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LONG-TERM DECLINES IN DISABILITY AMONG OLDER MEN: MEDICAL CARE, PUBLIC HEALTH, AND OCCUPATIONAL CHANGE

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ABSTRACT

Functional disability (difficulty in walking , difficulty in bending, paralysis, blindness in at least one eye, and deafness in at least one ear) in the United States has fallen at an average annual rate of 0.6 percent among men age 50 to 74 from the early twentieth century to the early 1990s. Twenty-four to 41 percent of this decline is attributable to innovations in medical care, 37 percent to reduced chronic disease rates, and the remainder is unexplained. The portion due to reduced chronic disease rates can be subdivided into the 9 percent accounted for by reduced infectious disease rates (particularly rheumatic fever, malaria, typhoid, and acute respiratory infections), the 7 percent accounted for by occupational shifts away from manual labor and to white collar jobs, and the 21 percent that is unexplained.

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1 Introduction

Functional disability among older men in the United States has improved greatly since the beginning of the twentieth century. Among men age 60 to 74 at the beginning of the century 50 percent had difficulty bending, 31 percent difficulty walking, 4 percent were partially paralyzed, 4 percent were blind in at least one eye, and 4 percent deaf in at least one ear. In contrast, among men in the same age group in the early 1990s, only 16 percent had difficulty bending, 11 percent had difficulty walking, 3 percent were partially paralyzed, 3 percent were blind in at least one eye, and 3 percent were deaf in at least one ear. The decline in disability in this time period among men age 50 to 64 is of a similar order of magnitude.[1]

Two main factors could account for long-term declines in functional disability at older ages. One factor is the increased efficacy of medical care. Even with no decline in chronic disease rates, functional disability may have improved because medical technology allows both for short-term symptom relief and for long-term control of chronic conditions. Since the late 1960s there has been a remarkable increase in therapies targetted at the elderly population. Non-steroid anti-inflammatory drugs, gold compounds, hydroxycholoquine, sulfasalasize, corticosteroids, and cytotoxic and immuno-suppressive drugs all alleviate rheumatoid arthritis. Cataracts was previously one of the main causes of blindness at older ages (Costa 1998: 64), but today cataract extraction and implantation of a plastic or silicone lens is a common outpatient procedure. Such surgeries as cardiac catheritization, bypass, angioplasty, and installation of pacemakers and such drugs as β-blockers, Ca-channel blockers, vasodilators, ACE inhibitors, and thrombolytics control cardiac conditions. Chronic obstructive airway disorders such as asthma and chronic obstructive pulmonary disease are controlled by bronchodilator drugs (e.g. β-agonists, anticholigeneric drugs, theophylline, and corticosteriods) and by antibiotics when exacerbated by viral infections.

[1] Trends and sources are reviewed later in the text.

The second explanation for the decline in functional disability at older ages is the decline in chronic disease rates. The average decline in such chronic conditions as respiratory problems, valvular heart disease, arteriosclerosis, and joint and back problems was about 66 percent from the early 1900s to the 1970s and 1980s (Costa forthcoming). Several explanations could account for this decrease, including a decline in the use of salt and wood smoke as food preservatives, increases in nutritional intake during the growing years (including in utero), declines in infectious disease, and reductions in occupational injuries (Barker 1992, 1994; Fogel and Costa 1997; Manton, Stallard, and Corder 1997b; Elo and Preston 1992). In previous work (Costa forthcoming) I estimate that roughly 29 percent of the decline in chronic conditions at older ages from the early 1900s to the 1970s and 1980s could be accounted for by occupational shifts from manual to white collar occupations and 18 percent by the decline in infectious disease rates. The decline in infectious disease rates in turn could be explained by public health investments in water filtration, vaccination, and sewage systems that were carried out in the United States by the 1930s.

This paper documents the decline in functional disability among men age 50 to 64 and 60 to 74 in the United States between the early 1900s and the early 1990s.[2] It examines whether these declines can be explained by the increased efficacy of medical care, the decline in infectious disease rates, or the shift from manual to white collar occupations. The paper uses a longitudinal data set on Union Army veterans of the American Civil War (1861-1865). These men represent the first cohort to reach age 65 in the twentieth century. Because medical care in the past was ineffective at best, I can examine the impact of untreated chronic disease on functional disability. Because these men were exposed to a variety of infectious diseases while in the army as young adults, I can investigate the impact of exposure to disease at young adult ages on later

[2]Riley 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. See Costa (forthcoming) for a contrary view.

life outcomes. Because the data are longitudinal, I can also investigate the impact of occupation during both young adult and older ages on disability at older ages.

The findings will help us understand why the health of different cohorts has been changing in the United States. Improvements in elderly health both from the early 1900s to the 1980s (Costa forthcoming) and during the 1980s (Cutler and Richardson 1997; Manton, Corder, and Stallard 1997a) suggest that aging is “plastic.” The plasticity of aging has implications both for policies that propose to postpone the age at which full Social Security retirement benefits can be collected and for the fiscal solvency of Medicare. It also has implications for investment in biomedical research areas and assessments of the benefits of medical technology as a whole. Many researchers (e.g. Chassin et al. 1987; Greenspan et al. 1988; Winslow et al. 1988; Newhouse 1993) have focused on the low productivity of the medical system and implicitly argued that limiting overall medical spending would improve welfare. But, studies of the overall costs and benefits of medical care since the 1970s suggest that the benefits far outweigh the costs (e.g. Cutler, McClellan, and Newhouse 1998; Cutler and Richardson 1997).

The findings will also help us target resources in developing countries. Many of 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. A large percentage of the labor force of developing countries works in manual occupations. But, developing countries have access to modern medicine.

The paper begins with a description of the data. Section 3 discusses trends in functional disability (difficulty in walking, difficulty in bending, paralysis, blindness in at least one eye, and deafness in at least one ear). Section 4 explains how declines in functional disability can be decomposed into the portions attributable to increased efficacy of medical care, reduced exposure to infectious disease, and occupational shifts. Section 5 presents the long-term trend in chronic disease rates and discusses diagnoses. Section 6 decomposes the decline in functional disability into the fractions accounted for by innovations in medical care and by reduced chronic disease rates. Section 7 decomposes the decline in chronic disease rates and in functional disability into the proportions attributable to reduced infectious disease rates and occupational shifts. The relationship between specific chronic conditions and infectious disease and manual occupations is investigated in this section as well.

2 Data

The data used in this paper are drawn from the records of the Union Army pension program (see the Data Appendix for a description). 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 (Costa 1998: 160). The program was established in 1862 to provide pensions to both regular and volunteer recruits who were severely disabled as a direct result of military service. By 1890 the program became a universal disability program for veterans and by 1904 it officially became a universal old-age pension program. The dataset that uses these records contains detailed medical examinations both for men whose pension application or bid for a pension increase was rejected and for men whose applications were accepted; occupational information from the 1900 and 1910 censuses and from enlistment records; and medical histories on such illnesses as measles, diarrhea, tuberculosis, typhoid, acute respiratory infections, malaria, smallpox, cholera, and stomach problems while these men were in the Army.

The records of the examining surgeons noted such functional disabilities as difficulty in walking, difficulty in bending, paralysis, blindness in at least one eye, and deafness in at least one ear. The surgeons also described specific chronic conditions in great detail. Thus for heart disease conditions 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, edema, cyanosis, dyspnea, arteriosclerosis, or impaired circulation. The physician also described such circulatory disorders as varicose veins and hemorrhoids. Respiratory examinations included reports of respiratory sounds such as murmurs, rales, crepitus, vocal fremitus, and ronchae and reports of decreased breath sounds. Descriptions of rheumatism included where the rheumatism was located and whether pain, tenderness, swelling, or crepitation was associated with the joint. Disease and disability rates are based upon an examining surgeon ever having noted a condition. 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.

I compare the Union Army data with a random sample of the American non-institutionalized, white population drawn from the 1988-1994 National Health and Nutritional Examination Survey (NHANES) and the 1994 and 1995 National Health Interview Surveys (NHIS).[3] NHANES includes measures of functional disabilities (difficulty in walking, difficulty in bending, and paralysis) as assessed by a physician and self-reported measures of functional disability (difficulty in walking, difficulty in bending, blindness in at least one eye, and deafness in at least one ear). NHIS includes some self-reported disability measures (difficulty in walking and difficulty in bending). NHANES also includes a medical exam which in some cases yields descriptions and diagnoses that can be compared with those of physicians working under contract from the Pension Bureau because these did not require any diagnostic equipment that was unavailable to late nineteenth century physicians. In addition, NHANES includes self-reports of whether a respondent ever had

[3] *Third National Health and Nutrition Examination Survey 1988-1994 NHANES III Examination Data File, Public Use Data File Documentation Number 76200, Third National Health and Nutrition Examination Survey 1988-1994, NHANES III Household Data File, Public Use Data File Documentation Number 77560, National Health Interview Survey on Disability, 1994: Phase I, Person and Condition Data (ICPSR 2562), National Health Interview Survey, 1994 (CPSR 6724), National Health Interview Survey on Disability, 1995: Phase I, Person and Condition Data (ICPSR 2576), National Health Interview Survey, 1995 (ICPSR 2533).*

cataracts, stroke, congestive heart failure, or arthritis. NHIS includes self-reports of whether a respondent had a chronic condition within the last 12 months. The specific chronic conditions that I will examine are adventitious sounds, decreased breath sounds, back problems, joint problems, murmurs, congestive heart failure, stroke, and irregular pulse in the Union Army sample and in NHANES and murmurs, varicose veins, hemorrhoids, poor circulation, arteriosclerosis, and tachycardia in the Union Army sample and in NHIS.[4]

3 Disability Trends

Table 1 gives disability rates as measured by difficulty in walking, difficulty in bending, paralysis, blindness in at least one eye, and deafness in at least one ear among men age 50-64 and 60-74 in the Union Army sample, NHANES, and NHIS. For comparison results are also presented from the 1978 Survey of Disability and Work (SDW). Three sets of results are presented for the Union Army sample. These include results for the entire sample and for veterans with a surgeons' exam. Veterans with a surgeons' exam were on average more disabled. Because I know disability and chronic disease rates only for men with a surgeons' exam (in calculating rates for the entire sample I am assuming that men without a surgeons' exam had no functional disabilities), I use the values for men with a surgeons' exam in the decomposition.

How representative of the health of the general population are the disability rates calculated for the entire Union Army sample? Because all Union Army veterans survived to young adult ages without any substantial physical handicaps and because of high infectious rates at young ages (e.g. scarlett fever or congenital rubella), the prevalence of blindness and deafness was probably higher in the general population. The prevalence of difficulty in walking or in

[4]Of course some of these conditions (adventitious sounds, dyspnea, and tachycardia) may not be chronic.

bending may have been higher in the general population as well. Disability may also have been higher in the general population because the proportion of immigrants was higher in the general population and these men experienced a worse disease and nutritional environment in early childhood. Although I cannot compare the health of veterans and non-veterans after the war, I can estimate the extent to which veterans' wartime experience contributed to their ill-health. The third measure that I present for Union Army veterans therefore includes predicted values for the entire sample from a probit regression in which the dependent variable is the measure of functional disability and the independent variables are age, dummy variables for occupation, dummy variables indicating what disease a veteran had while in the army, and dummies for whether the veteran had ever been wounded in the war, had ever been discharged for disability, or had ever been a POW. The latter three dummy variables are set equal to 0 to obtain predictions. These predicted values suggest that while the war did have an effect on such measures of disability as difficulty in walking or bending, the average annual rate of decline in disability obtained from using predicted disability is similar to that obtained from using actual disability rates for the entire sample.

Several measures of difficulty in walking and in bending are given in Table 1. The Union Army physicians noted gait abnormalities (e.g. "lame," "shuffles", "leg drags"), general difficulties in walking ("locomotion impaired," "crippled," "cannot walk"), and general difficulties in bending ("cannot touch floor", "cannot straighten"). Difficulty in walking (including gait abnormalities) is compared to three different measures in NHANES. The first of these is physican evaluated lameness, gait abnormalites, and limb paralysis. The second is physician evaluated difficulty (could not be done, moderate difficulty) in walking one quarter of a mile. The third of these is self-evaluated difficulty (could not be done, moderate difficulty, some difficulty) in walking 10 steps without rest. The difficulty in walking variable in NHIS is a yes/no response to the question of whether the individual had difficulty in walking. In SDW, an individual is

Table 1: Disability Rates (%) by Age, 1900/1910-1994

	UA 1900/1910	Predicted UA 1900/1910	SDW 1978	NHANES 1988-94	NHIS 1994	Surgeons' UA 1900/1910
Age 50-64						
Difficulty bending						
Physician evaluated	44.4	39.0		7.5		49.3
Self-evaluated			14.4	7.3	8.0	
Difficulty walking						
Physician evaluated	28.5	20.9		4.8/3.5		31.7
Self-evaluated			11.9	10.4	8.1	
Paralysis	4.8	4.8	1.3	0.9		5.5
Blindness in at least one eye	3.4	2.8		1.5	3.7	
Deafness in at least one ear	3.2	2.9		1.4	3.6	
Age 60-74						
Difficulty bending						
Physician evaluated	53.8	49.7		16.1		59.5
Self-evaluated				10.9	10.7	
Difficulty walking						
Physician evaluated	36.6	30.9		10.8/11.3		40.8
Self-evaluated				13.8	13.3	
Paralysis	6.1	6.0		2.7		6.9
Blindness in at least one eye	4.5	3.8		3.1		4.9
Deafness in at least one ear	4.1	3.7		2.7		4.5

Note. UA=Union Army, SDW=Survey of Disability and Work, NHANES=National Health and Nutrition Examination Survey, NHIS=National Health Interview Survey. Sample weights were used for SDW, NHANES, and NHIS. Evaluations of walking and bending difficulties do not include mild difficulties, e.g. walking several miles. Results from "Predicted UA" are predictions from a probit regression in which the controls were age, dummies indicating wartime diseases, occupational dummies, and dummies indicating whether the veteran has ever been wounded during the war, had been discharged for disability, or had been a POW. These last three dummies were set equal to 0 to obtain predicted values. Results from "Surgeons' UA" are means obtained from the UA sample restricted to men who had a surgeons' exam. Two different indicators are presented for difficulty in walking in NHANES. The first is based upon indications of lameness, shuffling, gait abnormalities, or leg paralysis. The second is based upon difficulty in walking a quarter of a mile.

considered to have difficulty in walking if he reported a lot of trouble using stairs or an incline. Difficulty in bending is compared to two different measures in NHANES. The first of these is the physician's evaluation of difficulty in bending (could not be done, moderate difficulty) and the second the individual's own assessment of difficulty in stooping, crouching, kneeling (could not be done, moderate difficulty). The variable in NHIS is a yes/no response to the question of whether the individual had difficulty in bending. The variable in SDW is a positive response to whether an individual had a lot of trouble in stooping, crouching, or kneeling.

How can the different measures of difficulty in walking and in bending be compared with the Union Army data? In the case of difficulty in walking, I use both the physician indicator of lameness and gait abnormalities and also self-assessed difficulties in walking ten steps in NHANES and present a range of estimates. These two measures are more comparable to the judgements of the Union Army examining surgeons, who noted lameness and gait abnormalities and observed difficulties in walking in the examining room but made no judgement about difficulty in walking a quarter of a mile. The physician indicator of difficulty in walking a quarter of a mile yields a very low percentage estimate for men age 50-64, but is somewhat more comparable to the lameness and gait abnormality measure for men age 60-74. I use the physician indicator of difficulty in bending in NHANES rather than self-assessed difficulty in bending, crouching, and stooping because the physician indicator of difficulty in bending is more comparable to both the measure in the Union Army sample and to the measure in NHIS (both of which were based on difficulty in bending only). The self-evaluated and physician evaluated measures of difficulty in bending in NHANES yield very similar numbers for men age 50-64, but for men age 60-74 the physician evaluated measure suggests a higher rate of disability for 60-74 year olds than the self-evaluated measure.

Table 1 shows that although functional disability declined substantially over the course of the twentieth century, the decline was sharper in recent decades. Among men age 50-64 physician assessed difficulty in walking and in bending and paralysis declined by 0.8 to 0.9 percent per year from 1900 to 1991 (the midpoint of NHANES). During these same years blindness in at least one eye and deafness in at least one ear declined by 0.6 percent per year. Among men age 60-74 the declines in difficulty in walking and in bending and in paralysis were 0.7 to 0.8 percent per year between 1910 and 1991. In this time span blindness in at least one eye and deafness in at least one ear declined by 0.2 to 0.3 percent per year. Among both age groups a comparison of difficulty in walking in the Union Army sample with self-assessed difficulty in walking in NHANES implies that the annual rate of decline was 0.6 percent. In contrast between 1978 and 1991 (using NHANES) or 1994 (using NHIS) declines among men age 50-64 were on the order of 2.8 to 3.8 percent per year in difficulty in bending, 1.0 to 2.0 percent per year in difficulty in walking, and 2.4 percent per year in paralysis. The average decline between 1910 and 1991 (0.6 percent per year) is lower than the 0.5 to 1.0 percent per year observed by Cutler and Richardson (1997) between 1980 to 1990, the 0.9 to 2.3 percent per year found by Freedman and Martin (1998) between 1984 and 1993, the 0.9 percent per year observed by Crimmins, Saito, and Reynolds (1997) between 1982 and 1993, and the yearly 1.1 percent and 1.5 percent between 1982 and 1989 and 1989 and 1994, respectively, found by Manton, Corder, and Stallard (1997a).[5]

4 Methods

Functional disability (difficulty in walking, difficulty in bending, paralysis, blindness in at least one eye, and deafness in at least one ear) can be related to chronic conditions through probit

[5]There may be cycles in health since the 1970s. Although clinician reports document continuous improvements in health since the 1970s (Waidmann, Bound, and Schoebaum 1995), self-reported health declined during the 1970s (Chirikos 1986; Colvez and Blanchet 1981; Crimmins 1990; Poterba and Summers 1987; Verbrugge 1984).

regressions of the form

$$D_{\text{UA}} = X_{\text{UA}}\beta_{\text{UA}} + U_{\text{UA}} \tag{1}$$

$$D_{\text{NHANES}} = X_{\text{NHANES}}\beta_{\text{NHANES}} + U_{\text{NHANES}} \tag{2}$$

$$D_{\text{NHIS}} = X_{\text{NHIS}}\beta_{\text{NHIS}} + U_{\text{NHIS}} \tag{3}$$

where D is an indicator variable that is equal to one if an individual had a specific functional disability, the matrix X includes dummy variables for specific chronic conditions, a dummy variable for whether a veteran had ever been wounded in the war (for the UA sample specification), a dummy variable indicating whether an individual was an amputee (unavailable in the NHIS specification), and age, and U is an error term. Because specific chronic conditions and functional disability for men in 1900 and 1910 are known only for those with a surgeons' exam, the Union Army sample is restricted to men with a surgeons' exam. Two different specifications are used for the Union Army sample. In the first specification the dummy variables for specific chronic conditions are dummies for adventitious sounds, decreased breath sounds, back problems, joint problems, murmurs, congestive heart failure, stroke, irregular pulse, and cataracts. This specification contains chronic conditions that can be compared with those found in NHANES. The second specification uses chronic condition dummies for murmurs, varicose veins, hemorrhoids, poor circulation, arteriosclerosis, and tachycardia. This specification can be compared with that used for NHIS.[6]

Declines in functional disability can be decomposed into the proportions attributable to the increased efficacy of medical care and to reduced chronic disease rates. The difference in

[6]Althought the assumption in this paper is that a condition that leads to greater functional disability is worse, some arrythmias may cause few or no symptoms but are associated with an adverse prognosis whereas other arrythmias, although symptomatic, are benign.

functional disability between the Union Army sample and NHANES and NHIS can be written as

$$\begin{aligned} D_{\text{UA}} - D_{\text{NHANES}} &= [X_{\text{UA}}\beta_{\text{UA}} - X_{\text{NHANES}}\beta_{\text{UA}}] + \\ &\quad [X_{\text{NHANES}}\beta_{\text{UA}} - X_{\text{NHANES}}\beta_{\text{NHANES}}] + \\ &\quad [U_{\text{UA}} - U_{\text{NHANES}}] \qquad (4) \\ D_{\text{UA}} - D_{\text{NHIS}} &= [X_{\text{UA}}\beta_{\text{UA}} - X_{\text{NHIS}}\beta_{\text{UA}}] + \\ &\quad [X_{\text{NHIS}}\beta_{\text{UA}} - X_{\text{NHIS}}\beta_{\text{NHIS}}] \\ &\quad [U_{\text{UA}} - U_{\text{NHIS}}], \qquad (5) \end{aligned}$$

where for each equation the first term in square brackets represents the difference attributable to changes in chronic disease rates (the X's), the second term in square brackets represents the differences due to changes in functional form (the βs), and the third term in square brackets the differences due to unobservables (the U's). These unobservables include uncontrolled disease states, differences in diagnostic capabilities, and nutritional and environmental changes. Changes in functional form will in turn depend upon the increased efficacy of medical care, definitional differences in chronic conditions, differences in the severity of chronic conditions, and changes in frailty. The change attributable to the βs, however, represents an upper bound estimate of the effect of medical care on disability under the assumption that there is no omitted variable bias. Predicted values for the Union Army sample are calculated by setting whether a veteran was ever wounded during the war or was an amputee equal to 0 so that the terms in brackets will reflect differences attributable either to differences in chronic disease rates or to differences in functional form.

The fall in chronic disease rates can in turn be decomposed into the decline attributable to public health measures (reduced infectious disease rates); that attributable to occupational shifts from manual to white collar work; and an unexplained portion (due to unobserved infectious disease or occupational hazards, improvements in nutritional intake during the growing years, the decreased use of wood smoke and salt as preservatives, better health habits, and preventive medicine, among other factors). I begin by estimating probit regressions of the form

$$C = X\beta + U \tag{6}$$

for the Union Army sample, where C is an indicator variable for whether an individual had a specific chronic condition (adventitious sounds, decreased breath sounds, back problems, joint problems, murmurs, congestive heart failure, irregular pulse, varicose veins, hemorrhoids, poor circulation, arteriosclerosis, and tachycardia). The matrix X includes dummies for whether a veteran was ever wounded in the war, ever discharged for disability, or was ever a POW; dummy variables indicating whether a veteran ever had specific illnesses while in the army (cholera, diarrhea, malaria, respiratory problems, measles, smallpox, tuberculosis, typhoid, scurvy, rheumatism, stomach problems, or syphilis); dummy variables indicating occupational class circa 1900 or 1910 (farmer, professional or proprietor I, professional or proprietor II, artisan, laborer I, laborer II); dummy variables indicating occupational class at enlistment (farmer, professional or proprietor, artisan, laborer, none/unknown); dummy variables indicating whether the examining surgeons ever noted that an individual had typhoid, malaria, or another infectious disease or fever either while in the army or later in life; dummy variables for size of city of enlistment; and age. The vector U is an error term. Regressions are estimated separately for men age 50 to 64 in 1900 and men age 60 to 74 in 1910. Regressions are not estimated for stroke or cataracts because too many of the independent variables were perfect predictors of the dependent variable.

I investigate the role of reduced infectious disease rates and of occupational shifts in the decline in functional disability among older men from the early 1900s to the 1990s by using predicted values for chronic disease rates derived from Equation 6 together with the regressions relating functional disability in the Union Army sample to chronic disease (Equation 1). I first use the chronic disease probit regressions to obtain two different sets of predictions of chronic disease rates. To obtain the first set of predictions, I set all illnesses while in the army equal to 0 and I set the dummy variables for whether the examining surgeons noted typhoid, malaria, or another infectious disease or fever equal to 0. Because men in NHANES probably did experience infectious disease when they were young, this procedure will lead me to overestimate the impact of public health measures on chronic disease rates. I will underestimate the impact of public health measures on chronic disease rates because I cannot observe infectious disease experience prior to military service and between military service and the first surgeons' exam. To obtain the second set of predictions, I set the values of the occupational variables for 1900/1910 equal to their values in 1990 and the values of occupation at enlistment variables equal to their 1940 variables. I then use the predicted values of specific chronic conditions to obtain predictions of functional disability.

5 Chronic Disease Trends

Before decomposing the decline in disability into the fractions attributable to medical innovations and to reduced chronic disease rates, I first establish the trend in chronic disease rates and discuss diagnoses. Table 2 shows that chronic disease rates were high among men age 50-64 in 1900 and among men age 60-74 ten years later. It also shows point prevalence rates and chronic disease rates for white men in the same age groups for ever diagnosed conditions in NHANES and prevalence rates for conditions an individual had in the last 12 months in NHIS. Note that the prevalence of most conditions has declined sharply. The prevalence of decreased breath sounds declined by about 0.6 percent per annum and that of adventitious sounds by about 0.9 to 1.1 percent per year. The annual rate of decline for back problems was 0.2 to 0.4 percent and for joint problems 0.4 to 0.5 percent. The high prevalence of joint and back problems observed in 1900 and 1910 are consistent with analyses of skeletal remains from the American frontier which report a high prevalence of degenerative joint disease (osteoarthritis), nonarthritic joint changes resulting from habitual postures, and fractures arising from traumas (e.g. Larsen et al. 1995).

The largest declines in prevalence rates are observed in heart and circulatory conditions. The prevalence of heart murmurs, irregular pulse, and tachycardia declined by 0.9 to 1.0 percent per year from the beginning of the century to the beginning of the 1990s. The prevalence of varicose veins and poor circulation declined by 0.7 to 0.9 percent per annum and that of hemorrhoids by 0.8 to 1.0 percent. Some of this decline may reflect the more careful examinations of surgeons accustomed to direct observation as well as to looser definitions of murmurs, irregular pulse, or tachycardia. However, the high prevalence rates for irregular pulse, tachycardia, poor circulation, and varicose veins are consistent with the high prevalence rate of valvular heart disease (39 percent among men age 60-74 in 1910).[7]

The time trend in other conditions over the course of the twentieth century is harder to pinpoint. The prevalence of cataracts declined among men age 50 to 64 but rose among those age 60 to 74. Examining surgeons may have been more likely to note the final condition (loss of vision) than the underlying cause. The same may be true for stroke. Furthermore, a much smaller percentage of stroke victims survived before the ability to maintain adequate oxygen, nutritional, and fluid intake after the initial stroke and the availability of anticoagulant and antiplatelet drugs to prevent subsequent strokes. Stroke was one of the primary causes of death in the past. Among Union Army veterans, 11 percent of men who were age 50-64 in 1900 died of cerebrovascular disease.[8] Stroke today is commonly associated with atherosclerosis or hypertension. Rates of

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[7]The relationship between valvular heart disease and varicose veins or tachycardia is much looser than for irregular pulse or tachycardia.

[8]The other major killers were heart disease (25 percent) and urinary problems (13 percent). Cause of death rates

Table 2: Prevalence Rates (%) of Chronic Conditions, Signs, and Symptoms, 1900-1994

	Age 50-64			Age 60-74		
	UA 1900	NHANES 1988-94	NHIS 1994	UA 1910	NHANES 1988-94	NHIS 1994
Decreased breath sounds	11.9	5.1		15.4	8.3	
Adventitious sounds	20.1	3.4		29.1	4.0	
Back problems	39.2	32.4		47.5	30.2	
Pain/tenderness/swelling in joints	44.8			54.1	35.2	
Ever diagnosed arthritis		20.1			32.7	
Missing limbs, fingers, or toes	3.3	0.1		3.7	1.0	
Cataracts	4.1	3.8		6.6	16.1	
Heart murmur	27.9	2.0	1.6	38.7	3.8	1.7
Valvular heart disease						
(mitral or aortic origin murmurs)	18.3			27.4		
Congestive heart failure						
Ever diagnosed		3.9			7.0	
(Edema, cyanosis, or dyspnea)	2.7			8.9		
(Above plus cardiomegaly and no co-existing respiratory)	2.0			6.1		
Ever diagnosed stroke	0.3	3.2		0.6	5.2	
Ischaemic heart disease			11.6			21.0
Hypertension		33.6	30.3		38.8	35.6
Arteriosclerosis	1.7		2.2	9.2		4.7
Cerebrovascular heart disease			3.2			4.8
Irregular pulse	32.4	4.4		43.7	8.6	
Tachycardia	19.2		2.2	27.0		3.4
Varicose veins	7.9		2.6	10.1		3.4
Hemorrhoids	30.7		8.2	36.1		4.7
Poor circulation	4.0		0.9	4.1		1.4

Note. UA=Union Army, NHANES=National Health and Nutrition Examination Survey, NHIS=National Health Interview Survey. Sample weights were used for NHANES and NHIS. A chronic condition is noted in the NHIS if the person had the condition in the last 12 months. A self-reported chronic condition is noted in NHANES if it was ever diagnosed. Symptoms and signs were noted in physician examinations. In UA a chronic condition is noted if it was ever mentioned in an exam.

hypertension are high in recent data (at least 36 percent among men age 60-74). We do not know rates of hypertension in the past because examining surgeons lacked the technology to diagnose hypertension in Union Army veterans.

The increasing specificity of diagnoses may make the time trend of certain cardiac and circulatory conditions hard to pinpoint. Arteriosclerosis was lower among Union Army veterans age 50 to 64 in 1900 than among men of the same age in 1994, but by 1910 rates were higher among Union Army veterans. Modern methods of diagnosing atherosclerosis are quite different. The examining surgeons' use of hard arteries as a detection criterion provides evidence of peripheral arteriosclerosis which may be evidence of either atherosclerosis (cholesterol and fatty plaques in the blood) or of such other disease states as diabetes mellitus or systemic or local inflammation. Prevalence rates of atherosclerosis may be relatively lower in the NHIS than in the Union Army data set because modern diagnoses are more specific. But, they might also be relatively higher because of the increased detection of atherosclerosis. Defining congestive heart failure using edema, cyanosis, and dyspnea as the diagnostic criteria suggests that the prevalence of congestive heart failure increased among men age 50 to 64 but fell by 0.3 percent per annum among men age 60 to 74. A more precise diagnosis of congestive heart failure which might include not only edema, cyanosis, and dyspnea, but also cardiomegaly and exclude co-existing conditions and asthma lowers the prevalence rates of congestive heart failure and implies that rates of congestive heart failure may have risen even among men age 60 to 74.

Cumulative prevalence rates calculated from the Union Army sample are not strictly comparable to the point prevalence rates estimated from NHANES both because a condition would be more likely to be noticed in multiple exams 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

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were calculated excluding men who died during the influenza epidemic.

latter is true then prevalence rates in the Union Army sample will be underestimated, but even if the former were true, it seems unlikely that such a large decline in prevalence rates could be explained by definitional biases alone.

6 Medical Care and Functional Disability

Tables 3 and 4 show that in the past chronic conditions had a larger impact on difficulty in walking or in bending. Adventitious sounds were significant predictors of both difficulty in walking and in bending among men 60-74 in the Union Army sample but not in NHANES. Irregular pulse and varicose veins were also more likely to be significant predictors of difficulty in walking and in bending in the Union Army data than in NHANES or NHIS. Congestive heart failure was a significant predictor of difficulty in walking and in bending in the Union Army sample and of self-assessed difficulty in walking in NHANES, but not of difficulty in bending. Murmurs were significant predictors of difficulty in walking and in bending when the second specification is used in the Union Army data (but not when the first specification is used) and were not significant predictors in either NHANES or NHIS. Arteriosclerosis was a significant predictor of difficulty in walking in both the Union Army data and in NHANES but was a significant predictor of difficulty in bending only in the Union Army data. Tachycardia was a significant predictor of difficulty in walking and in bending among men 50-64 only in the Union Army data (though the point estimates are substantial in NHIS) and was a significant predictor both of difficulty in walking and in bending among men age 60 to 74 in the Union Army sample and NHIS. Poor circulation affected mainly difficulty in walking in the Union Army data and in NHIS, with larger point estimates in the NHIS. The results for stroke are mixed but suggest that stroke was a significant predictor both in the Union Army data and in NHANES. Back problems were significant predictors of these functional disabilities in the Union Army data but in NHANES were only significant predictors of self-assessed difficulty in walking. Joint problems are consistently significant predictors of difficulty in walking and in bending both in the Union Army data and in NHANES; the point estimate is larger in the Union Army data.

Differences in the etiology of heart and circulatory conditions may explain why these conditions tended to predict difficulty in walking and in bending in the Union Army data, but generally only difficulty in walking in the more recent data. As will be shown later, rheumatic fever and rheumatic athropathies while in the army predicted heart and circulatory conditions at older ages. Heart and circulatory conditions may therefore have been accompanied by athropathies resulting from rheumatic fever. Indeed, the correlation between heart and circulatory problems was very high. More than 80 percent of men who had arterosclerosis or congestive heart failure in 1900 also had joint problems. Seventy percent of men with murmurs or tachycardia in 1900 also had joint problems.

In the case of paralysis and blindness, the main predictors in the Union Army data and in NHANES were similar (stroke and cataracts), but the point estimates were larger in the Union Army data (see Table 5). Results for deafness are not presented because in neither the Union Army data nor in NHANES was any of the chronic conditions a significant predictor. However, in 1900 a surgeons' report of an infectious disease other than malaria or typhoid was a significant predictor of deafness.

Using the regression results presented in Tables 3, 4, and 5 to decompose changes in functional disability between the Union Army data and NHANES into the fractions due to reduced chronic disease rates and to innovations in medical care shows that changes in functional form (and therefore innovations in medical care) are more important than changes in disease rates (see Table 6). Among men age 50 to 64 the increased efficacy of medical care may account for 11 to 43 percent of the decline in difficulty in walking observed between the Union Army data and NHANES, 41 percent of the decline in difficulty in bending, 61 percent of the decline in

Table 3: Impact of Chronic Conditions on Difficulty in Walking or in Bending, Men 50-64, 1900-1994

	Difficulty Walking			Difficulty Bending	
	UA	NHANES/NHIS		UA	NHANES/NHIS
	1900	1988-94/1994		1900	1988-94/1994
	$\frac{\partial P1}{\partial x}$	$\frac{\partial P2}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$
Specification 1					
Adventitious sounds	-0.015	0.050	0.081	-0.025	-0.020
	(0.017)	(0.057)	(0.094)	(0.021)	(0.045)
Decreased breath sounds	0.004	-0.024	0.061	-0.004	-0.031
	(0.021)	(0.024)	(0.069)	(0.025)	(0.033)
Back problems	0.116‡	0.009	0.066†	0.292‡	0.009
	(0.015)	(0.016)	(0.034)	(0.016)	(0.019)
Joint problems	0.139‡	0.067‡	0.151‡	0.418‡	0.081‡
	(0.014)	(0.022)	(0.039)	(0.014)	(0.026)
Murmurs	-0.024	-0.021	-0.036	0.012	0.054
	(0.015)	(0.038)	(0.087)	(0.018)	(0.075)
Congestive heart failure	0.087†	-0.004	0.228‡	0.147‡	0.094†
	(0.040)	(0.026)	(0.083)	(0.046)	(0.050)
Stroke	0.165	0.109†	0.256‡	0.085	0.012
	(0.117)	(0.067)	(0.118)	(0.125)	(0.046)
Irregular pulse	0.048‡	-0.007	-0.089	0.002	0.030
	(0.015)	(0.031)	(0.044)	(0.018)	(0.047)
Specification 2					
Murmurs	0.031†		-0.004	0.137‡	0.048
	(0.014)		(0.068)	(0.015)	(0.077)
Varicose veins	0.172‡		0.001	0.045*	0.011
	(0.024)		(0.057)	(0.024)	(0.058)
Hemorrhoids	-0.013		-0.122†	0.024*	
	(0.013)		(0.032)	(0.015)	
Poor circulation	0.140‡		0.139	0.032	0.066
	(0.033)		(0.141)	(0.033)	(0.130)
Arteriosclerosis	0.129‡		0.156†	0.229‡	-0.004
	(0.050)		(0.079)	(0.047)	(0.060)
Tachycardia	0.061‡		0.116	0.051‡	0.078
	(0.016)		(0.084)	(0.017)	(0.080)

Note. UA=Union Army, NHANES=National Health and Nutrition Examination Survey, NHIS=National Health Interview Survey, 1994 and 1995. The first NHANES difficulty in walking specification uses physician evaluated gait abnormalities and the second uses self-assessed difficulty in walking. Coefficients are derivatives from a probit regression in which the dependent variable was whether the individual had difficulty in walking or difficulty in bending and where additional independent variables included age and dummy variables indicating whether the Union Army veteran had ever been wounded in the war, whether the individual was an amputee, or whether the individual ever had cataracts. In specification 2, hemorrhoids perfectly predicted a 0 outcome for difficulty in bending. Derivates represent discrete changes from 0 to 1. The symbols $\ddagger$, $\dagger$, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 4: Impact of Chronic Conditions on Difficulty in Walking or in Bending, Men 60-74, 1910-1994

	Difficulty Walking			Difficulty Bending	
	UA	NHANES/NHIS		UA	NHANES/NHIS
	1910	1988-94/1994		1910	1988-94/1994
	$\frac{\partial P1}{\partial x}$	$\frac{\partial P2}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$
Specification 1					
Adventitious sounds	0.039†	0.069	0.073	0.053‡	0.011
	(0.019)	(0.080)	(0.087)	(0.020)	(0.068)
Decreased breath sounds	0.014	0.017	0.203‡	-0.009	0.120†
	(0.023)	(0.050)	(0.070)	(0.026)	(0.062)
Back problems	0.138‡	-0.027	0.063*	0.282‡	-0.011
	(0.018)	(0.028)	(0.037)	(0.018)	(0.028)
Joint problems	0.139‡	0.130‡	0.152‡	0.430‡	0.240‡
	(0.018)	(0.028)	(0.032)	(0.017)	(0.030)
Murmurs	-0.003	0.002	0.076	0.047†	-0.002
	(0.018)	(0.073)	(0.097)	(0.019)	(0.073)
Congestive heart failure	0.099‡	0.067	0.177‡	0.102‡	0.060
	(0.029)	(0.052)	(0.065)	(0.032)	(0.051)
Stroke	0.242‡	0.214‡	0.179†	0.025	0.128‡
	(0.095)	(0.079)	(0.081)	(0.034)	(0.071)
Irregular pulse	0.085‡	0.001	-0.001	0.036*	0.110†
	(0.018)	(0.048)	(0.059)	(0.019)	(0.064)
Specification 2					
Murmurs	0.064‡		0.025	0.163‡	0.040
	(0.017)		(0.080)	(0.016)	(0.075)
Varicose veins	0.153‡		0.121†	0.071‡	0.045
	(0.025)		(0.069)	(0.024)	(0.060)
Hemorrhoids	-0.026		-0.138	0.020	-0.113
	(0.016)		(0.059)	(0.016)	(0.053)
Poor circulation	0.137‡		0.419‡	0.012	0.150
	(0.033)		(0.124)	(0.033)	(0.117)
Arteriosclerosis	0.154‡		0.124†	0.179‡	0.009
	(0.026)		(0.063)	(0.023)	(0.051)
Tachycardia	0.101‡		0.116*	0.068‡	0.110*
	(0.018)		(0.071)	(0.017)	(0.068)

Note. UA=Union Army, NHANES=National Health and Nutrition Examination Survey, NHIS=National Health Interview Survey, 1994 and 1995. The first NHANES difficulty in walking specification uses physician evaluated gait abnormalities and the second uses self-assessed difficulty in walking. Coefficients are derivatives from a probit regression in which the dependent variable was whether the individual had difficulty in walking or difficulty in bending and where additional independent variables included age and dummy variables indicating whether the Union Army veteran had ever been wounded in the war (if applicable), whether the individual was an amputee, or whether the individual ever had cataracts. Derivates represent discrete changes from 0 to 1. The symbols ‡, †, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 5: Impact of Chronic Conditions on Paralysis and Blindness, Men 50-64 and 60-74, 1900-1994

	Paralysis		Blindness	
	UA	NHANES	UA	NHANES
	1900/1910	1988-94	1900/1910	1988-94
	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$
Age 50-64				
Stroke	0.784‡	0.067‡		
	(0.088)	(0.048)		
Irregular pulse	0.031‡	0.001	-0.006	0.031
	(0.007)	(0.010)	(0.004)	(0.032)
Decreased breath sounds	0.031‡		-0.005	
	(0.012)		(0.006)	
Cataracts	0.046‡	0.013	0.363‡	0.042†
	(0.018)	(0.015)	(0.031)	(0.030)
Adventitious sounds	-0.009		0.002	0.073†
	(0.007)		(0.006)	(0.060)
Joint problems	-0.011*		-0.001	
	(0.007)		(0.005)	
Back problems	0.007		-0.006	0.012
	(0.007)		(0.005)	(0.10)
Murmurs	-0.007		-0.008	0.023
	(0.006)		(0.005)	(0.041)
Congestive heart failure	0.002		0.026*	0.023
	(0.017)		(0.020)	(0.024)
Age 60-74				
Stroke	0.701‡	0.128‡	-0.006	0.016
	(0.081)	(0.045)	(0.032)	(0.023)
Irregular pulse	0.036‡	0.013	-0.001	0.049‡
	(0.009)	(0.017)	(0.006)	(0.029)
Decreased breath sounds	0.025†	-0.002	0.005	0.002
	(0.012)	(0.012)	(0.008)	(0.016)
Cataracts	0.054‡	-0.003	0.343‡	0.044‡
	(0.018)	(0.007)	(0.028)	(0.017)
Adventitious sounds	-0.005	-0.006	-0.004	0.010
	(0.009)	(0.014)	(0.006)	(0.026)
Joint problems	-0.021†		-0.003	
	(0.009)		(0.006)	
Back problems	0.019†	0.005	-0.008	0.008
	(0.009)	(0.008)	(0.006)	(0.010)
Murmurs	-0.003		-0.013	
	(0.008)		(0.006)	
Congestive heart failure	-0.004	0.004	0.005	0.006
	(0.012)	(0.012)	(0.011)	(0.016)

Note. UA=Union Army, NHANES=National Health and Nutrition Examination Survey, NHIS=National Health Interview Survey Coefficients are derivatives from a probit regression in which the dependent variable was whether the individual had paralysis, blindness in at least one eye, or deafness in at least one year. Independent variables in all regressions included age and dummy variables indicating whether the Union Army veteran has ever been wounded in the war and whether the individual was an amputee, and dummy variables for adventitious sounds, decreased breath sounds, back problems, joint problems, murmurs, arrhymias, congestive heart failure, stroke, and cataracts. Only coefficients that were statistically significant in at least one regression are presented. Decreased breath sounds perfectly predicted paralysis in NHANES. Derivates represent discrete changes from 0 to 1. The symbols ‡, †, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

paralysis, and 23 percent of the decline in blindness. The figures attributable to reduced chronic disease rates are 21 to 26 percent, 40 percent, 4 percent, and 36 percent, respectively. Among men age 60 to 74 changes in chronic disease rates are more important than changes in functional forms. Nine to 28 percent of the difference in difficulty in walking is explained by changes in the βs and 34 to 47 percent by changes in chronic disease rates. Fifty-one percent of difficulty in bending is explained by changes in chronic disease rates and 33 percent by changes in the βs. Sixty-nine percent of the decline in paralysis is explained by changes in the βs and more than all of the decline in blindness. Averaging over both age groups and over 5 measures of functional disability (including deafness) implies that 28 to 42 percent of the decline in functional disability can be explained by improved medical care.[9] Averaging over difficulty in walking and in bending alone, the increased efficacy of medical care explains at most 24 to 41 percent of the decline in functional disablity in these two measures. Another 37 percent was explained by reduced chronic disease rates and the remaining 22 to 39 percent was unexplained.

The increased efficacy of medical care also explains a substantial fraction of the differences in functional disability between the Union Army sample and NHIS. Improved medical care may explain up to 57 percent of the decline in difficulty in bending between the Union Army data and NHIS and reduced chronic disease rates only 22 percent of the decline. The increased efficacy of medical care accounts for a smaller fraction of the decline in difficulty in walking between the Union Army and NHIS (at most 26 percent); lower chronic disease rates account for 25 percent of the decline. On average, innovations in medical care explain up to 42 percent of the decline in functional disability between the Union Army data and NHIS as measured by difficulty in walking and in bending. Reduced chronic disease explain 24 percent of the decline, with the remaining 34 percent unexplained.

[9] I assume that the increased efficacy of medical care explains 0 percent of the decline in deafness.

Table 6: Decomposition of Changes in Disability Among Men 50-64, 1900-1994, and Among Men 60-74, 1910-1994

	Difficulty walk-ing (1)	Difficulty walk-ing (2)	bend-ing	Para-lysis	Blind-ness
UA and NHANES, Age 50-64					
ΔD	26.9	21.3	41.8	4.6	2.2
$(\Delta X)\beta$	5.6	5.6	16.7	0.2	0.8
$X(\Delta\beta)$	11.7	2.3	17.2	2.8	0.5
ΔU	9.6	13.4	7.9	1.6	0.9
UA and NHANES, Age 60-74					
ΔD	30.0	27.0	43.4	4.2	1.8
$(\Delta X)\beta$	10.1	10.1	22.3	0.4	-0.4
$X(\Delta\beta)$	8.5	2.4	14.2	2.9	1.9
ΔU	11.4	14.5	6.9	0.9	0.3
UA and NHIS, Age 50-64					
ΔD		23.6	41.3		
$(\Delta X)\beta$		2.8	5.5		
$X(\Delta\beta)$		6.0	23.6		
ΔU		14.8	12.2		
UA and NHIS, Age 60-74					
ΔD		27.5	48.8		
$(\Delta X)\beta$		6.8	10.6		
$X(\Delta\beta)$		7.1	27.3		
ΔU		13.6	10.9		

Note. UA=Union Army, NHANES=National Health and Nutrition Examination Survey, NHIS=National Health Interview Survey. Column (1) uses physician assessed gait abnormalities and column (2) self-assessed difficulty in walking. ΔD is calculated from Table 1 using results for men with a surgeons' exam and is the difference in disability prevalence rates across years. $(\Delta X)\beta$ was calculated as the difference in predicted disability measured at the values of X and of β in the UA data and predicted disability measured at the values of β in the UA data and X in the NHANES/NHIS data. $X(\Delta\beta)$ was calculated as the difference in predicted disability measured at the values of β in the UA data and X in the NHANES/NHIS data and predicted disability measured at the values of β and X in the NHANES/NHIS data. ΔU is the difference in unobservables. In the Union Army sample the value of the dummy variable for whether a veteran was ever wounded in the war was set equal to 0, that of the dummy variable indicator for whether the veteran was an amputee was set equal to the NHANES value, and age was set equal to the median age in the NHANES sample. Predicted disability in the Union Army sample is based upon men with a surgeons' exam only.

7 Disease, Occupation, and Disability

The decline in functional disability between the Union Army sample and NHANES and NHIS can be further decomposed into the proportions attributable to reduced infectious disease rates and to occupational shifts by decomposing the change in chronic conditions (the X's) into these two factors. I first relate chronic conditions in the Union Army data to illnesses during wartime service, infectious disease reported by the examining surgeons, occupational group at enlistment, and occupational class circa 1900 or 1910 using probit regressions and obtain predicted values under the assumptions that infectious disease rates were zero and that the occupational distribution resembled the recent one. I then use the predicted values of chronic disease rates obtained from these probits together with the regressions from section 6 for the Union Army sample to predict functional disability. Selected derivatives from the probit regressions relating chronic disease to infectious disease and to occupation are shown in Tables 7, 8, 9, 10, 11, and 12.

Table 7 shows that both illnesses and occupation are important predictors of later life respiratory problems. Respiratory problems, measles, smallpox, and tuberculosis while in the army were large and significant predictors of adventitious sounds and decreased breath sounds at age 50 to 64 and 60 to 74. Typhoid fever was a strong predictor of both adventitious sounds and decreased breath sounds at age 50 to 64. Malaria was a significant predictor at all ages, as was other infectious/fever. A manual occupation at enlistment, many of which included exposure to dust (both organic and inorganic), fumes, or gases, was a predictor of adventitious sounds but not of decreased breath sound.[10]

The relations between infectious disease and respiratory distress observed in Table 7 are consistent with the medical literature. Tuberculosis may lead to respiratory abnormalities.

[10]Laborers I were significantly less likely to have adventitous sounds in 1900, but this results was only true for watchmen and to a lesser extent drivers. These men were in occupations with little exposure to either occupational hazards or to individuals who might be disease carriers.

Table 7: Impact of Infectious Disease and Occupation on Respiratory Problems in Union Army Sample

	Aventitious sounds				Decreased Breath			
	1900		1910		1900		1910	
	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dummy=1 if during war had								
Cholera	0.147	(0.140)	0.141	(0.271)	-0.061	(0.065)		
Diarrhea	-0.030†	(0.013)	-0.028	(0.020)	0.004	(0.010)	-0.011	(0.015)
Malaria	0.006	(0.032)	0.041	(0.047)	-0.018	(0.023)	0.015	(0.037)
Respiratory problem	0.141‡	(0.021)	0.126‡	(0.029)	0.069‡	(0.020)	0.081‡	(0.024)
Measles	0.078‡	(0.025)	0.063*	(0.035)	0.038†	(0.020)	0.030	(0.028)
Smallpox	0.085*	(0.052)	0.026	(0.071)	0.075†	(0.044)	0.128†	(0.066)
Tuberculosis	0.253†	(0.055)	0.204‡	(0.069)	0.148‡	(0.049)	0.212‡	(0.068)
Typhoid	0.024	(0.025)	0.056	(0.038)	-0.008	(0.019)	0.033	(0.031)
Scurvy	0.103	(0.055)	0.124	(0.084)	0.048	(0.044)	0.021	(0.064)
Rheumatism	0.012	(0.019)	0.014	(0.028)	0.018	(0.015)	0.040*	(0.024)
Stomach problems	0.106†	(0.053)	0.038	(0.075)	0.017	(0.039)	-0.023	(0.054)
Syphilis	0.005	(0.054)	-0.050	0.081	-0.022	(0.039)	-0.006	(0.064)
Dummy=1 if circa 1900/1910								
Farmer	-0.004	(0.026)	0.028	(0.041)	0.001	(0.021)	0.006	(0.032)
Professional or proprietor II	-0.034	(0.027)	0.012	(0.046)	-0.003	(0.023)	0.007	(0.037)
Artisan	-0.016	(0.028)	0.036	(0.047)	0.004	(0.024)	0.020	(0.038)
Laborer I	-0.069†	(0.030)	0.022	(0.056)	-0.040	(0.023)	0.004	(0.044)
Laborer II	-0.014	(0.028)	0.056	(0.046)	-0.008	0.022	0.019	(0.037)
Dummy=1 if at enlistment								
Farmer	0.073†	(0.036)	0.139‡	(0.054)	0.036	(0.028)	0.041	(0.042)
Artisan	0.083†	(0.045)	0.142†	(0.065)	-0.018	(0.029)	-0.028	(0.043)
Laborer	0.083†	(0.044)	0.159‡	(0.064)	0.041	(0.035)	0.065	(0.053)
None/unknown	0.053	(0.037)	0.145‡	(0.057)	0.021	(0.028)	0.034	(0.044)
Dummy=1 if surgeons reported								
Typhoid	0.102†	(0.050)	0.011	(0.060)	0.101‡	(0.045)	0.041	(0.051)
Malaria	0.099‡	(0.030)	0.123‡	(0.037)	0.045†	(0.024)	0.076‡	(0.032)
Other infectious/fever	0.156‡	(0.028)	0.149‡	(0.037)	0.117‡	(0.025)	0.145‡	(0.034)

Note. Derivates are from a probit regression in which the additional control variables are age, dummy variables indicating whether the veteran had ever been wounded in the war, ever discharged for disability, or was ever a POW, and dummy variables for city size at enlistment. Derivatives represent discrete changes from 0 to 1. Cholera perfectly predicted decreased breath sounds in 1910. The symbols ‡, †, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 8: Impact of Infectious Disease and Occupation on Musculoskeletal Problems in Union Army Sample

	Back problems				Joint problems			
	1900		1910		1900		1910	
	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dummy=1 if during war had								
Cholera	-0.011	(0.144)	0.025	(0.250)	0.183	(0.130)	0.214	(0.188)
Diarrhea	0.008	(0.016)	-0.011	(0.021)	-0.015	(0.016)	-0.029	(0.021)
Malaria	0.037	(0.039)	0.020	(0.049)	0.034	(0.039)	-0.030	(0.049)
Respiratory problems	-0.025	(0.022)	-0.023	(0.029)	-0.016	(0.022)	-0.034	(0.029)
Measles	0.022	(0.028)	0.013	(0.036)	0.014	(0.029)	0.018	(0.035)
Smallpox	0.008	(0.058)	-0.020	(0.075)	-0.063	(0.058)	-0.033	(0.074)
Tuberculosis	-0.063	(0.054)	-0.096	(0.069)	-0.073	(0.056)	-0.061	(0.068)
Typhoid	0.063†	(0.030)	0.037	(0.039)	0.001	(0.030)	0.042	(0.037)
Scurvy	0.146†	(0.060)	0.107	(0.082)	0.114	(0.059)	0.069	(0.080)
Rheumatism	0.176‡	(0.022)	0.178‡	(0.028)	0.221‡	(0.021)	0.208‡	(0.024)
Stomach	0.086	(0.057)	0.090	(0.074)	0.024	(0.056)	-0.013	(0.075)
Syphilis	-0.053	(0.064)	-0.069	(0.090)	-0.015	(0.066)	0.020	(0.088)
Dummy=1 if circa 1900/1910								
Farmer	0.079‡	(0.032)	0.059	(0.042)	0.094‡	(0.032)	0.028	(0.041)
Professional and proprietor II	-0.045	(0.035)	-0.089*	(0.047)	0.008	(0.036)	-0.089	(0.048)
Artisan	0.028	(0.036)	-0.001	(0.048)	0.096‡	(0.035)	0.010*	(0.047)
Laborer I	0.077*	(0.043)	0.076	(0.056)	0.034	(0.043)	-0.034	(0.057)
Laborer II	0.061*	(0.035)	0.000	(0.046)	0.098‡	(0.034)	0.045	(0.044)
Dummy=1 if at enlistment								
Farmer	0.027	(0.040)	0.079	(0.053)	0.047	(0.040)	0.060	(0.050)
Artisan	0.013	(0.046)	0.069	(0.059)	0.038	(0.045)	0.059	(0.055)
Laborer	0.063	(0.045)	0.139†	(0.055)	0.092†	(0.043)	0.111†	(0.051)
None/unknown	0.079†	(0.040)	0.122†	(0.052)	0.115‡	(0.039)	0.128‡	(0.048)
Dummy=1 if surgeons reported								
Typhoid	0.113†	(0.054)	0.020	(0.064)	0.020	(0.054)	0.002	(0.062)
Malaria	0.090‡	(0.032)	0.100‡	(0.037)	0.148‡	(0.031)	0.113‡	(0.034)
Other infectious/fever	0.083‡	(0.030)	0.063*	(0.036)	0.063†	(0.029)	0.039	(0.035)

Note. Derivates are from a probit regression in which the additional control variables are age, dummy variables indicating whether the veteran had ever been wounded in the war, ever discharged for disability, or was ever a POW, and dummy variables for city size at enlistment. Derivatives represent discrete changes from 0 to 1. The symbols ‡, †, and ∗ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 9: Impact of Infectious Disease and Occupation on Murmurs and Congestive Heart Failure in Union Army Sample

	Murmurs				Congestive Heart Failure			
	1900		1910		1900		1910	
	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dummy=1 if during war had								
Cholera	0.121	(0.141)	0.070	(0.260)	0.059	(0.084)		
Diarrhea	0.019	(0.015)	0.024	(0.021)	0.002	(0.005)	-0.006	(0.011)
Malaria	-0.025	(0.034)	-0.013	(0.048)	-0.020*	(0.006)	-0.002	(0.026)
Respiratory problems	-0.005	(0.020)	0.022	(0.029)	-0.000	(0.007)	-0.014	(0.015)
Measles	0.017	(0.026)	-0.022	(0.035)	0.000	(0.009)	-0.008	(0.019)
Smallpox	0.095*	(0.057)	0.087	(0.075)	-0.003	(0.017)	0.104†	(0.060)
Tuberculosis	-0.057	(0.048)	0.020	(0.068)	0.011	(0.022)	0.029	(0.045)
Typhoid	0.016	(0.028)	0.043	(0.039)	0.001	(0.009)	0.010	(0.023)
Scurvy	0.072	(0.057)	-0.043	(0.082)	-0.006	(0.015)	-0.068	(0.022)
Rheumatism	0.100‡	(0.022)	0.130‡	(0.029)	0.016†	(0.008)	0.067‡	(0.020)
Stomach	0.049	(0.055)	0.066	(0.077)	0.027	(0.025)	0.040	(0.051)
Syphilis	-0.039	(0.058)	-0.019	(0.088)	0.014	(0.024)	-0.034	(0.040)
Dummy=1 if circa 1900/1910								
Farmer	-0.004	(0.030)	-0.053	(0.042)	0.018	(0.013)	0.036	(0.026)
Professional or proprietor II	-0.041	(0.032)	-0.083*	(0.046)	0.010	(0.017)	-0.013	(0.027)
Artisan	0.004	(0.033)	0.007	(0.048)	0.022	(0.020)	0.017	(0.031)
Laborer I	-0.016	(0.039)	-0.073	(0.055)	0.020	(0.023)	-0.005	(0.033)
Laborer II	0.045	(0.033)	0.012	(0.046)	0.038†	(0.022)	0.031	(0.032)
Dummy=1 if at enlistment								
Farmer	0.057	(0.038)	0.106†	(0.053)	0.007	(0.015)	0.026	(0.036)
Artisan	-0.001	(0.043)	0.032	(0.061)	0.007	(0.019)	0.034	(0.048)
Laborer	0.045	(0.043)	0.111*	(0.059)	-0.001	(0.016)	0.024	(0.044)
None/unknown	0.046	(0.038)	0.072	(0.054)	0.017	(0.018)	0.055	(0.042)
Dummy=1 if surgeons reported								
Typhoid	0.084*	(0.053)	0.104*	(0.064)	0.017	(0.022)	0.028	(0.040)
Malaria	0.160‡	(0.032)	0.123‡	(0.037)	0.011	(0.012)	0.039*	(0.024)
Other infectious/fever	0.117‡	(0.029)	0.139‡	(0.036)	0.005	(0.010)	0.018	(0.022)

Note. Derivates are from a probit regression in which the additional control variables are age, dummy variables indicating whether the veteran had ever been wounded in the war, ever discharged for disability, or was ever a POW, and dummy variables for city size at enlistment. Derivatives represent discrete changes from 0 to 1. Cholera perfectly predicted congestive heart failure in 1910. The symbols ‡, †, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 10: Impact of Infectious Disease and Occupation on Irregular Pulse and Tachycardia in Union Army Sample

	Irregular Pulse				Tachycardia			
	1900		1910		1900		1910	
	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dummy=1 if during war had								
Cholera	-0.008	(0.136)	-0.205	(0.242)	0.041	(0.120)	-0.045	(0.232)
Diarrhea	0.032†	(0.015)	0.028	(0.021)	0.005	(0.013)	0.002	(0.019)
Malaria	0.002	(0.036)	-0.024	(0.049)	0.047	(0.032)	0.043	(0.045)
Respiratory problems	0.012	(0.021)	0.055*	(0.029)	0.050‡	(0.019)	0.037	(0.027)
Measles	-0.025	(0.027)	-0.030	(0.036)	0.001	(0.023)	0.017	(0.033)
Smallpox	0.052	(0.057)	0.124*	(0.073)	0.018	(0.048)	-0.059	(0.064)
Tuberculosis	-0.004	(0.053)	-0.003	(0.069)	0.037	(0.047)	0.007	(0.063)
Typhoid	0.049*	(0.029)	0.116‡	(0.039)	0.034	(0.025)	0.111‡	(0.038)
Scurvy	0.102*	(0.059)	0.032	(0.085)	-0.014	(0.047)	-0.020	(0.076)
Rheumatism	0.086‡	(0.022)	0.106‡	(0.029)	0.041†	(0.019)	0.073‡	(0.028)
Stomach	0.060	(0.056)	0.064	(0.077)	0.046	(0.049)	0.125*	(0.076)
Syphilis	-0.001	(0.062)	-0.095	(0.087)	0.002	(0.052)	0.143*	(0.088)
Dummy=1 if circa 1900/1910								
Farmer	0.002	(0.031)	0.014	(0.042)	0.005*	(0.026)	0.036	(0.039)
Professional or proprietor II	-0.026	(0.034)	-0.012	(0.048)	0.006*	(0.029)	0.003	(0.044)
Artisan	-0.030	(0.034)	-0.034	(0.048)	0.017*	(0.030)	0.045	(0.046)
Laborer I	-0.066*	(0.039)	-0.113†	(0.056)	0.006	(0.035)	0.028	(0.055)
Laborer II	0.016	(0.033)	0.035	(0.046)	0.025	(0.029)	0.048	(0.044)
Dummy=1 if at enlistment								
Farmer	-0.009	(0.038)	0.048	(0.053)	-0.053	(0.030)	-0.118‡	(0.046)
Artisan	-0.032	(0.042)	0.028	(0.061)	-0.063	(0.030)	-0.107†	(0.044)
Laborer	0.016	(0.043)	0.092	(0.058)	-0.064	(0.029)	-0.097†	(0.045)
None/unknown	0.050	(0.039)	0.121†	(0.053)	-0.039	(0.029)	-0.047	(0.045)
Dummy=1 if surgeons reported								
Typhoid	0.112†	(0.054)	0.029	(0.065)	0.067	(0.048)	0.025	(0.059)
Malaria	0.147‡	(0.032)	0.128‡	(0.037)	0.116‡	(0.029)	0.123‡	(0.037)
Other infectious/fever	0.125‡	(0.030)	0.094‡	(0.036)	0.096‡	(0.027)	0.083†	(0.036)

Note. Derivates are from a probit regression in which the additional control variables are age, dummy variables indicating whether the veteran had ever been wounded in the war, ever discharged for disability, or was ever a POW, and dummy variables for city size at enlistment. Derivatives represent discrete changes from 0 to 1. The symbols ‡, †, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 11: Impact of Infectious Disease and Occupation on Arteriosclerosis and Varicose Veins in Union Army Sample

	Arteriosclerosis				Varicose Veins			
	1900		1910		1900		1910	
	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dummy=1 if during war had								
Cholera					0.116	(0.111)	0.113	(0.205)
Diarrhea	-0.004	(0.003)	0.013	(0.012)	-0.005	(0.009)	0.015	(0.013)
Malaria	-0.005	(0.006)	-0.012	(0.025)	0.005	(0.021)	0.038	(0.034)
Respiratory problems	-0.004	(0.004)	-0.007	(0.016)	0.003	(0.012)	-0.006	(0.018)
Measles	-0.001	(0.006)	0.001	(0.020)	-0.026*	(0.013)	-0.029	(0.020)
Smallpox	-0.004	(0.012)	0.042	(0.051)	0.008	(0.032)	0.062	(0.056)
Tuberculosis	-0.001	(0.013)	0.004	(0.040)	0.016	(0.034)	0.030	(0.047)
Typhoid	0.015†	(0.010)	-0.002	(0.022)	0.015	(0.017)	-0.000	(0.024)
Scurvy	0.004	(0.015)	-0.013	(0.043)	0.042	(0.038)	0.048	(0.059)
Rheumatism	0.006	(0.004)	0.042‡	(0.019)	0.016	(0.013)	-0.007	(0.018)
Stomach problems	0.020	(0.020)	0.049	(0.054)	0.010	(0.033)	-0.022	(0.043)
Syphilis	-0.004	(0.012)	0.141†	(0.075)	-0.013	(0.030)	-0.065	(0.036)
Dummy=1 if circa 1900/1910								
Farmer	-0.002	(0.007)	-0.014	(0.023)	-0.005	(0.018)	0.009	(0.027)
Professionals and proprietors II	-0.003	(0.007)	-0.023	(0.023)	0.010	(0.021)	0.032	(0.035)
Artisan	-0.003	(0.007)	-0.022	(0.023)	0.011	(0.021)	0.049	(0.037)
Laborer I	-0.007	(0.007)	-0.047*	(0.022)	0.007	(0.025)	0.017	(0.039)
Laborer II	0.006	(0.009)	-0.012	(0.023)	0.010	(0.020)	0.036	(0.034)
Dummy=1 if at enlistment								
Farmer	0.014	(0.015)	0.040	(0.034)	-0.003	(0.021)	0.015	(0.034)
Artisan	0.030	(0.033)	0.037	(0.046)	-0.024	(0.020)	-0.009	(0.036)
Laborer	0.021	(0.028)	0.103†	(0.055)	0.001	(0.023)	0.025	(0.041)
None/unknown	0.037†	(0.026)	0.043	(0.038)	-0.001	(0.021)	0.026	(0.036)
Dummy=1 if surgeons reported								
Typhoid	-0.006	(0.008)	0.018	(0.039)	0.074‡	(0.039)	0.068	(0.049)
Malaria	0.037‡	(0.014)	0.073‡	(0.027)	0.024	(0.020)	0.006	(0.024)
Other infectious/fever	-0.003	(0.006)	0.024	(0.023)	0.059‡	(0.021)	0.020	(0.025)

Note. Derivates are from a probit regression in which the additional control variables are age, dummy variables indicating whether the veteran had ever been wounded in the war, ever discharged for disability, or was ever a POW, and dummy variables for city size at enlistment. Derivatives represent discrete changes from 0 to 1. Cholera perfectly arteriosclerosis. The symbols ‡, †, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 12: Impact of Infectious Disease and Occupation on Hemorrhoids and Poor Circulation in Union Army Sample

	Hemorrhoids				Poor circulation			
	1900		1910		1900		1910	
	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dummy=1 if during war had								
Cholera	0.119	(0.140)	0.057	(0.254)	0.049	(0.082)		
Diarrhea	0.170‡	(0.015)	0.181‡	(0.021)	0.002	(0.006)	0.003	(0.010)
Malaria	0.023	(0.036)	-0.013	(0.048)	0.005	(0.015)	0.027	(0.027)
Respiratory problems	0.011	(0.021)	0.038	(0.029)	-0.001	(0.008)	0.004	(0.014)
Measles	0.014	(0.027)	0.001	(0.035)	-0.007	(0.009)	-0.006	(0.016)
Smallpox	-0.005	(0.055)	0.011	(0.074)	0.007	(0.022)	0.046	(0.045)
Tuberculosis	0.046	(0.054)	0.081	(0.069)	-0.024	(0.013)	-0.035	(0.023)
Typhoid	0.011	(0.029)	0.026	(0.039)	-0.017*	(0.008)	-0.017	(0.016)
Scurvy	0.083	(0.059)	0.070	(0.085)	0.028	(0.030)	0.012	(0.043)
Rheumatism	0.015	(0.021)	0.004	(0.029)	0.003	(0.009)	0.013	(0.015)
Stomach problems	0.102*	(0.056)	0.155†	(0.077)	0.028	(0.028)	0.045	(0.048)
Syphilis	-0.045	(0.061)	-0.004	(0.090)	0.057†	(0.039)	0.064	(0.060)
Dummy=1 if circa 1900/1910								
Farmer	-0.054*	(0.030)	-0.082†	(0.041)	-0.012	(0.011)	-0.014	(0.019)
Professional or proprietor II	-0.068†	(0.031)	-0.141‡	(0.042)	-0.005	(0.012)	-0.012	(0.020)
Artisan	-0.050	(0.032)	-0.090†	(0.045)	-0.014	(0.011)	-0.013	(0.020)
Laborer I	-0.108‡	(0.035)	-0.139‡	(0.049)	-0.013	(0.012)	-0.013	(0.023)
Laborer II	-0.063†	(0.031)	-0.095†	(0.043)	-0.008	(0.011)	-0.003	(0.020)
Dummy=1 if at enlistment								
Farmer	0.068*	(0.039)	0.001	(0.053)	0.026	(0.018)	0.011	(0.027)
Artisan	0.078*	(0.046)	0.012	(0.060)	0.026	(0.026)	-0.004	(0.030)
Laborer	0.086†	(0.045)	0.047	(0.060)	0.047†	(0.031)	0.055	(0.043)
None/unknown	0.086†	(0.040)	0.013	(0.053)	0.018	(0.019)	0.026	(0.030)
Dummy=1 if surgeons reported								
Typhoid	-0.021	(0.050)	-0.005	(0.063)	0.043†	(0.030)	0.053	(0.041)
Malaria	0.126‡	(0.032)	0.070*	(0.038)	0.066‡	(0.019)	0.056‡	(0.023)
Other infectious/fever	0.051*	(0.029)	0.035	(0.036)	0.029†	(0.015)	0.030	(0.021)

Note. Derivates are from a probit regression in which the additional control variables are age, dummy variables indicating whether the veteran had ever been wounded in the war, ever discharged for disability, or was ever a POW, and dummy variables for city size at enlistment. Derivatives represent discrete changes from 0 to 1. Cholera perfectly predicted poor circulation in 1910. The symbols ‡, †, and $*$ represent significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Among typhoid patients today, one third of them also suffer from cough, suggesting that typhoid fever may be a likely candidate for respiratory distress problems later in life (Stein 1990). The same may be true for malaria which is sometimes associated with pulmonary disease as the result of a systemic inflammatory response (Kemper 1997). Among Civil War soldiers measles was followed by such complications as chronic bronchitis, pneumonia, and pleurisy (Cliff, Haggett, and Smallman-Raynor 1993: 105) and these may have had an independent effect on respiratory function. Measles could also have exerted a direct effect. Measles bronchopneumonia results in bronchiolar obstruction, airways distension, and a thickening of the peri-bronchial walls (Jean et al. 1981). Pneumonia in the nineteenth and early twentieth century may also have had lasting effects; follow-ups of disadvantaged children in South Africa revealed that lung function abnormalities persisted years after the contraction of pneumonia (Wesley 1991).

Illnesses and occupation also played a role in later life musculoskeletal problems (see Table 8). Rheumatism while in the army and malaria or another infectious disease or fever as noted by an examining surgeon were important predictors of both back and joint problems. 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. Reports submitted by camp doctors to the Surgeon General suggest that 40 percent of all cases of rheumatism were acute and caused mainly by rheumatic fever (Bollet 1991). Musculoskeletal symptoms are common with many viral infections, including malaria, and could conceivably lead to permanent joint damage. The other main predictors of musculoskeletal problems were manual occupations, which in 1900 and in 1910 were only partially mechanized.

Infectious disease is an important predictor of cardiac and circulatory problems in later life (see Table 9, 10, 11, 12). Rheumatism while in the army was a large and significant predictor of murmurs, congestive heart failure, irregular pulse, and tachycardia at all ages and of arteriosclerosis at ages 60-74. Diarrhea and stomach problems while in the army were predictors of hemorrhoids. A white collar occupation was a positive predictor of hemorrhoids. Malaria as noted by an examining surgeon was a predictor of murmurs, irregular pulse, tachycardia, arteriosclerosis, hemorrhoids, and poor circulation. Typhoid fever either as noted by the examining surgeons or in the army was a predictor of murmurs and irregular pulse at all ages and of arteriosclerosis, varicose veins, and poor circulation among men 50-64. Other fever and infectious disease was a predictor of murmurs, irregular pulse, and tachycardia among men in all age groups and of varicose veins among men 50-64. Laborers I were at significantly lower risk of tachycardia and arteriosclerosis, but it was only those in the more physically demanding occupations, suggesting that this result may be due to selection.

The relationship between infectious disease and murmurs, irregular pulse, tachycardia, and congestive heart failure should come as no surprise. Acute rheumatic fever results in damage to heart valves which in turn could manifest itself as murmurs, irregular pulse, tachycardia, and congestive heart failure. Wilson et al. (1998) find that among Civil War veterans valvular heart disease preceeded congestive heart failure 60 percent of the time. Electrocardiogram assessments of typhoid fever patients show cardiac involvement (Khosla 1981; Olowu and Taino 1990). Cardiac involvement is also possible with malaria, resulting either from malarial changes in the myocardium or myocardiopathy arising from malarial chronic anemia (Charles and Bertrand 1982).

The etiology of hemorrhoids and atherosclerosis is still controversial. There is, however, evidence that is consistent with the findings from the Union Army data. Diarrheal diseases (including ulcerative colitis, noninfectious gastroenteritis, and functional diarrhea) have been identified as pathogenic risk factors for hemorrhoids (Johanson 1997). In recent data hemorrhoids is also positively correlated with higher socioeconomic status (Johanson and Sonnenberg 1990). Infectious disease and atherosclerosis may be linked either through chlamydia pneumoniae infections, through infection induced changes in lipid metabolism, or through damage and inflammation in the vascular endothelium caused by infections in the presence of hypercholesterolemia (see reviews by Lindholt et al. 1999; Valtonen 1991; Wong, Gallagher, and Ward 1999). Because atherosclerosis is a form of arteriosclerosis, the latter two channels might explain the link between typhoid and malaria and arteriosclerosis in the Union Army data.

Table 13 summarizes the relative impact of infectious disease and of occupation on chronic disease rates by comparing actual disease rates with two different predicted values, one of which is calculated under the assumption that there is no exposure to infectious disease and the second of which is calculated using the modern occupational distribution. Averaging within respiratory, musculoskeletal, and heart and circulatory conditions, Table 13 suggests that declines in infectious disease played a more important role than occupational shifts in explaining the decline in respiratory and heart and circulatory problems but that occupational shifts played a more important role in explaining the decline in musculoskeletal problems.[11] I find that the 23 percent of the decline in respiratory disorders between 1900/1910 and NHANES/NHIS could be explained by reduced infectious disease rates and 11 percent by occupational shifts; 17 percent of the decline in musculoskeletal conditions by reduced infectious disease rates and 21 percent by occupational shifts; 17 percent of the decline in reduced infectious disease rates and 7 percent in occupational shifts. On average, 19 percent of the decline in chronic disease rates can be accounted for by reduced infectious disease rates and 13 percent by occupational shifts.[12] Because I cannot observe all bouts of infectious disease and because I do not account for reduced job hazards within occupation group, these figures probably underestimate the importance of

[11]Costa (forthcoming) finds that occupational shifts played a larger role in reductions in chronic disease rates than reduced exposure to infectious disease. However, note that this conclusion is specific to the chronic conditions examined.

[12]I assume assumes that the percentage decline in specific chronic disease rates due to reduced infectious disease rates and occupational shifts was the same overall as for men with a surgeons' exam. I average over both age groups and within disease groups.

reduced infectious disease rates and occupational hazards in lowering chronic disease rates.

Table 14 summarizes the relative impact of infectious disease and occupation on functional disability. (Results for paralysis and blindness are not presented because change in functional form, not changes in prevalence rates were more important determinants of declines in these measures of functional disability.) Because Table 14 cannot account for unobserved infectious disease episodes or occupational hazards, it probably underestimates the role of reduced infectious disease rates and occupational risks in lowering functional disability. On average, Table 14 shows that 9 percent of the decline in difficulty in walking and in bending between the Union Army data and NHANES is accounted for by reduced infectious disease rates and 7 percent by occupational shifts. These figures are probably underestimates because of unobserved infectious disease episodes and reduced job risk within occupation group. Occupational shifts explain roughly 9 percent of the decline in difficulty in walking and reduced infectious disease rates roughly 8 percent. Occupational shifts account for 8 percent of the decline in difficulty in bending between 1910 and NHANES and lower infectious disease rates for 7 percent. Between 1900 and NHANES occupational shifts account for only 2 percent of the decline in difficulty in bending and reductions in infectious disease for 12 percent. Table 14 also shows the relative importance of occupational shifts and infectious disease reductions in accounting for differences between the Union Army sample and NHIS. Because the independent disease variables in the NHIS specification did not include musculoskeletal conditions, infectious disease plays a more important role in disability declines than occupational shifts.

8 Implications

This paper has shown that functional disability as measured by difficulty in walking, difficulty in bending, paralysis, blindness in at least one eye, and deafness in at least one ear has fallen at

Table 13: Predicted Chronic Disease Rates Among Union Army Veterans with Surgeons' Exam Assuming Elimination in Infectious Disease and Occupational Shifts

	1900			1910		
	At Actual Values	Inf=0	Occ= 1940/1990	At Actual Values	Inf=0	Occ= 1940/1990
Decreased breath sounds	0.130	0.103	0.120	0.176	0.139	0.169
Adventitious sounds	0.223	0.182	0.206	0.334	0.291	0.296
Back problems	0.432	0.393	0.394	0.529	0.499	0.497
Joint problems	0.498	0.465	0.447	0.605	0.581	0.568
Murmurs	0.312	0.277	0.290	0.438	0.391	0.427
Congestive heart failure	0.028	0.025	0.016	0.093	0.083	0.063
Irregular pulse	0.356	0.316	0.339	0.500	0.451	0.465
Tachycardia	0.212	0.182	0.210	0.301	0.262	0.299
Varicose veins	0.088	0.081	0.091	0.113	0.107	0.107
Hemorrhoids	0.340	0.274	0.331	0.406	0.336	0.426
Impaired circulation	0.044	0.037	0.047	0.067	0.056	0.075
Arteriosclerosis	0.019	0.017	0.011	0.098	0.081	0.101

Note. Predictions are from a probit model in which the dependent variable was the specific condition and the independent variables were age; dummy variables indicating whether the veteran was ever wounded, discharged for disability, or was a prisoner of war; dummy variables indicating whether the veteran had ever had respiratory problems, diarrhea, cholera, stomach problems, syphilis, smallpox, scurvy, typhoid, tuberculosis, malaria, or measles during the war; dummy variables indicating size of city of enlistment; dummy variables indicating occupation group circa 1900/1910 (farmer, professional or proprietor level 1, professional or proprietor level 2, artisan, laborer level 1, laborer level 2); dummy variables indicating occupation group at enlistment (farmer, professional or proprietor, artisan, laborer, no occupation or occupation unknown); and, dummy variables indicating whether there is any record in the surgeons' exams of typhoid, malaria, or other infectious disease or fever. Because the sample is limited to men with a surgeons' records, predicted values are slightly higher than those presented in Table 2.

Table 14: Decomposition of Changes in Chronic Conditions

	1900 Difficulty walking	1900 Difficulty bending	1910 Difficulty walking	1910 Difficulty bending
$D_{\text{UA}} - D_{\text{NHANES}}$	26.9	41.8	30.0	43.4
$(X_{\text{UA}} - X_{\text{NHANES}})\beta$	5.6	16.7	10.1	22.3
$(X_{\text{UA}} - X_{\text{UA,inf=0}})\beta$	2.1	5.0	2.5	3.0
$(X_{\text{UA}} - X_{\text{UA,occ=1990}})\beta$	2.4	1.0	2.7	3.6
$D_{\text{UA}} - D_{\text{NHIS}}$	23.6	41.3	27.5	48.8
$(X_{\text{UA}} - X_{\text{NHIS}})\beta$	2.8	5.5	6.8	10.6
$(X_{\text{UA}} - X_{\text{UA,inf=0}})\beta$	0.7	0.9	1.4	1.1
$(X_{\text{UA}} - X_{\text{UA,occ=1990}})\beta$	0.4	0.6	0.6	-0.3

Note. UA=Union Army, NHANES=National Health and Nutrition Examination Survey, NHIS=National Health Interview Survey. ΔD is calculated from Table 1 and is the difference in disability prevalence rates across years. $(\Delta X)\beta$ was calculated as the difference in predicted disability measured at the values of X and of β in the UA data and predicted disability measured at the values of β in the UA data and X in the NHANES/NHIS data. $(X_{\text{UA}} - X_{\text{UA,inf=0}})\beta$ is the difference between the predicted value of disability in the Union Army sample and the predicted value assuming no infectious disease. $(X_{\text{UA}} - X_{\text{UA,occ=1990}})\beta$ is the difference between the predicted value of disability in the Union Army sample and the predicted value assuming the same occupational distribution at older ages as that in 1990 and at younger ages as that in 1940.

an average rate of 0.6 percent per year among men age 50 to 64 and age 60 to 74 from the early twentieth century to the early 1990s. This rate of decline is not as pronounced as that in the 1980s and early 1990s (Crimmins, Saito, and Reynolds 1997; Cutler and Richardson 1997; Freedman and Martin 1998; Manton, Corder, and Stallard 1997a), suggesting that a large proportion of the decline in disablity at older ages has occurred only recently.

I attributed 24 to 41 percent of the decline in functional disability as measured by difficulty in walking and in bending from the early 1900s to the early 1990s to the increased efficacy of medical care and 37 percent to reduced chronic disease rates. The remaining 22 to 39 percent was unexplained. Of the 37 percent atttributable to reduced chronic disease rates, 9 percent could be accounted for by reduced infectious disease rates and 7 percent by occupational shifts away from manual labor and to white collar jobs. The remaining 21 percent was unexplained. The sizable proportion attributable to medical care is consistent with the larger improvements in functional disability experienced by recent cohorts relative to past cohorts and suggests that investments in medical care targetted at the elderly population have had substantial payoffs.

This paper has also shown that chronic disease rates (as measured by respiratory disorders, musculoskeletal problems, and heart and circulatory problems) among men age 50 to 64 and 60 to 74 fell by 0.7 percent per year between the early 1900s and the early 1990s, with 19 percent of the decline accounted for by reduced infectious disease rates, 13 percent by occupational shifts, and the remainder unexplained. Rheumatic fever, typhoid, malaria, and acute respiratory infections were the major predictors of chronic conditions. These infectious diseases were widespread in the United States in the nineteenth and early twentieth century and were brought on by crowding, poor sanitation and unfiltered and unchlorinated water, and migration to mosquito-producing wetlands (common in the Midwest). Public health measures, rising incomes, swamp drainage, and the depopulation of rural areas may therefore have played a role in reduced chronic disease rates. The 68 percent of the decline in chronic conditions that is unexplained may be accounted for by unobserved bouts of infectious disease, reduced job hazards within occupation groups, improvements in nutritional intake during the growing years, the decreased use of wood smoke and salt as food preservatives, or improved knowledge of health habits and of preventive medicine.

Are functional disability and chronic disease rates likely to continue to decline? Because infectious disease mortality declined throughout the first half of the century and because of the continuing shift to white collar work, the full benefit of these changes may not be seen until 2035 or later, when the baby boomers will begin to reach age 90. The importance of the increased efficacy of medical care in explaining the long-run decline suggests that current investments in biotechnology, pharmaceuticals, and surgical procedures will lead to continued declines in functional disability. These innovations in medical care are likely to become increasingly important predictors of declines in functional disability for those generations born after 1950 because by then many public health and workplace safety investments were already firmly in place.

This paper has emphasized the benefits of medical technology as a whole and not its costs. But, as medical care becomes increasingly effective in reducing disability and if it becomes the main determinant of disability declines, costs are likely to continue to rise. Although healthier people require less medical care, 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 historically increased costs (Cutler, McClellan, and Newhouse 1998; Cutler and Richardson 1997). Cutler and Sheiner (forthcoming) predict that if technological change in medicine continues at its historic rate, then even if disability rates continue to fall at their recent rates, medical costs will still rise. The financing of medical care will continue to remain an issue well into the future.

Data Appendix

The Union Army data set is comprised of three different data sets: the military service and pension data, the records of the examining surgeons, and the census data. The military service and pension data and the census data are available from the Interuniversity Consortium on Political and Social Science Research (ICPSR) as *Aging of Veterans of the Union Army: Military, Pension, and Medical Records, 1820-1940 (ICPSR 6837)* and as *Aging of Veterans of the Union Army: United States Federal Census Records, 1850, 1860, 1900, 1910 (ICPSR 6836)*. The principal investigator is Robert Fogel. The records of the examining surgeons are expected to be available at ICPSR sometime in the year 2000. More information can be obtained from http://www.cpe.uchicago.edu.

The records used in this paper represent a 58 percent sample of the final sample that will be available. By 1900, approximately 10 percent of veterans were not collecting a pension, either because their applications had been rejected or because they had not yet applied for a pension. A surgeons' exam is available for 90 percent of all men who had a pension in 1900. Veterans had every incentive to undergo a complete medical examination because those with a severe chronic condition, particularly if it could be traced to war-time experience, were eligible for larger pensions. The surgeons rated the severity of specific conditions using detailed guidelines provided by the Pension Bureau. Men for whom a surgeons' exam is missing tended to be men who entered at a late age and received a pension on the basis of age. In estimating prevalence rates for the sample as a whole, I assume that these men did not have the specific functional disability or chronic disease that I examine. In estimating the relationship between functional disability and chronic conditions (Equation 1) I restrict the sample to men with a surgeons' exam. In estimating the relationship between chronic conditions and infectious disease and occupation (Equation 6) I further restrict the sample to men found in either the 1900 or 1910 census.

Men who entered the Union Army were probably healthier than the population as a whole. An examination of men who were rejected for military serviced 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 bias.

Although little is known about the experience of Union Army veterans from the time they left the service until they appear on the pension rolls, several tests indicate that this sample is representative of the general population in terms of wealth and circa 1900 in terms of mortality experience. 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, suggesting that military service was not very selective of men of lower socioeconomic status. In fact, 95 percent of the sample consisted of volunteers. Cohort life expectancies of veterans who reached age 60 between 1901 and 1910 resemble 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).

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