.001	0.017	0.066	0.043	0.064	0.044
Laborer at enlistment	0.161	0.069	0.038	0.059*	0.037	0.113‡	0.046	0.103†	0.046
Married in 1900	0.861	0.037‡	0.011	0.035‡	0.011	0.021	0.022	0.022	0.022
Age in 1900	57.479	0.002	0.001	0.002	0.001	0.004†	0.002	0.004	0.002
Regiment fixed effects		No.		Yes.		No.		Yes.	
Pseudo R^2		0.08		0.10		0.04		0.06	

Note. 2972 observations. The derivative is evaluated at the sample means and, for dummy variables, is for a discrete change of the dummy variable from 0 to 1. All regressions include state of enlistment fixed effects.

Table 3: Marginal Effects for Probits for Respiratory Conditions, Men Aged 60-74 in 1910, Dependent Variable is Equal to One if Condition by 1910

		Dullness chest				Decreased breath/ Adventitious sounds			
	Mean	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dullness chest	0.113	.		.		.			
Decreased breath/		.		.		.			
adventitious sounds	0.378	.		.		.			
High infant mortality county	0.127	0.027	0.023	0.021	0.024	0.015	0.036	0.013	0.040
City enlistment $\geq$ 50,000		.		.					
$<$ 50,000 and $\geq$ 2,500	0.323	0.103	0.041	0.088‡	0.044	0.096†	0.047	0.061	0.052
$<$ 2,500	0.615	0.039	0.034	0.027	0.037	0.021	0.047	-0.004	0.053
Wartime diarrhea	0.321	-0.028†	0.012	-0.026†	0.013	-0.015	0.024	-0.006	0.025
respiratory infection	0.120	0.099‡	0.027	0.102‡	0.027	0.106‡	0.036	0.119‡	0.037
tuberculosis	0.019	0.219‡	0.077	0.231‡	0.081	0.207†	0.083	0.217‡	0.085
measles	0.074	0.095‡	0.032	0.095‡	0.032	0.201‡	0.043	0.198‡	0.044
typhoid	0.069	0.061†	0.030	0.059†	0.031	0.020	0.044	0.034	0.045
malaria	0.039	-0.014	0.028	-0.019	0.027	0.130†	0.059	0.143†	0.060
syphilis	0.011	0.124*	0.086	0.132*	0.090	0.150†	0.105	0.105	0.105
rheumatism	0.121	-0.012	0.017	-0.016	0.017	0.030	0.034	0.030	0.035
injury	0.327	-0.025*	0.013	-0.030†	0.013	-0.036	0.024	-0.047*	.025
Prisoner of war	0.108	0.000	0.021	-0.005	0.021	0.017	0.037	0.018	0.039
Discharged for disability	0.195	-0.008	0.015	-0.011	0.015	-0.007	0.028	-0.007	0.029
Lives in top ten city, 1900	0.043	-0.019	0.0334	-0.020	0.035	-0.014	0.057	-0.005	0.059
Lives in medium size city, 1900	0.105	-0.009	0.020	-0.012	0.019	0.013	0.036	-0.008	0.036
Lives in small city/noncity, 1900		.		.					
Professional/proprietor c. 1900		.		.					
Farmer c. 1900	0.418	0.002	0.017	0.003	0.018	0.040	0.031	0.045	0.032
Artisan c. 1900	0.137	0.003	0.023	-0.002	0.023	0.097‡	0.040	0.094†	0.041
Laborer c. 1900	0.224	0.001	0.020	0.004	0.020	0.071†	0.035	0.079†	0.036
Professional/proprietor		.		.					
at enlistment		.		.					
Farmer at enlistment	0.647	0.140‡	0.035	0.136‡	0.034	0.070	0.046	0.080*	0.047
Artisan at enlistment	0.130	0.151†	0.086	0.158†	0.089	0.022	0.054	0.044	0.056
Laborer at enlistment	0.156	0.263‡	0.097	0.250‡	0.097	0.133†	0.056	0.119†	0.057
Married in 1900	0.873	0.050‡	0.014	0.050‡	0.014	0.076†	0.031	0.076†	0.031
Age in 1910	67.191	0.001	0.002	0.001	0.002	0.005	0.003	0.004	0.003
Regiment fixed effects		No.		Yes.		No.		Yes.	
Pseudo R^2		0.10		0.12		0.04		0.07	

Note. 2044 observations. The derivative is evaluated at the sample means and, for dummy variables, is for a discrete change of the dummy variable from 0 to 1. All regressions include state of enlistment fixed effects.

breath and adventitious sounds would have been 21 percent lower in 1900 and 12 percent lower in 1910, thus accounting for 31 percent of the decline in decreased breath or adventitious sounds among men aged 50 to 64 and 18 percent of the decline among men aged 60 to 74.

Marginal effects for probits for valvular heart disease and irregular pulse in 1900 are given in Tables 4 and 5. Measles, typhoid fever, and rheumatism while in the army increased the probability of valvular heart disease by about 0.08 in 1900 and 0.10 in 1910. Rheumatism while in the army increased the probability of an irregular pulse by 0.1 both in 1900 and in 1910; typhoid fever increased the probability by 0.06 in 1900 and 0.11 in 1910; acute respiratory infection by 0.05 in 1900 and 0.09 in 1910; tuberculosis by 0.14 in 1910; and measles by 0.09 in 1910. Men who enlisted in cities with populations below 25,000 were less likely to have developed valvular heart disease in 1900, but not in 1910. When state of enlistment fixed effects are omitted from the regressions, infant mortality in county of enlistment becomes a significant predictor of an irregular pulse.

Table 6 presents marginal effects for probits for congestive heart failure and for atherosclerosis in 1910. (These conditions are not examined in 1900 because so few men had them.) Only rheumatism while in the army was a statistically significant predictor of congestive heart failure, consistent with the findings of Wilson et al. (1998) that in the Civil War cohort valvular heart disease (which is predicted by rheumatism) preceded congestive heart failure over 60 percent of the time. Infant mortality in county of enlistment and diarrhea and measles while in the army were significant positive predictors of atherosclerosis.

Tables 7 and 8 show the marginal effects for probits for joint and back problems in 1900 and in 1910. Rheumatism while in the army is a strong predictor of joint problems, increasing the probability of a joint problem in 1900 by 0.24 and in 1910 by 0.20. Rheumatism while in the army also predicts back problems both in 1900 and in 1910, increasing their probability by about 0.14. Another predictor of joint problems was malaria, which increased the probability of

Table 4: Marginal Effects for Probits for Irregular Pulse and Valvular Heart Disease, Men Aged 50-64 in 1900, Dependent Variable is Equal to One if Condition by 1900

		Irregular Pulse				Valvular Heart Disease			
	Mean	$\frac{\partial P}{\partial x}$ c	Std Err	$\frac{\partial P}{\partial x}$ c	Std Err	$\frac{\partial P}{\partial x}$ c	Std Err	$\frac{\partial P}{\partial x}$ c	Std Err
Irregular pulse	0.300	.		.		.			
Valvular heart disease	0.192	.		.		.			
High infant mortality county	0.121	0.036	0.029	0.058*	0.032	0.037	0.026	0.056†	0.030
City enlistment $\geq$ 50,000		.		.					
$<$ 50,000 and $\geq$ 2,500	0.321	0.021	0.035	0.010	0.039	-0.009	0.028	-0.037	0.030
$<$ 2,500	0.610	-0.024	0.035	-0.030	0.039	-0.050*	0.028	-0.072†	0.032
Wartime diarrhea	0.320	0.022	0.019	0.020	0.019	0.012	0.016	0.012	0.016
respiratory infection	0.120	0.045*	0.027	0.047*	0.028	-0.024	0.021	-0.025	0.021
tuberculosis	0.020	0.082	0.065	0.098	0.067	0.010	0.053	0.015	0.054
measles	0.070	0.031	0.034	0.033	0.034	0.051*	0.031	0.043	0.031
typhoid	0.068	0.056*	0.035	0.056*	0.036	0.078‡	0.032	0.083‡	0.033
malaria	0.036	-0.001	0.044	0.004	0.045	-0.007	0.036	-0.008	0.036
syphilis	0.013	-0.055	0.066	-0.062	0.066	0.014	0.063	0.001	0.062
rheumatism	0.123	0.103	0.028	0.104‡	0.028	0.075‡	0.024	0.078‡	0.025
injury	0.330	-0.044	0.018	-0.046‡	0.019	-0.046‡	0.015	-0.054‡	0.015
Prisoner of war	0.106	0.001	0.028	0.016	0.030	-0.020	0.023	-0.018	0.025
Discharged for disability	0.197	0.010	0.022	0.011	0.022	-0.024	0.018	-0.019	0.018
Lives in top ten city, 1900	0.046	-0.159‡	0.032	-0.147‡	0.034	-0.056*	0.031	-0.039	0.033
Lives in medium size city, 1900	0.109	-0.067‡	0.025	-0.070‡	0.025	-0.004	0.023	-0.010	0.023
Lives in small city/noncity, 1900		.		.					
Professional/proprietor c. 1900		.		.					
Farmer c. 1900	0.410	0.017	0.024	0.013	0.025	0.034*	0.021	0.032	0.021
Artisan c. 1900	0.148	0.060†	0.032	0.058*	0.032	0.056	0.023	0.056†	0.028
Laborer c. 1900	0.230	0.057†	0.028	0.052	0.028	0.037	0.024	0.036	0.024
Professional/proprietor		.		.					
at enlistment		.		.					
Farmer at enlistment	0.629	0.017	0.024	0.032	0.036	-0.002	0.030	-0.009	0.030
Artisan at enlistment	0.144	-0.042	0.039	-0.048	0.039	-0.047	0.030	-0.048	0.030
Laborer at enlistment	0.161	-0.011	0.041	-0.024	0.041	-0.003	0.034	-0.005	0.034
Married in 1900	0.861	0.041*	0.023	0.041*	0.023	-0.005	0.020	-0.004	0.020
Age in 1900	57.479	0.007‡	0.003	0.006‡	0.003	0.005	0.002	0.004	0.002
Regiment fixed effects		No.		Yes.		No.		Yes.	
Pseudo R^2		0.05		0.06		0.02		0.04	

Note. 2972 observations. The derivative is evaluated at the sample means and, for dummy variables, is for a discrete change of the dummy variable from 0 to 1. All regressions include state of enlistment fixed effects.

Table 5: Marginal Effects for Probits for Irregular Pulse and Valvular Heart Disease, Men Aged 60-74 in 1910, Dependent Variable is Equal to One if Condition by 1910

		Irregular Pulse				Valvular Heart Disease			
	Mean	$\frac{\partial P}{\partial x}$ c	Std Err	$\frac{\partial P}{\partial x}$ c	Std Err	$\frac{\partial P}{\partial x}$ c	Std Err	$\frac{\partial P}{\partial x}$ c	Std Err
Irregular pulse	0.420	.		.		.			
Valvular heart disease	0.269	.		.		.			
High infant mortality county	0.127	0.057	0.038	0.076*	0.042	0.070‡	0.033	0.100‡	0.045
City enlistment $\geq$ 50,000		.		.					
$<$ 50,000 and $\geq$ 2,500	0.323	0.076	0.049	0.043	0.054	0.043	0.038	-0.000	0.055
$<$ 2,500	0.615	0.012	0.049	-0.008	0.054	0.032	0.036	-0.041	0.056
Wartime diarrhea	0.321	0.038	0.025	0.051	0.026	0.008	0.017	0.013	0.025
respiratory infection	0.120	0.093‡	0.036	0.110†	0.026	0.042*	0.028	0.027	0.036
tuberculosis	0.019	0.138*	0.083	0.142*	0.084	-0.065	0.033	-0.021	0.073
measles	0.074	0.079*	0.044	0.070	0.044	0.027	0.033	0.109‡	0.047
typhoid	0.069	0.108†	0.046	0.117‡	0.047	0.066*	0.040	0.112†	0.049
malaria	0.039	-0.013	0.057	-0.002	0.059	-0.060*	0.024	-0.042	0.049
syphilis	0.011	-0.042	0.100	-0.093	0.096	0.014	0.072	0.024	0.101
rheumatism	0.121	0.111‡	0.035	0.114‡	0.036	0.042*	0.027	0.073†	0.036
injury	0.327	-0.051†	0.024	-0.048*	0.025	-0.049‡	0.016	-0.103‡	0.023
Prisoner of war	0.108	0.018	0.038	0.045	0.040	0.005	0.026	-0.013	0.038
Discharged for disability	0.195	-0.017	0.029	-0.018	0.030	-0.018	0.019	-0.011	0.029
Lives in top ten city, 1900	0.043	-0.168‡	0.052	-0.163‡	0.054	-0.033	0.032	0.091	0.072
Lives in medium size city, 1900	0.105	-0.059*	0.035	-0.069*	0.036	-0.013	0.024	0.007	0.036
Lives in small city/noncity, 1900		.		.					
Professional/proprietor c. 1900		.		.					
Farmer c. 1900	0.418	0.039	0.032	0.037	0.032	-0.001	0.022	0.016	0.031
Artisan c. 1900	0.137	0.059	0.041	0.059	0.042	-0.005	0.028	0.045	0.044
Laborer c. 1900	0.224	0.063*	0.035	0.061*	0.036	-0.027	0.029	-0.028	0.034
Professional/proprietor		.		.					
at enlistment		.		.					
Farmer at enlistment	0.647	0.015	0.047	0.001	0.049	0.012	0.034	0.082*	0.048
Artisan at enlistment	0.130	-0.120†	0.050	-0.122†	0.051	-0.025	0.035	0.004	0.058
Laborer at enlistment	0.156	-0.022	0.053	-0.048	0.054	0.031	0.046	0.107*	0.065
Married in 1900	0.873	0.050	0.032	0.044	0.033	-0.023	0.025	-0.002	0.027
Age in 1910	67.191	0.008†	0.003	0.008†	0.004	0.000	0.002	0.004	0.003
Regiment fixed effects		No.		Yes.		No.		Yes.	
Pseudo R^2		0.06		0.12		0.04		0.07	

Note. 2044 observations. The derivative is evaluated at the sample means and, for dummy variables, is for a discrete change of the dummy variable from 0 to 1. All regressions include state of enlistment fixed effects.

Table 6: Marginal Effects for Probits for Atherosclerosis and Congestive Heart Failure, Men Aged 60-74 in 1910, Dependent Variable is Equal to One if Condition by 1910

		Atherosclerosis				Congestive Heart Failure			
	Mean	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Atherosclerosis	0.082	.		.		.			
Congestive heart failure	0.100	.		.		.			
High infant mortality county	0.127	0.072‡	0.027	0.053†	0.028	0.005	0.021	-0.002	0.021
City enlistment $\geq$ 50,000		.		.					
$<$ 50,000 and $\geq$ 2,500	0.323	0.002	0.025	0.001	0.027	0.023	0.029	0.024	0.031
$<$ 2,500	0.615	-0.018	0.026	-0.032	0.028	0.015	0.028	0.015	0.030
Wartime diarrhea	0.321	0.029†	0.014	0.029†	0.014	-0.001	0.013	0.005	0.013
respiratory infection	0.120	0.007	0.019	0.010	0.019	0.008	0.019	0.009	0.019
tuberculosis	0.019	0.031	0.050	0.027	0.049	0.069	0.061	0.055	0.059
measles	0.074	0.044*	0.028	0.037	0.027	0.012	0.024	0.016	0.024
typhoid	0.069	0.006	0.025	0.002	0.023	0.008	0.024	0.006	0.023
malaria	0.039	0.002	0.031	0.009	0.032	0.016	0.032	0.021	0.034
syphilis	0.011	0.021	0.060	0.014	0.057	.		.	
rheumatism	0.121	0.022	0.020	0.024	0.020	0.108‡	0.025	0.103‡	0.025
injury	0.327	-0.008	0.013	-0.006	0.013	0.007	0.013	0.011	0.013
Prisoner of war	0.108	0.027	0.022	0.037*	0.024	0.016	0.021	0.026	0.023
Discharged for disability	0.195	-0.027*	0.014	-0.024*	0.013	-0.023	0.013	-0.022	0.013
Lives in top ten city, 1900	0.043	-0.003	0.031	0.004	0.033	-0.075†	0.011	-0.070†	0.010
Lives in medium size city, 1900	0.105	-0.016	0.018	-0.016	0.017	-0.030*	0.016	-0.030*	0.015
Lives in small city/noncity, 1900		.		.					
Professional/proprietor c. 1900		.		.					
Farmer c. 1900	0.418	0.029	0.019	0.028	0.019	-0.002	0.017	-0.001	0.016
Artisan c. 1900	0.137	0.044*	0.028	0.041*	0.028	-0.001	0.021	-0.007	0.016
Laborer c. 1900	0.224	0.029	0.022	0.032	0.022	0.004	0.019	0.003	0.018
Professional/proprietor		.		.					
at enlistment		.		.					
Farmer at enlistment	0.647	0.002	0.027	-0.003	0.026	0.011	0.026	0.008	0.025
Artisan at enlistment	0.130	-0.032	0.024	-0.028	0.024	-0.004	0.030	0.002	0.030
Laborer at enlistment	0.156	0.034	0.035	0.027	0.034	0.021	0.034	0.007	0.030
Married in 1900	0.873	-0.007	0.018	-0.006	0.017	0.004	0.017	0.003	0.017
Age in 1910	67.191	0.008‡	0.002	0.008‡	0.002	0.003	0.002	0.003*	0.002
Regiment fixed effects		No.		Yes.		No.		Yes.	
Pseudo R^2		0.06		0.12		0.04		0.07	

Note. 2044 observations. The derivative is evaluated at the sample means and, for dummy variables, is for a discrete change of the dummy variable from 0 to 1. All regressions include state of enlistment fixed effects. Syphilis is excluded from the regression for congestive heart failure because it predicted congestive heart failure perfectly.

Table 7: Marginal Effects for Probits for Musculoskeletal Problems, Men Aged 50-64 in 1900, Dependent Variable is Equal to One if Condition by 1900

		Joint Problems				Back Problems			
	Mean	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Joint problem	0.482	.		.		.			
Back problem	0.402	.		.		.			
High infant mortality county	0.121	0.034	0.032	0.035	0.035	0.029	0.031	0.030	0.034
City enlistment $\geq$ 50,000		.		.					
$<$ 50,000 and $\geq$ 2,500	0.321	0.018	0.038	-0.012	0.042	0.048	0.037	0.033	0.041
$<$ 2,500	0.610	-0.048	0.037	-0.075*	0.042	-0.030	0.037	-0.029	0.042
Wartime diarrhea	0.320	0.003	0.021	0.003	0.022	0.026	0.020	0.026	0.021
respiratory infection	0.120	-0.004	0.030	0.000	0.030	0.006	0.029	0.005	0.029
tuberculosis	0.020	-0.061	0.069	-0.070	0.070	0.047	0.068	0.046	0.069
measles	0.070	0.023	0.038	0.018	0.038	0.041	0.040	0.031	0.037
typhoid	0.068	-0.054	0.038	-0.058	0.038	0.007	0.037	0.007	0.038
malaria	0.036	0.154‡	0.049	0.162‡	0.050	0.081*	0.050	0.096*	0.051
syphilis	0.013	0.049	0.081	0.032	0.083	-0.014	0.077	-0.029	0.078
rheumatism	0.123	0.240‡	0.027	0.237‡	0.028	0.138‡	0.029	0.132‡	0.029
injury	0.330	-0.014	0.021	-0.027	0.021	-0.053‡	0.020	-0.066‡	0.020
Prisoner of war	0.106	-0.003	0.031	-0.008	0.032	0.045	0.031	0.030	0.032
Discharged for disability	0.197	-0.057†	0.024	-0.057†	0.025	-0.016	0.024	-0.012	0.024
Lives in top ten city, 1900	0.046	-0.043	0.046	-0.017	0.048	-0.132‡	0.042	-0.106†	0.044
Lives in medium size city, 1900	0.109	-0.042	0.030	-0.058*	0.031	-0.051*	0.029	-0.059†	0.029
Lives in small city/noncity, 1900		.		.					
Professional/proprietor c. 1900		.		.					
Farmer c. 1900	0.410	0.076‡	0.027	0.072‡	0.027	0.095‡	0.026	0.090‡	0.027
Artisan c. 1900	0.148	0.071†	0.033	0.064†	0.033	0.090‡	0.033	0.084‡	0.033
Laborer c. 1900	0.230	0.081‡	0.029	0.082‡	0.030	0.086‡	0.030	0.079‡	0.030
Professional/proprietor		.		.					
at enlistment		.		.					
Farmer at enlistment	0.629	0.044	0.040	0.042	0.040	0.103‡	0.039	0.094†	0.040
Artisan at enlistment	0.144	0.033	0.044	0.040	0.045	0.068	0.046	0.075*	0.047
Laborer at enlistment	0.161	0.078*	0.045	0.059	0.046	0.102†	0.047	0.081*	0.047
Married in 1900	0.861	0.015	0.027	0.005*	0.003	0.022	0.026	0.022	0.026
Age in 1900	57.479	0.006†	0.003	0.005*	0.003	0.004	0.003	-0.005	0.004
Regiment fixed effects		No.		Yes.		No.		Yes.	
Pseudo R^2		0.04		0.05		0.03		0.05	

Note. 2972 observations. The derivative is evaluated at the sample means and, for dummy variables, is for a discrete change of the dummy variable from 0 to 1. All regressions include state of enlistment fixed effects.

Table 8: Marginal Effects for Probits for Musculoskeletal Problems, Men Aged 60-74 in 1910, Dependent Variable is Equal to One if Condition by 1910

		Joint Problems				Back Problems			
	Mean	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Joint problem	0.591	.		.		.			
Back problem	0.495	.		.		.			
High infant mortality county	0.127	0.079†	0.035	0.089†	0.039	0.082†	0.045	0.109†	0.046
City enlistment $\geq$ 50,000		.		.					
$<$ 50,000 and $\geq$ 2,500	0.323	0.026	0.046	-0.015	0.052	0.008	0.046	0.074	0.064
$<$ 2,500	0.615	-0.061	0.046	-0.082	0.052	0.010	0.046	0.006	0.065
Wartime diarrhea	0.321	0.040	0.025	0.043*	0.026	-0.006	0.027	0.051*	0.030
respiratory infection	0.120	-0.036	0.036	-0.017	0.037	-0.113‡	0.027	-0.036	0.041
tuberculosis	0.019	-0.065	0.083	-0.065	0.086	0.114	0.110	0.058	0.092
measles	0.074	0.082*	0.042	0.067	0.043	0.005	0.048	0.046	0.050
typhoid	0.069	-0.030	0.046	-0.025	0.047	-0.014	0.052	-0.048	0.052
malaria	0.039	0.119†	0.054	0.148‡	0.052	-0.100	0.049	0.111*	0.064
syphilis	0.011	-0.020	0.101	-0.079	0.105	-0.090	0.077	-0.030	0.120
rheumatism	0.121	0.196‡	0.030	0.201‡	0.031	0.074*	0.046	0.132‡	0.039
injury	0.327	-0.012	0.024	-0.021	0.025	-0.025	0.025	-0.070†	0.029
Prisoner of war	0.108	-0.044	0.038	-0.047	0.040	0.027	0.044	0.077*	0.045
Discharged for disability	0.195	-0.091‡	0.029	-0.085‡	0.030	-0.081‡	0.026	-0.048	0.034
Lives in top ten city, 1900	0.043	0.028	0.056	0.060	0.056	0.042	0.059	0.077	0.073
Lives in medium size city, 1900	0.105	0.005	0.036	-0.027	0.037	-0.008	0.039	-0.078*	0.042
Lives in small city/noncity, 1900		.		.					
Professional/proprietor c. 1900		.		.					
Farmer c. 1900	0.418	0.069†	0.031	0.067†	0.032	0.062*	0.036	0.103‡	0.036
Artisan c. 1900	0.137	0.054	0.038	0.046	0.039	0.112†	0.053	0.109†	0.047
Laborer c. 1900	0.224	0.061*	0.033	0.063*	0.034	0.100‡	0.044	0.066	0.041
Professional/proprietor		.		.					
at enlistment		.		.					
Farmer at enlistment	0.647	0.031	0.047	0.030	0.048	-0.034	0.048	0.125†	0.056
Artisan at enlistment	0.130	0.007	0.052	0.027	0.053	-0.019	0.052	0.097	0.064
Laborer at enlistment	0.156	0.101†	0.050	0.065	0.053	0.028	0.058	0.137†	0.063
Married in 1900	0.873	0.054*	0.033	0.048	0.034	-0.007	0.035	-0.011	0.032
Age in 1910	67.191	0.003	0.003	0.002	0.004	-0.004	0.004	-0.005	0.004
Regiment fixed effects		No.		Yes.		No.		Yes.	
Pseudo R^2		0.04		0.08		0.03		0.08	

Note. 2044 observations. The derivative is evaluated at the sample means and, for dummy variables, is for a discrete change of the dummy variable from 0 to 1. All regressions include state of enlistment fixed effects.

joint problems in 1900 by 0.15 and in 1910 by 0.12. This malaria was not recurrent. Relatively few men had recurring infectious disease acquired during their service and those who did were no more likely to have joint problems than those who did not.

Occupation was an important predictor of both joint and back problems. For men in such manual occupations as farmer, artisan, or laborer circa 1900 the probability of having a joint problem relative to a professional or proprietor increased by 0.06 to 0.08 and of having a back problem by 0.09 to 0.13. Men who had been laborers when they enlisted were particularly likely to have joint and back problems; the probability of these conditions increased by 0.11. If the occupational distribution circa 1900 had been that for older men in 1990 and the occupational distribution at enlistment had been that for younger men in 1940, the probability of joint problems would have been 9 percent lower in 1900 and 6 percent lower in 1910 and the probability of back problems 20 percent lower in 1900 and 15 percent lower in 1910. Changes in the occupational distribution alone therefore could explain 13 to 18 percent of the difference in prevalence rates for joint problems between Union Army veterans and men in 1971-1980 and over 75 percent of the difference in back problems.

Men who had been discharged for disability were significantly less likely to have developed joint problems and those who had been injured during the war to have developed back problems. The latter were also less likely to have either valvular heart disease or an arrhythmia and in two of the respiratory problem probits were significantly more likely not to have a respiratory disorder at older ages. The inverse correlation between a war injury and morbidity is found both among men who could trace their disabilities to the war and those who could not and among men judged to have pensionable wounds by the examining surgeons and those who did not, suggesting that the correlation does not arise from the rules of the pension program. Recall that men who were injured in the war were initially healthier and may have remained healthier because they had been exposed to milder forms of infectious disease rather than the more severe camp forms. A

Table 9: Predicted Probabilities of Specific Chronic Conditions Assuming Elimination of Infectious Disease

Predicted Probability	Dullness Chest	Dec. Breath/ Adventitious Sounds	Arryth-mias	Valvular Heart Disease	Athero-sclerosis	Congestive Heart Failure	Joint Problems	Back Problems
Age 50-64, 1900								
Actual	0.088	0.233	0.286	0.183			0.480	0.396
Diarrhea=0	0.096	0.232	0.280	0.179			0.479	0.388
Respiratory=0	0.079	0.221	0.281	0.186			0.480	0.395
Tuberculosis=0	0.085	0.230	0.285	0.183			0.481	0.395
Measles=0	0.079	0.225	0.284	0.179			0.478	0.393
Typhoid=0	0.086	0.230	0.282	0.177			0.484	0.395
Malaria=0	0.088	0.232	0.286	0.183			0.474	0.393
Syphilis=0	0.086	0.231	0.287	0.183			0.479	0.396
Rheumatism=0	0.087	0.229	0.274	0.174			0.452	0.380
All Infect.=0	0.071	0.201	0.255	0.164			0.449	0.364
Age 60-74, 1910								
Actual	0.106	0.371	0.405	0.256	0.093	0.089	0.591	0.489
Diarrhea=0	0.117	0.375	0.394	0.250	0.093	0.089	0.579	0.476
Respiratory=0	0.094	0.358	0.394	0.253	0.092	0.088	0.595	0.495
Tuberculosis=0	0.085	0.367	0.402	0.256	0.093	0.088	0.592	0.487
Measles=0	0.107	0.357	0.400	0.249	0.090	0.088	0.586	0.485
Typhoid=0	0.101	0.369	0.398	0.249	0.093	0.088	0.593	0.491
Malaria=0	0.107	0.366	0.405	0.259	0.093	0.088	0.586	0.487
Syphilis=0	0.104	0.369	0.405	0.255	0.093		0.590	0.489
Rheumatism=0	0.108	0.367	0.392	0.246	0.090	0.075	0.568	0.472
All Infect.=0	0.089	0.336	0.356	0.228	0.076	0.071	0.553	0.459

Note. "Actual" probabilities were derived by using the previous probits to predict a prevalence rate for each individual and then summing over all individuals. All other probabilities used the same procedure, but set the value of dummy variables for infectious disease equal to zero.

war injury may therefore proxy for lower frailty, though I cannot rule out that men who survived their war injuries were less likely to be genetically susceptible to disease.

Table 9 summarizes the impact of infectious disease on chronic disease rates. It shows that if no men had had respiratory infections while in the army the prevalence of decreased breath and adventitious sounds would have been 4 to 5 percent lower and that of dullness of chest 10 to 11 percent lower; that if no men had had rheumatism while in the army the prevalence rate of valvular heart disease would have been 4 to 5 percent lower, that of arrhythmias 3 to 4 percent lower, and that of congestive heart failure 16 percent lower; that if no men had had malaria while in the army the prevalence rate of joint problems would have been 1 percent lower; and, that if no men had had measles while in the army the prevalence rate for valvular heart disease would have been 2 to 3 percent lower, that for decreased breath or adventitious sounds 3 to 4 percent lower, and that for dullness of chest 8 to 10 percent lower. If no men had had any infectious diseases while in the army the prevalence rates for dullness of chest would have been 16 to 19 percent lower, for decreased breath or adventitious sounds 9 to 14 percent lower, for arrhythmias 11 to 12 percent lower, for valvular heart disease 10 to 11 percent lower, for atherosclerosis 18 percent lower, for congestive heart failure 20 percent lower, for joint problems 6 percent lower, and for back problems 6 to 8 percent lower. Infectious disease therefore accounts for up to 19 percent of the difference in chronic disease rates between 1900/1910 and recent surveys for decreased breath or adventitious sounds and at least 13 percent of the difference for arrhythmias, 11 percent of the difference for valvular disease, 24 percent of the difference for atherosclerosis, 13 percent of the difference for joint problems, and 31 percent of the difference for back problems (see Table 10).

Table 9 probably underestimates the impact of lifetime exposure to infectious disease on chronic disease rates for the population as whole. Although prevalence rates for Union Army veterans were probably similar to those for the population as a whole (veterans may have had greater exposure to infectious disease, but were initially healthier), because illnesses are not observed for men both prior to and after their army service, the coefficient on infectious disease may be biased toward zero and the incidence rate for infectious disease will be too low. For example, a 1928-1931 health survey shows that 12 percent of men and women aged 55 to 64 and 11 percent of those older than 64 had a history of typhoid fever (Collins 1937). In contrast, only 7 percent of Union Army veterans are known to have ever had typhoid. Assuming that at least 12 percent of men had had a history of typhoid in 1900 and in 1910, then the elimination of typhoid fever alone would have lowered prevalence rates for valvular heart disease by at least 5 percent

Table 10: Percentage of Long-term Decline in Chronic Disease Rates Arising from Elimination Infectious Disease

	1900/1910 Actual	1900/1910 Predicted	1971-80/ 1988-1994	% Decline Due to Elimination
Ages 50-64				
Decreased breath or adventitious sounds	23.7	20.1	7.6/7.8	18.7
Joint problem	48.0	44.9	24.3/NA	13.1
Back problem	39.6	36.4	29.1/NA	30.5
Irregular pulse	28.6	25.5	3.6/4.3	12.6
Valvular heart disease	18.3	16.4	1.7/NA	11.4
Ages 60-74				
Decreased breath or adventitious sounds	37.1	33.6	12.0/11.1	13.7
Joint problem	59.1	55.3	30.8/43.1	17.2
Back problem	48.9	45.9	39.5/NA	31.9
Irregular pulse	40.5	35.6	7.7/6.7	14.7
Valvular heart disease	25.6	22.8	3.6/NA	12.7
Atherosclerosis	9.3	7.6	2.3/NA	24.2

Note. Prevalence rates are calculated from the Union Army data, the 1971-1975 and 1976-1980 National Health and Nutrition Examination Surveys, and the 1988-1994 National Health and Nutrition Examination Survey. The percentage decline is estimated by taking the average of prevalence rates over the 1971-1980 and 1988-1994 surveys, when possible.

and for irregular pulse by 3 percent. If the proportion of older men with a history of typhoid fever declined by 83 percent between 1900 and 1910 and the 1970s, then at least 5 percent of the decline in valvular heart disease can be attributed to declines in typhoid fever.[19] In contrast, the elimination of wartime typhoid could explain only 3 percent of the difference in valvular heart disease between Union Army veterans and modern populations.

5 Disability and Chronic Disease

This paper has emphasized that chronic disease rates in the past were extremely high and that this was in part caused by occupational hazards and in part by the high incidence of infectious disease. This section examines whether conditional on having a chronic disease disability rates are now lower or higher than they were in the past. My two measures of disability are subsequent mortality and difficulty in walking.

I compare the mortality experience of Union Army veterans with that of white men in the 1971-1975 National Health and Nutrition Examination Survey. Because men in the latter survey are still being followed up, I restrict my observation period to ten years and examine mean years lived within this ten year interval. I also present the uncensored means for Union Army veterans (see Table 11).[20]

Table 11 shows that although mean length of life in a ten year interval was higher overall among men examined in 1971-1975 than among Union Army veterans, mean length of life has not improved for men with specific chronic conditions. Wilson et al. (1998) find that

[19] Allowing for a modest increase in typhoid fever history with age, the numbers in Collins (1937) imply that at most 2 percent of the men in the first National health and Examination Surveys had had typhoid fever.

[20] The NHANES sample is too small to examine disease interactions. I do not control for wartime experiences among Union Army veterans because once I control for chronic conditions these were not statistically significant predictors of subsequent mortality.

Table 11: Mean Years Lived, Union Army Veterans, 1900 and 1910, and National Health and Nutrition Examination Survey, 1971-1975

	Within Ten Year Interval		Uncensored
	1900/1910	1971-1975	1900/1910
Ages 50-64			
Whole sample	8.8	9.4	16.0
Decreased breath or adventitious sounds	8.8	8.9	15.7
Dullness chest	8.9		16.1
Joint problem	8.9	9.2	16.4
Back problem	8.9	9.1	16.5
Irregular pulse	8.8	8.3	16.0
Valvular heart disease	8.8	8.8	16.0
Congestive heart failure	8.9		15.2
Atherosclerosis/arteriosclerosis	8.6	8.8	15.9
Ages 60-74			
Whole sample	7.6	8.3	11.0
Decreased breath or adventitious sounds	7.4	7.3	10.3
Dullness chest	7.5		10.6
Joint problem	7.5	6.9	10.3
Back problem	7.5	7.8	10.4
Irregular pulse	7.4	6.9	10.3
Valvular heart disease	7.3	7.1	10.1
Congestive heart failure	7.2		9.8
Atherosclerosis/arteriosclerosis	7.2	7.3	9.5

Note. Among men aged 50 to 64 only the difference in mean years lived between the Union Army sample and 1971-1975 survey for the whole sample is statistically significant. Among men aged 60 to 74 the difference is statistically significant only for the whole sample and for men with joint problems.

survival rates for congestive heart failure in the Union Army sample are similar to those in the 1971-1975 survey when patient history is used to determine prevalence of congestive heart failure in the latter survey. These results do not necessarily imply that we have made little progress in treatment. Men with specific chronic conditions in 1971-1975 may have had a much more severe form of the chronic condition than Union Army veterans either because prevention efforts have lowered incidence among men who would have gotten a less severe form of the disease or because increased medical efficacy may be keeping alive men who in the past would have died before being examined.

Although life expectancy has not improved for men with specific chronic diseases, the quality of life consequences of having a given chronic condition may now be less severe. Anti-inflammatory drugs provide for improved control or alleviation of arthritis. Symptomatic therapies can now be directed against reversible elements of obstructic airflow. Valve replacement is common when severe stenosis accompanies valvular heart disease. Digitalis, diuretics, and vasodilators are used to control aortic regurgitation and anti-arrhythmic drugs to control arrhythmias. The Union Army records provide one measure of the activities of daily living that can be compared with recent data to assess long-run changes in functioning – ability to walk.

Union Army physicians noted gait abnormalities (“limps,” “lame,” “crippled,” “drags leg”, “use left leg difficult”) and whether a veteran could not walk (“cannot stand”) and I use these descriptions to construct a variable indicating whether the veteran had difficulty walking. Because I only know whether a veteran had difficulty in walking and whether he had a specific chronic disease from the surgeons’ exams, I restrict my sample to men with surgeons’ exams.[21] A probit in which the dependent variable was equal to one if the veteran had difficulty walking and in which I control for early life conditions shows that a back problem increased the probability of

[21] Because relatively few men did not have surgeons’ exams, I obtain similar results when I drop this sample restriction.

walking difficulties by 0.15 in 1900 among men aged 50 to 64 and by 0.18 in 1910 among men aged 60 to 74; a joint problem by 0.12 percent both in 1900 and in 1910; congestive heart failure and atherosclerosis by 0.10 percent both in 1900 and in 1910; an irregular pulse by 0.04 in 1900 and 0.09 in 1910; and decreased breath or adventitious sounds by 0.04 in 1900 and 0.08 in 1910. Controlling for adult chronic conditions, malaria, rheumatism, an injury while in the army, and a discharge for disability were strong, positive predictors of difficulty walking.

The examiners in the 1988-1994 National Health and Nutrition Examination Survey also noted gait abnormalities and I used this variable together with variables indicating whether the individual was in a wheelchair or stretcher, whether he had paralysis or paresis of the leg, and whether he was an amputee or had a cast on his leg to construct a measure of difficulty in walking comparable to that used for Union Army veterans. Controlling for age and whether an individual had a joint problem, a heart murmur, an arrhythmia, and a respiratory problem, a probit reveals that a joint problem increased the probability of walking difficulties by 0.19 among men aged 60 to 74 in the 1988-1994 survey and respiratory difficulties by 0.12. Heart murmurs and arrhythmias were not statistically significant predictors of walking difficulties. In contrast, when I run a similar specification among Union Army veterans in 1910 but with additional controls for war injury and having been discharged for disability, a joint problem increased the probability of walking difficulties by 0.20, murmurs by 0.06, and respiratory difficulties by 0.07.

Table 12 presents predicted probabilities of difficulty walking for men with joint problems, decreased breath or adventitious sounds, murmurs, and arrhythmias. These probabilities are derived from a probit regression of difficulty walking on age, whether an individual had a joint problem, a respiratory difficulty, a murmur, or an arrhythmia. For Union Army veterans I control for whether a veteran had a war injury or was ever discharged for disability and evaluate probabilities setting the values of these variables to zero. These predicted probabilities show that overall men's probability of difficulty in walking has fallen by 18 to 54 percent (depending upon

Table 12: Probability of Difficulty in Walking (Predicted from Probit) for Men with Specific Chronic Diseases, Union Army Sample, 1910, and 1988-1994 National Health and Nutrition Examination Survey

	age	all men	joint problem	respiratory problem	murmur	arrhythmia	none of the previous conditions
1910	60	0.182	0.223	0.121	0.117	0.100	0.085
1988-1994	60	0.084	0.128	0.073	0.051	0.047	0.040
1910	65	0.209	0.256	0.143	0.139	0.120	0.103
1988-1994	65	0.132	0.194	0.119	0.086	0.081	0.070
1910	70	0.239	0.291	0.169	0.164	0.143	0.124
1988-1994	70	0.196	0.277	0.183	0.137	0.130	0.114

Note. The probabilities are predicted from probits of the difficulty of walking on joint problems, decreased breath or adventitious sounds, murmurs, and arrhythmias. The 1910 probit also includes controls for whether a veteran was injured in the war and whether he was discharged for disability. The probabilities are evaluated with the values of these variables set equal to 0. Note that men with "none of the previous conditions" might still have other chronic conditions.

age) or about 0.3 to 0.7 percent per annum. These estimates of declines in disability are somewhat lower than the decline of 0.5 to 1 percent between 1980 and 1990 found by Cutler and Richardson (forthcoming) and are lower than the decline of over 1 percent per year found by Manton et al. (1997) between 1982 and 1994. Table 12 also shows that conditional on having a specific chronic condition, disability has fallen. Although the improvement in health has not been as great for men with joint problems and respiratory problems as it has for men overall or for men with murmurs and arrhythmias, nonetheless Table 12 suggests that quality of life has improved both overall and for men with chronic conditions.

6 Implications

This paper has shown that the shift from manual to white collar occupations and reduced exposure to infectious disease were important determinants of declines in chronic disease rates among older men, declines that were on the order of 70 percent for respiratory conditions, 90 percent for irregular pulse rates, murmurs, and valvular heart disease, 60 percent for atherosclerosis, and 30 percent for joint and back problems between 1900 and 1910 and the 1970s. Occupational shifts accounted for 13 to 18 percent of the decline in joint problems since the early 1900s, over 75 percent of the decline in back problems, and 18 to 31 percent of the decline in respiratory difficulties. Acute respiratory infections while in the army increased the probability of chronic respiratory problems and arrhythmias at older ages; measles of chronic respiratory problems and of valvular heart disease; typhoid fever of valvular heart disease and irregular pulse; tuberculosis of chronic respiratory problems; rheumatic fever or post-rheumatic athropathies of valvular heart disease, arrhythmias, congestive heart failure, joint problems, and back problems; diarrhea of atherosclerosis; and malaria of joint problems. A high infant mortality rate in area of enlistment, a proxy for exposure prior to army service, increased the probability of respiratory problems and atherosclerosis. The infections likely to have the larger impact on chronic disease rates (rheumatic fever or post-rheumatic athropathies on joint problems and tuberculosis on respiratory difficulties) did have the larger effect.

Although some of the relationships between early life conditions and later morbidity outcomes were expected from a reading of the medical literature, the links between some of these conditions, such as malaria and subsequent joint problems, are not well-established and therefore represent new findings. Nor has the impact of occupational shifts and of reduced exposure to infectious disease on the long-term decline in chronic disease rates previously been quantified. The results of this paper imply that reduced exposure to infectious disease explains at least 10 to 25 percent of the decline in chronic disease rates among older men since the early 1900s.

The paper also showed that the burden of chronic disease was high in the past not just because prevalence rates were high but also because the duration of chronic disease was long and chronic disease was disabling. Men aged 50 to 64 in 1900 lived an additional 16 years.

Conditional on having a chronic condition, life expectancy was as high as for men in the same age group in the 1970s, perhaps because men with a given chronic disease now have a more severe form of that condition. However, conditional on having a chronic condition, the probability that an older man would have difficulty in walking has fallen. By this measure disability for the total population has fallen by 0.3 to 0.7 percent per year since the early 1900s.

The sizable impact of infectious disease on chronic disease rates suggests that the link between infectious and chronic disease may be much closer than that postulated by theories of the epidemiological transition and that chronic diseases should not necessarily be thought of as part of the natural process of aging. It also suggests that such public health investments as water filtration, vaccination, and sewage systems could considerably improve elderly health in developing countries by lowering infectious disease rates. The rate of return on these investments may therefore be underestimated by analyses that take only infectious disease mortality into account. These public health investments had been carried out in the United States by the 1930s and childhood and infectious disease mortality fell throughout the first half of the century. The full impact of these improvements, and of the continued shift towards white collar work and the mechanization of tasks, may not be seen until 2035 or later, when the baby boomers will begin to reach age 90. These potential increases in health and in longevity represent impressive gains in the standard of living, but may aggravate the financing crisis in Social Security pension and health care costs. Although healthier people may decide to work longer, retirement rates have been rising throughout the century despite improvements in health (Costa 1998). Healthier people need less medical care, but innovations in medical care, while improving outcomes for ill patients and improving them by more than per person spending on medical care has risen, have increased costs (Cutler, McClellan, and Newhouse 1998; Cutler and Richardson, forthcoming). Assessing how effective proposals to resolve the financing crisis are likely to be will require us to draw upon both the demographic and economic evidence.

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