HEALTH, WARTIME STRESS, AND UNIT COHESION: EVIDENCE FROM UNION ARMY VETERANS*

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We find that Union Army veterans of the American Civil War who faced greater wartime stress (as measured by higher battlefield mortality rates) experienced higher mortality rates at older ages, but that men who were from more cohesive companies were statistically significantly less likely to be affected by wartime stress. Our results hold for overall mortality, mortality from ischemic heart disease and stroke, and new diagnoses of arteriosclerosis. Our findings represent one of the first long-run health follow-ups of the interaction between stress and social networks in a human population in which both stress and social networks are arguably exogenous.

Economic and epidemiological research has linked social networks to health. People who report themselves to be socially isolated, both in the number and quality of their personal relationships, face a higher mortality risk from all causes. In particular, they face a greater risk of death from several infectious, neoplastic, and cardiovascular diseases (e.g., Caspi et al. 2006; Cohen et al. 1997; Hawkley et al. 2006; Kroenke et al. 2006; Lett et al. 2007; Reynolds and Kaplan 1990; Seeman 1996). Social networks affect health through both biological and social pathways. Friends provide physical, cognitive, and economic assistance, health information, and the peer pressure needed to reinforce good health habits (Aizer and Currie 2004; Christakis and Fowler 2007; Gresenz, Rogowski, and Escarce 2007; Miguel and Kremer 2007; Rao, Möbius, and Rosenblat 2007). Social networks may positively affect cellular immune response (Cohen et al. 1992; Thomas, Goodwin, and Goodwin 1985) and neuroendocrine functioning (Seeman et al. 1994); feelings of social isolation may even be linked to alterations in the activity of genes that drive inflammation, the first response of the immune system (Cole et al. 2007).

Many studies have investigated how social networks mediate the effects of stress (e.g., Bolger and Amarel 2007; House, Landis, and Umberson 1988; Lett et al. 2007). Stress is associated with several chronic diseases, particularly cardiovascular disease. Experimentally induced stress leads to atherosclerosis and hypertension in primates and mice (Henry and Stephens 1977). Job stress leads to greater risk of cardiovascular disease (Marmot and Wilkinson 1999), and working in low-control jobs raises mortality risk (Amick et al. 2002). Vietnam veterans with post-traumatic stress syndrome face higher overall and cardiovascular mortality (Boscarino 2006b) and a higher prevalence of cardiovascular disorders, including myocardial infarctions (Boscarino 1997). Subramanian, Elwert, and Christakis (2008) presented suggestive evidence that the well-known effect of widowhood on older age mortality is modified by the neighborhood concentration of widowed individuals. Perceptions of social support are associated with better adjustment to stressful events (e.g., House et al. 1988; Lett et al. 2007) even though actual social support often is not correlated with better adjustment (e.g., Bolger and Amarel 2007).

Social networks could either mitigate or accentuate the effects of stress. They could mitigate the effects of stress through beneficial effects on psychological and physical

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well-being. But they could accentuate the effects of stress if the initial trauma involves the death of friends or family (e.g., the well-established effect of death of a spouse on the mortality of a survivor) or if well-intentioned support efforts remind individuals of the initial trauma or of their lack of coping ability.

In this article, we examine whether social networks mitigate or accentuate the effects of wartime stress on older age mortality and morbidity using a unique longitudinal database of veterans of the Union Army in the American Civil War, 1861–1865. We study how the interaction between unit cohesiveness and combat mortality affected older-age all-cause mortality, mortality by cause, and morbidity. In most studies (with the exception of animal studies; e.g., Capitanio et al. 1998; Cohen et al. 1992; Levine and Mody 2003; Lyons, Ha, and Levine 1995; Thaker et al. 2006), social networks are not exogenous, and individuals choose their social networks. Thus, those who are socially isolated may be so because they are in poor health. In our Civil War setting, cohesiveness is arguably exogenous (and varies considerably across companies) because of the way companies were formed and because companies were rarely replenished. In addition, combat mortality varied across units because it depended on where a unit was in a battle.

The Civil War provides a unique opportunity to examine how social networks influence the long-term effects of stress. The Civil War was a unique war. During the Vietnam War, individuals were rotated in and out of units. During World War II, units were replenished with new men, and wounded men who had recuperated were sent to new units. A researcher would therefore need to collect data not just on individuals and their initial units but also on all units the individual served in. In addition, privacy concerns might make obtaining records difficult. A difficulty in studying World War I is that many of these records were destroyed in a fire. Only the Civil War enables us to examine at low cost the interaction between unit cohesion and wartime stress on older age mortality.

EFFECTS OF WARTIME TRAUMA

Stress can result from war, natural disaster, divorce, lack of control on the job, or even disrupted sleep patterns, among many other causes. The brain responds to stress by cognitively assessing the threat potential and then orchestrating a physiological and behavioral response in which stress hormones are released.

This release of stress hormones may trigger several psychiatric disorders, including post-traumatic stress disorder (PTSD). After an initial trauma, a person will reexperience it in the form of recurrent memories, dreams, feelings that the event is recurring, and psychological and physical distress when reminded of the trauma. It is the recurrent nature of the trauma that may contribute to higher mortality. PTSD in particular has been identified as the intervening variable linking trauma and subsequent mortality. For example, Boscarino (2006a) found that among Vietnam veterans, combat exposure was not associated with mortality once he controlled for PTSD. Allostatic load (the cumulative wear and tear that results from repeated efforts to adapt to stressors over time), as measured by a composite index of biological risk factors, is particularly elevated in women with PTSD (Glover, Stuber, and Poland 2006). Data on World War II and Korean War POWs suggest that PTSD symptoms follow a pattern of immediate onset and gradual decline, followed by increasing symptom levels at older ages (Port, Engdahl, and Frazier 2001). A 40-year follow-up of World War II soldiers who had seen fierce fighting found that 18% had PTSD at the time of the survey (Sutker, Allain, and Winstead 1993). Additional psychiatric disorders that can follow trauma include depression and anxiety disorders. However, among Vietnam veterans, depression was not consistently associated with mortality once other factors were controlled for (Boscarino 2008).

How individuals respond to the initial trauma depends on their personality type, financial resources, and social network. Social support may have a *direct* effect on psychological and physical well-being that is independent of stress levels (Andrews et al. 1978; Solomon, Mikulincer, and Hobfoll 1986). Alternatively or in addition to the direct effect, social support may have a *stress-buffering* effect; that is, it aids stress resistance under high-stress conditions but has little effect under low-stress conditions (Hobfoll and Walfisch 1984; Wilcox 1981).

During wartime, men in more cohesive companies may code social support as physical safety (Shay 2002:210) and be less likely to develop PTSD. Consider that Capt. Frank Hollinger of the 19th USCT wrote, "I have always found comforting in battle the companionship of a friend, one in whom you had confidence, one you felt assured would stand by you until the last" (quoted by Hess 1997:117). Alternatively, friends might provide emotional consolation: they could provide exoneration for killing and the promise that they would not be forgotten and could decrease men's fear of death. After World War II, Audie Murphy (1949:158) wrote of his experiences, "At this moment the grave seems merely an open door that divides us from our comrades."

Quantitative evidence on social networks and PTSD comes from the Yom Kippur War, when the unexpected attack led men to fight in different tank crews. PTSD rates immediately after the war were higher among men who did not end up with their usual tank crew in the chaos to get to the front (Belenky, Noy, and Solomon 1987; Gal 1986:217). But a tank crew is more likely than an infantry company to lose either all or none of its men. Among the men of an infantry company, being in a more cohesive company might worsen the effects of stress if men lose those who are close to them.

Shell shock, combat fatigue, and post-traumatic stress (all names for the same phenomenon in different wars) were not recognized as disorders during the Civil War (for a history of PTSD, see Hyams, Wignall, and Roswell 1996). Not flinching under enemy bullets was viewed as a test of manhood, and those who failed courted contempt (McPherson 1997:77–78). Nonetheless, Oliver Wendell Holmes could write in 1864, "I tell you that many a man has gone crazy since the end of this campaign began from the terrible pressure on mind & body" (quoted in McPherson 1997:165). McPherson (1997:166) described how "after eighteen hours of continuous combat at the Bloody Angle of Spotsylvania, a Union lieutenant the next morning found enemy soldiers piled three or four deep in the trenches, mostly dead, but 'one Rebel sat up praying at the top of his voice and others were gibbering in insanity.'"

Historical accounts are relatively silent on whether Civil War trauma left a lasting effect. Most diaries cease with the end of the war. Dean (1997) argued for a lasting effect of wartime trauma but based his finding on a biased sample of Civil War veterans who were in soldiers' homes. Drawing from the same database as our study, Pizarro, Silver, and Prause (2006) found that the fraction of the company who died during the war affected the probability of cardiac and gastrointestinal disease among the survivors, but not older age mortality. However, because half of all Civil War deaths were from disease, Pizarro et al. may have measured the effects of wartime illness on later disease outcomes.[1] They might not have found an effect of company wartime mortality on older age mortality because of the way they constructed their sample.[2]

We observe men during the war and then from about 1900 onward, when roughly 90% of all white veterans were on the pension rolls and therefore enter our data set (Costa

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1. Most of their cardiac disease category consists of heart disease that resulted from rheumatic fever (Costa 2000) and is therefore unlikely to be linked to wartime trauma. Pizarro et al. (2006) did not control for specific wartime illnesses, even though these data are available.

2. They restricted the sample to men who lived until 1890 or later but did not restrict the sample to men who were on the pension rolls by 1890. Because all date-of-death information comes from the pension rolls, men are not at risk to die until they are on the pension rolls. Analysis time therefore needs to begin at the time men enter the pension rolls. In addition, Pizarro et al. (2006) would not have found an effect of the fraction of the company who died on older age mortality if, because of soldiers' changing companies, the fraction of the company who died becomes a poor indicator of a veteran's wartime experience.

1998:198). Short of insanity that led to commitment to an asylum (of which there are very few cases), senile dementia, or the aftermaths of stroke, we cannot observe psychiatric disorders. (Because PTSD was accepted into the diagnostic literature only in 1980, we never observe who had PTSD.) We also cannot observe any health effects of trauma until men entered the pension rolls. However, we would expect stronger effects of psychiatric disorders on mortality from natural causes and on cardiovascular health at older ages because cardiovascular problems increase with age.

EMPIRICAL FRAMEWORK

We begin by examining the effect of wartime stress on older age mortality. We investigate the use of different measures of battlefield stress, such as fraction of the company dying of wounds, number of the company dying of wounds, number of the regiment killed in action, maximum number of men in a regiment killed in a single engagement, and logarithms of these quantities, to account for potential nonlinearities. These measures reflect differences in the strength of ties between men (presumably stronger in a company than in a regiment because companies were more of a local neighborhood), in the nature of the trauma (a single, big traumatic event versus a repetition of the trauma), and in localized stress levels. Although the regiment was sent into battle as a unit, companies could have different battle experiences because their locations on the battlefield differed.

Using the year 1900 as our baseline period (when the majority of veterans were between ages 55 and 64), we estimate a Gompertz hazard model of time until death in years:

$$h(t) = \lambda \exp(\gamma^{t})$$
$$\lambda = \exp(\beta_s s + \beta_c c + \beta_{\mathbf{x}} \mathbf{x}),$$

where s is a measure of stress and c is a measure of company cohesion.[3] If $\beta_s > 0$ (or if the hazard ratio $\exp(\beta_s) > 1$), then stress increases older age mortality. The vector of control variables, $\mathbf{x}$, includes age in 1900 and measures of wartime experience and socioeconomic status.

If stress affects the mortality experience of only those veterans who develop psychiatric disorders, then our estimate of β_s captures both the probability of developing psychiatric disorders (an unobservable) and the effects of psychiatric disorders on older age mortality. Because men could avoid wartime stress by straggling (remaining in the rear, an unobservable), we may underestimate the effect of our stress measure on older age mortality because it no longer proxies for men's actual wartime experience. Men could also avoid wartime stress by deserting. Many deserters are lost to follow-up because they never returned to their units and were ineligible for the pension, which provides a record of their death. If deserters were inherently at greater risk to develop psychiatric disorders, then the effect of stress will be underestimated.

Once we establish which measure of stress best predicts older age mortality, our primary specification becomes the Gompertz hazard model of time until death in years:

$$h(t) = \lambda \exp(\gamma^{t})$$
$$\lambda = \exp(\beta_s s + \beta_c c + \beta_{sc}(s \times c) + \beta_{\mathbf{x}} \mathbf{x}),$$

where the only difference with our previous specification is the inclusion of the interaction term between company cohesion and wartime stress. We are thus allowing for a heterogeneous treatment effect; that is, while $\beta_s > 0$, we are allowing for $\beta_{sc} < 0$ (or a hazard ratio that is less than 1).

3. We obtain similar coefficients using a Cox proportional hazards model but prefer the Gompertz because we can predict survivor proportions from the model output.

One of the challenges of quantification is the definition of company cohesion. Most studies of unit cohesion use either answers to questionnaires or information on how long the unit was together (e.g., Solomon, Mikulincer, and Hobfoll 1987). We rely on our past work for a revealed preference approach to creating an index of cohesion (Costa and Kahn 2003a, 2003b). A large literature (summarized in Costa and Kahn 2003a) has shown that people in more diverse communities are less willing to join organizations, volunteer, pay taxes for public goods, and vote than people in more homogeneous communities. A soldier's unit, the men he lives and fights with, has always been his community. As a World War I German student wrote, "The company is the only truly existent community. This community allows neither time nor rest for a personal life. It forces us into its circle, for life is at stake" (Shils and Janowitz 1948). During the Civil War, this unit consisted of the roughly 100 men in a soldier's company.

Roughly 10% of all Union Army soldiers deserted. They were more likely to desert if they were from more diverse companies, controlling for individual characteristics (including time of enlistment), ideology, and morale (including recent company deaths) (Costa and Kahn 2003b). We therefore call a company cohesive if it was less diverse in ethnicity, occupation, and age. As we will discuss in more detail later, we construct an index of company cohesion based on the coefficients on company heterogeneity in a desertion regression. Our index weights thus give the effect of company heterogeneity on desertion (and hence arguably cohesion), controlling for other factors, including commitment to the cause and breakdown in combat (as proxied by recent company deaths).

We use several strategies to investigate why stress and social networks might affect health. First, we examine whether stress and social networks affected socioeconomic status at older ages and investigate how our results change if we control for socioeconomic status and health at older ages. Second, assuming that causes of death are independent, we estimate a competing risks model of mortality by cause. Finally, we estimate probit equations to examine what chronic condition veterans who survived to 1915 developed between 1900 and 1915. That is, we estimate

$$\Pr(C = 1) = \Phi(\beta_s s + \beta_c c + \beta_{sc}(s \times c) + \beta_x \mathbf{x}),$$

where C is an indicator variable for a specific chronic condition, s is our measure of stress, c is our measure of company cohesion, and $\mathbf{x}$ is our vector of control variables. If wartime stress increases the probability of developing a chronic condition, then $\beta_s > 0$. If company cohesion mitigates the effects of wartime stress, then $\beta_{sc} < 0$.

DATA

Our data set is based on a sample of roughly 35,000 white men in 303 Union Army infantry companies collected under the auspices of Robert Fogel and available at the Web site of the University of Chicago's Center for Population Economics (http://www.cpe.uchicago.edu). (The full sample contains 39,000 men in 331 companies, but the full sample was not available at the time of analysis. Data on almost 6,000 enlisted men in 52 companies of black troops, also available at this Web site, were not used because relatively few black troops saw intensive action.) All soldiers were linked to the 1850, 1860, 1880, 1900, and 1910 census and to pension records to create a longitudinal data set.

The Union Army pension program began in 1862 to provide assistance to soldiers wounded during the war. In 1890, the program was expanded, and any disability entitled a veteran to a pension, doubling the number of veterans on the rolls overnight. Old age was considered a disability in practice and then became a disability by law in 1907.

Detailed medical records are available for veterans because any veteran who applied for a pension or who wished for a pension increase was examined by a board of surgeons. Ninety-three percent of all men on the pension rolls had an exam. Those who applied on the basis of age were less likely to have an exam and in the analysis are assumed not to have any chronic conditions.

The examining surgeons could note a chronic condition, a symptom, or a sign through sight, touch, feel, and smell. Cardiovascular conditions illustrate how their examinations can be used. We diagnose valvular heart disease from a murmur in the aortic or mitral valve noted in the exam. We diagnose congestive heart failure as concurrent edema, cyanosis, and dyspnea. The examining surgeons diagnosed arteriosclerosis by feeling whether the arteries had hardened. Arteriosclerosis therefore refers to peripheral arteriosclerosis and could be atherosclerosis, an associated disease (such as diabetes), or local inflammation. The examining surgeons also noted whether the pulse was irregular or bounding and the presence of arrythmia, tachycardia, or bradycardia. The examining surgeons were unable to detect any of the conditions that required modern diagnostic equipment, such as hypertension. However, the team of physicians who reviewed the data reported that if in the field, with no diagnostic equipment, they could not do any better. (For a detailed discussion of potential biases in the surgeons' exams, see Costa 2000, 2002).

We restrict our sample to men who were alive and at least age 50 in 1900 and who were on the pension rolls. This leaves us with a sample size of 12,119 men. We also restrict the sample to men for whom we have complete enlistment and discharge information and men who did not change companies. Men who changed companies were most commonly those promoted to officer or the original volunteers who enlisted for 90 days and then reenlisted in another company when their term was up. These two sample restrictions reduce the sample size to 7,721 men.

We construct several variables. Our measures of battlefield stress are both on the company level, based on the full sample of 35,000 men, and on the regiment level, based on a database compiled from Frederick Dyer's *A Compendium of the War of the Rebellion* and from William Fox's *Regimental Losses in the American Civil War, 1861–1865*. (This regiment-level database is available from http://www.cpe.uchicago.edu.) These enable us to examine the fraction of the company dying of wounds (including deaths from septicemia resulting from wounds sustained in action), the number in the company that died of wounds, the number in the regiment killed in action, the maximum number killed in a single engagement, and logarithms of the above. As seen in Figure 1, during the war, some men were in companies with high death rates from wounds, while others were in companies that suffered no deaths from wounds.

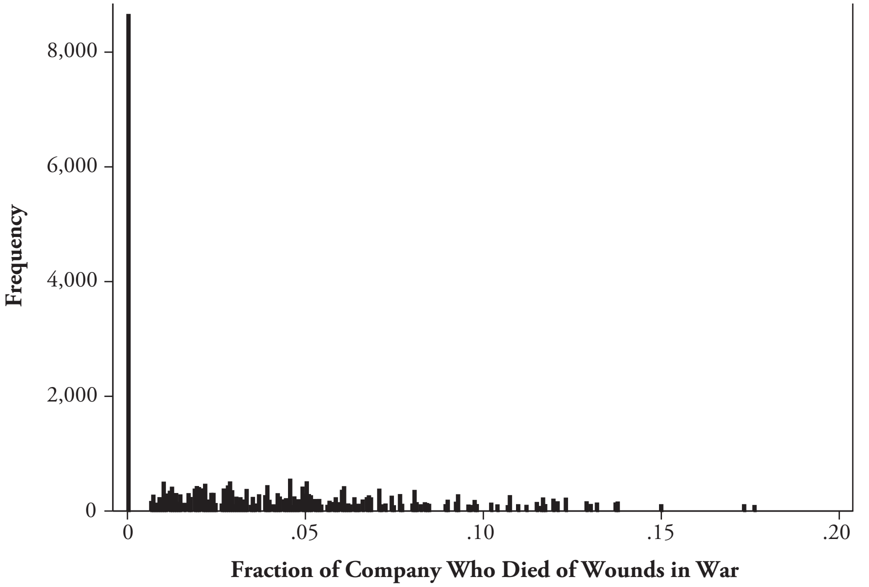
We treat our measures of stress as exogenous; that is, we assume that the characteristics of the company did not determine whether it was placed in a more dangerous place on the battlefield. The unit that went into battle was the regiment, and regiments contained both homogeneous and diverse companies. The order of battle was often determined by when a specific regiment arrived and if it had had time to rest after its long march.

The more cohesive companies were the ones that were the most homogeneous in birthplace, occupation, and age (Costa and Kahn 2003b). We therefore construct an index of company cohesion using the hazard ratios from a hazard model predicting time until desertion to weigh company birthplace, occupation, and age diversity. (Our hazard model of time until desertion controls for potential confounders, such as year of enlistment, company mortality rates, ideology in county of enlistment, and own characteristics, such as ethnicity, socioeconomic status, and volunteer status.) Our index for company j, I_j, is

$$I_j = \alpha_B B + \alpha_O O + \alpha_A A,$$

where B is birthplace fragmentation, O is occupational fragmentation, A is the coefficient of variation of age multiplied by 100, and the αs are the hazard ratios (details are available in the Appendix). We then label as "highly cohesive" a company that was below the

Figure 1. Wartime Frequency Distribution of Company Mortality From Wounds



Notes: Frequencies are estimated from the full wartime sample of 35,000 men. The frequency gives the number of soldiers whose companies had the specified mortality.

median on our index.[4] We also run specifications using the individual components of this index to examine which of our diversity measures is the best predictor of older age mortality. However, we lose information by using the individual components of our index of cohesion rather than our index.

Why was there diversity in companies? All regiments were formed locally. Costa and Kahn's (2008:57–73) examination of Civil War diaries and letters identified six sources of diversity within companies. The volunteer infantry regiments consisted of 10 companies, each containing roughly 100 men, commanded by a captain and two lieutenants who were often volunteer officers drawn from state militias, men of political significance, or other prominent men in the community. At the beginning of the war, men would enlist with one or several friends but rarely with as many as 50. Once companies were full, they would take no more men, and friends would need to find another company or regiment. Men's eagerness to get to the front led them to pick regiments thought to be departing soon, and they quickly left regiments that were late in departing, even enlisting in a regiment of another state. Later in the war, when the new recruits were not so eager, men might enlist in a distant town to receive a large bounty, adding to company diversity. Although a company was generally not replenished with new men when disease, military casualties, and desertions whittled down its numbers, some states added new recruits to existing regiments, and regiments whose members' three-year terms were up were reconstituted with veterans and new men. Finally, the need to travel to recruiting stations increased company diversity. Farmers and farmers' sons had to travel to town to enlist. Small towns could not raise an

4. Although company composition might change with desertions and deaths, we obtain similar results when we use company heterogeneity at the end rather than the beginning of the war.

entire company, so their men would enlist elsewhere and do so only with a few friends. Commissioned officers were responsible for finding their own men and often had to scour the entire state to fill their regiments. James Garfield, who later became president, traveled throughout Ohio holding revival-style meetings.

Statements in soldiers' diaries and letters indicate that they were thrown together with strangers. Amos Stearns, who enlisted with five of his friends, lamented, "Life in the army was very different from life at home. In one place we could choose our companions and those we wished to associate with, but in the army how different" (Kent 1976:214–15). One soldier wrote home, "We have a remarkable civil and Religious company. . . . I think it is a providencial circumstance that I enlisted in this company for I hear that there is desperate sight of wickedness in the very regiments that I came so near enlisting in" (letter of David Close, Nov. 4, 1862, 126th Ohio Volunteer Infantry, Company D, http://www.frontierfamilies.net/family/DCletters.htm).

Our control variables are age in 1900, measures of individual wartime stress (whether the soldier was wounded and how severely, POW status, and illnesses experienced), rank, whether the soldier was in a support position, household personal property wealth in 1860, occupation at enlistment, country of birth, if volunteer, population of city of enlistment, if deserter, if illiterate, and fixed effects for the state served. In addition, we examine whether our findings change when we control for occupation in 1900, marital status in 1900, home ownership in 1900, and body mass index (BMI) circa 1900.

Table 1 illustrates how the characteristics of men change from the starting sample of 35,000 soldiers to the war survivors and the pensioners in 1900. Men who survived the war were more likely to be deserters, non-POWs, nonfarmers, support and officers, rich, and short. A slight wound rather than no wound or a severe wound increased men's chances of surviving. Men were more likely to have survived the war if they were not ill during the war, particularly from measles, typhoid, a respiratory condition, or smallpox. Men in the more cohesive companies were less likely to survive because they were also the men who were less likely to desert. Although 10% of soldiers deserted, roughly 13% of the surviving soldiers had ever deserted.

Compared with all war survivors, men who were alive and on the pension rolls in 1900 were the nondeserters (deserters were not eligible for a pension), men who enlisted in smaller cities, farmers, the native-born and the German-born (all groups with lower postwar mortality rates), and support and officers. Men who were wounded in the war were more likely to be on the pension rolls, as were men who were ill during the war, particularly from cardiovascular causes, smallpox, typhoid, malaria, fever, gastric causes, sunstroke, rheumatic fever, measles, and diarrhea. Even controlling for all other factors, company cohesion was not a statistically significant predictor of being alive and on the pension rolls in 1900.

We cannot observe what happened to men after the war ended and before they entered the pension rolls. Until men entered the pension rolls, they were not at risk of dying (because the pension is our only source of information on date of death), and only after 1890, when pensions became widely available to all veterans, is the sample representative of the veteran population. We begin our analysis in 1900 because linkage to the census provides us with information on socioeconomic variables. If the most traumatized men died before 1900, we may underestimate the effects of wartime stress on older age mortality. When we search for all men known to have survived the war in the 1880 census, we do not find that wartime stress, company cohesion, or the interaction term between wartime stress and company cohesion are statistically significant predictors of being found in the 1880 census and therefore arguably of mortality.

RESULTS

We test three hypotheses. The first is that wartime stress increases mortality at older ages. The second is that company cohesion mitigates the effect of wartime stress on older age

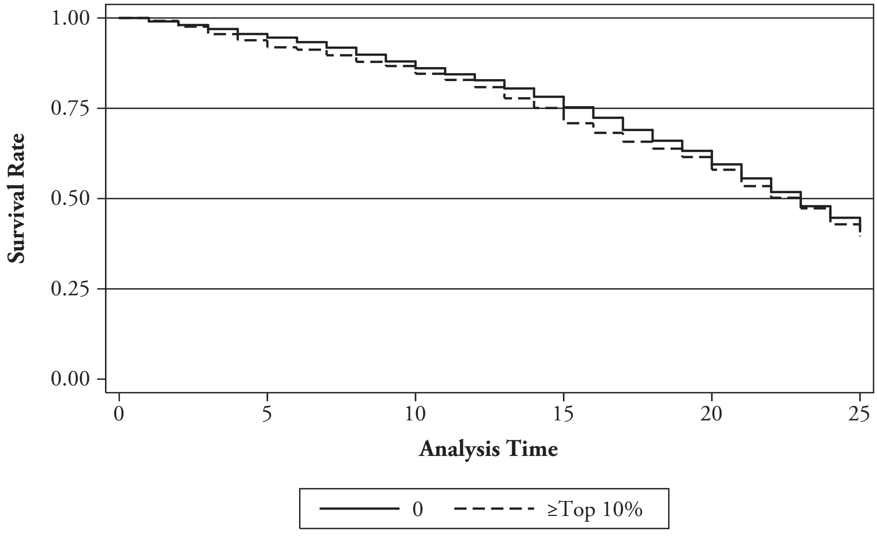
Table 1. Characteristics of Soldiers, War Survivors, and Pensioners in 1900

	Soldiers		War Survivors		Pensioners in 1900	
Variable	Mean	SD	Mean	SD	Mean	SD
Age at Enlistment	25.751	7.603	25.761	7.588	24.045	6.228
Log(Population) in Enlistment City	8.622	1.884	8.659	1.896	8.219	1.513
Dummy Variable = 1 if at Enlistment						
Farmer						
Professional or proprietor	0.075	0.264	0.079	0.270	0.059	0.235
Artisan	0.200	0.400	0.205	0.404	0.173	0.378
Laborer	0.212	0.409	0.220	0.415	0.160	0.366
Unknown	0.007	0.085	0.008	0.087	0.007	0.084
Log(Household Personal Property Wealth), 1860	2.676	4.902	2.718	4.886	2.987	4.792
Dummy Variable = 1 if						
U.S.-born						
British	0.039	0.193	0.041	0.197	0.027	0.161
Irish	0.087	0.282	0.089	0.285	0.036	0.186
German	0.074	0.262	0.076	0.266	0.056	0.231
Other	0.054	0.225	0.056	0.230	0.041	0.199
Height in Inches	67.599	2.621	67.557	2.614	67.726	2.568
Dummy Variable = 1 if POW Who Was						
Captured early in war	0.035	0.184	0.034	0.181	0.035	0.184
Captured late in war	0.048	0.214	0.040	0.196	0.045	0.207
Dummy Variable = 1 if Deserter	0.103	0.304	0.130	0.337	0.046	0.209
Dummy Variable = 1 if						
Private						
Support	0.026	0.158	0.027	0.163	0.031	0.173
Commissioned or noncommissioned officer	0.171	0.376	0.174	0.379	0.210	0.407
Dummy Variable = 1 if						
Slight wound	0.032	0.175	0.034	0.180	0.043	0.204
Severe wound	0.259	0.438	0.251	0.434	0.321	0.467
Ill during war	0.644	0.479	0.633	0.482	0.732	0.443
Dummy Variable = 1 if Company Cohesive	0.487	0.500	0.482	0.500	0.492	0.500
Fraction of Company Who Died of Wounds	0.038	0.037	0.036	0.036	0.035	0.037

Notes: 34,941 soldiers, 30,801 war survivors, and 11,921 pensioners. Pensioners are restricted to men on the pension rolls in 1900 and with known date of death. We created an index of company cohesion based on diversity within a company in birthplace, occupation, and age (see the text for details).

mortality. Company cohesion could buffer the effects of stress if men in more cohesive companies are less likely to develop psychiatric disorders, or it could accentuate the effects of stress if men lose those who are very close to them. The third hypothesis is that company cohesion reduces the effects of wartime stress on the probability of developing cardiovascular disease.

Figure 2. Kaplan–Meier Survival Curves, by High and Low Company Death Rates From Wounds



Notes: The data are restricted to men on the pension rolls in 1900, with known date of death, who did not change companies, and with both muster-in and discharge information. Analysis time is time in years. The survival curve is adjusted for age. The top 10th percentile for company death rates from wounds was 8.9%.

Wartime Stress and Mortality

Survival probabilities were slightly higher among men in companies with low death rates from wounds than among men in companies in the top death rate decile (see Figure 2). Table 2 shows that the fraction of the company dying of wounds has a statistically significant effect on older age mortality, controlling for many individual characteristics, company cohesion, and state-of-regiment fixed effects. The fraction of the company dying of wounds has a larger impact on older age mortality than other measures of wartime stress, and the linear form of the specification illustrates this best. The number of men in the company dying of wounds has a stronger effect than the number killed in the regiment. The fraction of men in the company dying of illness also has an effect on older age mortality, but the effect is not as strong as that of the fraction killed; when both are entered simultaneously in the regression, statistical significance on both coefficients disappears. However, the coefficients are jointly statistically significant. We prefer to use the fraction of men dying of wounds rather than the total fraction dying in the war because the fraction of men dying of illnesses might be a proxy for unobserved individual illness. We find some evidence that the maximum number of men killed in a single battle has an effect on older age mortality, but the effect is nonlinear and not as strong as the fraction of the company dying of wounds. When we include both the logarithm of the maximum number of men killed in a single battle and the total number of men killed in the regiment, statistical significance on both wartime stress measures disappears, but the coefficients are jointly statistically significant. We find no evidence that the fraction of the company dying of wounds might proxy for unobserved own probability of being wounded in wartime. When we include whether or not a veteran claimed a wound on his pension application (presumably anyone who was

Table 2. Effects of Different Stress Measures on Older Age Mortality: Hazard Ratios

Stress Measure	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fraction of Company Dying	1.530* (0.972)									
Fraction of Company Dying of Wounds		2.139* (0.788)			1.747 (0.636)					
Log(Fraction of Company Dying of Wounds)			1.010* (0.005)							
Fraction of Company Dying of Illness				1.310* (0.181)	1.239 (0.172)					
Number in Company Dying of Wounds						1.005* (0.002)		1.003 (0.003)		
Number in Regiment Killed							1.001† (0.001)	1.001 (0.001)		
Maximum Number Killed in Regiment in a Single Battle									1.000 (0.001)	
Log(Maximum Number Killed in Regiment in a Single Battle)										1.010* (0.004)
Test of Joint Significance, $\chi^2(2)$					5.32 (0.070)			5.47 (0.065)		

Notes: Hazard ratios are from a Gompertz model of years until death. The data are restricted to men on the pension rolls in 1900, with known date of death, who did not change companies, and with both muster-in and discharge information. Additional control variables are age in 1900; dummy variables indicating whether the veteran had been wounded slightly in the war, whether he had ever been wounded severely, whether he had been a POW early in the war, and whether he had been a POW late in the war; occupation-at-enlistment dummy variables (professional or proprietor, artisan, laborer, and unknown, with farmer as the omitted category); country-of-birth dummy variables (Britain, Ireland, Germany, and other foreign country, with the United States as the omitted category); dummy variables indicating whether the veteran had been in a support position or had been a commissioned or noncommissioned officer; a dummy variable indicating whether the veteran had deserted; the logarithm of household personal property wealth in 1860; a dummy variable indicating that the veteran was illiterate; dummy variables indicating that information on wealth and on literacy was missing; a dummy variable indicating that the veteran had been a volunteer; dummy variables for wartime disease (typhoid, smallpox, respiratory, rheumatic fever, measles, diarrhea, insanity, malaria, fever, syphilis, gonorrhea, hepatitis, and cardiovascular disease); and state-of-regiment fixed effects. Numbers in parentheses are clustered standard errors. 7,494 observations.

†$p < .10$; *$p < .05$

wounded had every incentive to claim this on the pension), the coefficient on the fraction of the company wounded remained roughly similar at 2.119 ($\hat{\sigma}$ = 0.779).

We investigate whether there are any interaction effects between personal characteristics and wartime stress. When we control for age at enlistment, we find that men younger than 17 faced an odds of dying that were 1.286 ($\hat{\sigma}$ = 0.176) times greater than did men aged 17–40.[5] But we find no evidence of any interaction effects between age and wartime stress. We also find no interaction effects between whether a soldier was wounded in the war and wartime stress. We find some suggestive evidence that the Irish and the British were more adversely affected by wartime stress than the native-born, and the Germans less so (interaction effects not shown).

We test whether our estimates of the impact of wartime stress depended on the timing of enlistment and days served. Because companies that were formed earlier fought in the war longer, our measures of wartime stress are greater for companies organized earlier. When we include dummy variables indicating year of enlistment in our specification (results not shown), we find that the hazard ratio on the fraction of the company dying of wounds falls from 2.139 to 1.647 ($\hat{\sigma}$ = 0.655), statistically indistinguishable from 1. The hazard ratios on the year-of-enlistment dummy variables are individually statistically indistinguishable from 1. However, the hazard ratios on the fraction of the company dying of wounds and the dummy variables indicating year of enlistment are jointly statistically significantly different from 1 ($\chi^2(2) = 4.91$). Similarly, when we control for days served, we find that the hazard ratio on the fraction of the company dying of wounds falls from 2.139 to 1.900 ($\hat{\sigma}$ = 0.766) and that the hazard ratio on days served is statistically significantly different from 1. But the hazard ratio on the fraction of the company dying of wounds and the hazard ratio on days served are jointly statistically significantly different from 1 ($\chi^2(2) = 5.69$). We find no evidence of interaction effects between days served and wartime stress.

Wartime Stress, Cohesion, and Later Outcomes

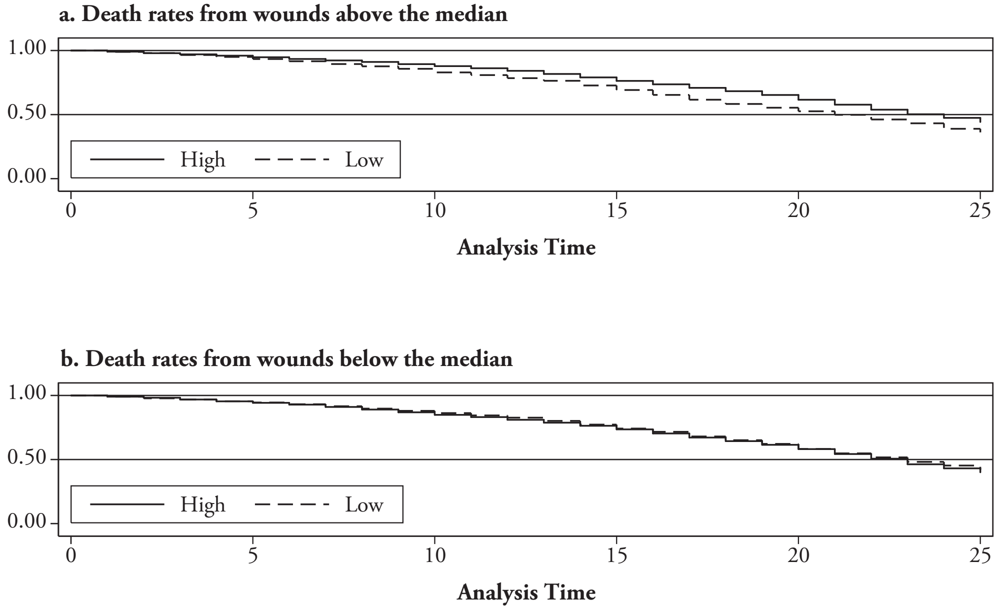
As shown in Figure 3, when company death rates from wounds were above the median, men who were in cohesive companies had higher older age survival probabilities than men who were in companies in which cohesion was low. However, when company death rates from wounds were below the median, company cohesion did not affect survival probabilities, suggesting that social support aids stress resistance in high-stress situations but has no effect in low-stress conditions.

Table 3 shows that using the fraction of the company dying of wounds, either in a linear or logarithmic form, and controlling for individual characteristics and state-of-regiment fixed effects, being in a cohesive company reduces the negative effects of stress on older age mortality. (Using other measures of wartime stress reveals a similar pattern.) Cohesion by itself does not affect older age mortality. An increase of 0.01 in the fraction of the company dying of wounds increases the odds of dying by 0.06 for men in an uncohesive company and by 0.01 for men in a cohesive company. The mean of the predicted mortality probabilities for every individual would have been 50.5% if all men had been in an uncohesive company and 49.9% if they had been in a cohesive company. The effects of stress and company cohesion remain roughly the same when we control for socioeconomic status in 1900, marital status in 1900, and health (as proxied by BMI) in 1900. We do not find that wartime stress predicts these control variables, suggesting that we are not uncovering the effects of wartime stress as mediated through socioeconomic status and health in 1900.

We investigate a quartile rather than a median split on company cohesion. Although we lose power by doing so, we find that the difference that matters is that between the two top and two bottom quartiles.

5. When we control for 10-year birth cohorts, the hazard ratio on age less than 17 becomes 1.237 ($\hat{\sigma}$ = 0.161), still statistically significant at the 10% level.

Figure 3. Kaplan–Meier Survival Curves, by Low and High Company Cohesion When Company Death Rates From Wounds Are Above and Below the Median



Notes: The data are restricted to men on the pension rolls in 1900, with known date of death, who did not change companies, and with both muster-in and discharge information. Analysis time is time in years. Survival curves are adjusted for age. The median company death rate from wounds was 2.7%.

We might overestimate the extent to which company cohesion mitigated wartime stress if men who sought out more cohesive companies were the men most likely to develop psychiatric disorders or if we are confounding the effects of cohesion with those of home community. However, we do not find that county-of-enlistment characteristics have any predictive power. Finding a company that was a good match was largely a matter of luck. Until the first battle, soldiers could not know if any of their comrades or officers were good soldiers because the volunteers were all civilians.

We estimate models of unobserved heterogeneity because some individuals might be more susceptible to stress than others. Assuming that unobserved heterogeneity can be modeled as having a gamma distribution, tests reveal evidence of heterogeneity. However, our basic results remain unchanged. The hazard ratios are 6.844 ($\hat{\sigma} = 3.298$) on the fraction of the company killed, 1.038 ($\hat{\sigma} = 0.388$) on the dummy variable for a cohesive company, and 0.154 ($\hat{\sigma} = 0.098$) on the interaction between company killed and the dummy variable for a cohesive company.

We also investigate whether the degree of company cohesiveness depends on the timing of enlistment. Although the weights used for our index of cohesion control for the timing of enlistment, we may not fully capture that early companies were the more cohesive companies. We therefore ran our specification including a dummy variable for early enlistment (enlistment in 1861) and the interaction of this dummy variable with our measure of company cohesion. The resulting hazard ratios on our dummy variable for enlistment and on the interaction term of this dummy variable with our measure of company cohesion are,

Table 3. Effects of Company Cohesion and Stress on Older Age Mortality: Hazard Ratios

Variable	(1)	(2)	(3)	(4)	(5)
Log(Fraction of Company Dying of Wounds)		1.020**			
		(0.007)			
Fraction of Company Dying of Wounds	6.347***		6.770***	8.397***	7.848***
	(2.809)		(3.031)	(4.096)	(3.846)
Dummy Variable = 1 if Cohesive	1.035	0.890*	1.044	1.047	1.043
	(0.036)	(0.046)	(0.037)	(0.038)	(0.037)
Fraction of Company Dying of Wounds × Dummy Variable = 1 if Cohesive	0.161**	0.982†	0.156***	0.126***	0.133***
	(0.094)	(0.009)	(0.091)	(0.074)	(0.079)
Includes 1900 SES and Marriage	N	N	Y	Y	Y
Restricted to Known BMI	N	N		Y	Y
Includes BMI	N	N			Y

Notes: Hazard ratios are from a Gompertz model of years until death. The data are restricted to men on the pension rolls in 1900, with known date of death, who did not change companies, and with both muster-in and discharge information. Additional control variables are age in 1900; dummy variables indicating whether the veteran had been wounded slightly in the war, whether he had ever been wounded severely, whether he had been a POW early in the war, and whether he had been a POW late in the war; occupation-at-enlistment dummy variables (professional or proprietor, artisan, laborer, and unknown, with farmer as the omitted category); country-of-birth dummy variables (Britain, Ireland, Germany, and other foreign country, with the United States as the omitted category); dummy variables indicating whether the veteran had been in a support position or had been a commissioned or noncommissioned officer; a dummy variable indicating whether the veteran had deserted; the logarithm of household personal property wealth in 1860; a dummy variable indicating that the veteran was illiterate; dummy variables indicating that information on wealth and on literacy was missing; a dummy variable indicating that the veteran had been a volunteer; dummy variables for wartime disease (typhoid, smallpox, respiratory, rheumatic fever, measles, diarrhea, insanity, malaria, fever, syphilis, gonorrhea, hepatitis, and cardiovascular disease); and state-of-regiment fixed effects. Numbers in parentheses are clustered standard errors. Specifications 1, 2, and 3 contain 7,494 observations. Specifications 4 and 5 contain 6,845 observations.

†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$

respectively, 0.989 ($\hat{\sigma} = 0.084$) and 2.901 ($\hat{\sigma} = 3.365$), both statistically indistinguishable from 1. (Using enlistment prior to 1863 made little difference to our results.) The hazard ratios on the fraction of the company wounded and the interaction term between the fraction of the company wounded and our measure of company cohesion are, respectively, 4.858 ($\hat{\sigma} = 2.254$) and 0.167 ($\hat{\sigma} = 0.097$), both highly statistically significant from 1.

We investigate different specifications of the hazard. Again, our basic results remain unchanged. For example, when we estimate a Weibull model, we obtain hazard ratios of 5.248 ($\hat{\sigma} = 2.082$) and 0.196 ($\hat{\sigma} = 0.101$) on the fraction of the company dying of wounds and on the interaction term between the fraction of the company killed and the dummy variable for a cohesive company.

Table 4 shows that the most statistically significant interaction effects on mortality are seen in mortality from ischemic heart disease and stroke. An increase of 0.01 in the company killed increases the odds of dying from ischemic heart disease and stroke by 0.50 for men in uncohesive companies, but by only 0.02 for men in high-cohesion companies. The effects on the odds of dying of a respiratory disease are even larger, but the standard errors are very large as well. We find no interaction effects between wartime stress and company cohesion on other causes of death.

When we examine the probability of men who lived until 1915 developing a heart condition between 1900 and 1915, we find that men in a more cohesive company were less likely to develop arteriosclerosis and bounding pulse than men in an uncohesive company (see Table 5). The predicted probability of developing heart disease is 0.138 for men in an uncohesive company and 0.127 for men in a cohesive company. The predicted probability of developing bounding pulse is 0.081 for men in an uncohesive company and 0.068 for men in a cohesive company.

Table 4. Effects of Company Cohesion and Stress on Different Causes of Death at Older Ages: Hazard Ratios

Variable	All Known, Excluding Violence	Ischemic Heart Disease and Stroke	Other Cardiovascular Disease	Respiratory Disease
Fraction Dying of Wounds	15.859***	50.364**	2.338	132.819†
	(9.635)	(71.395)	(3.133)	(362.328)
Dummy Variable = 1 if Cohesive	1.051	1.120	1.040	1.323
	(0.052)	(0.113)	(0.106)	(0.202)
Fraction Dying of Wounds × Dummy Variable = 1 if Cohesive	0.161*	0.041†	0.684	0.007†
	(0.125)	(0.075)	(1.201)	(0.022)

Notes: Hazard ratios are from a Gompertz model of years until death by cause. Competing causes of death are assumed to be independent. The data are restricted to men on the pension rolls in 1900, with known date of death, who did not change companies, and with both muster-in and discharge information. Additional control variables are age in 1900; dummy variables indicating whether the veteran had been wounded slightly in the war, whether he had ever been wounded severely, whether he had been a POW early in the war, and whether he had been a POW late in the war; occupation-at-enlistment dummy variables (professional or proprietor, artisan, laborer, and unknown, with farmer as the omitted category); country-of-birth dummy variables (Britain, Ireland, Germany, and other foreign country, with the United States as the omitted category); dummy variables indicating whether the veteran had been in a support position or had been a commissioned or noncommissioned officer; a dummy variable indicating whether the veteran had deserted; the logarithm of household personal property wealth in 1860; a dummy variable indicating that the veteran was illiterate; dummy variables indicating that information on wealth and on literacy was missing; a dummy variable indicating that the veteran had been a volunteer; dummy variables for wartime disease (typhoid, smallpox, respiratory, rheumatic fever, measles, diarrhea, insanity, malaria, fever, syphilis, gonorrhea, hepatitis, and cardiovascular disease); and state-of-regiment fixed effects. Numbers in parentheses are clustered standard errors. 3,650 observations.

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Table 5. Effects of Company Cohesion and Stress on the Probability of Developing Arteriosclerosis and Bounding Pulse

	Arteriosclerosis		Bounding Pulse	
Variable	$\partial P / \partial x$	$\partial P / \partial x$	$\partial P / \partial x$	$\partial P / \partial x$
Fraction of Company Wounded	0.227	0.484**	0.101	0.393**
	(0.164)	(0.221)	(0.116)	(0.132)
Dummy Variable = 1 if Cohesive	–0.009	0.016	–0.011	0.010
	(0.013)	(0.016)	(0.009)	(0.012)
Fraction of Company Wounded × Dummy Variable = 1 if Cohesive		–0.554†		–0.579**
		(0.275)		(0.214)
Pseudo-R^2	0.040	0.041	0.069	0.074

Notes: Results are from a probit model. The dependent variables in the first two regressions are equal to 1 if the veteran developed arteriosclerosis between 1900 and 1915. The dependent variables in the last two regressions are equal to 1 if the veteran developed bounding pulse between 1900 and 1915. The samples are restricted to veterans alive in 1915, age 50–64 in 1900, and who did not have arteriosclerosis or bounding pulse, respectively, in 1900. The samples are also restricted to men on the pension rolls in 1900, with known date of death, who did not change companies, and with both muster-in and discharge information. Additional control variables are age in 1900; dummy variables indicating whether the veteran had been wounded slightly in the war, whether he had ever been wounded severely, whether he had been a POW early in the war, and whether he had been a POW late in the war; occupation-at-enlistment dummy variables (professional or proprietor, artisan, laborer, and unknown, with farmer as the omitted category); country-of-birth dummy variables (Britain, Ireland, Germany, and other foreign country, with the United States as the omitted category); dummy variables indicating whether the veteran had been in a support position or had been a commissioned or noncommissioned officer; a dummy variable indicating whether the veteran had deserted; the logarithm of household personal property wealth in 1860; a dummy variable indicating that the veteran was illiterate; dummy variables indicating that information on wealth and on literacy was missing; a dummy variable indicating that the veteran had been a volunteer; dummy variables for wartime disease (typhoid, smallpox, respiratory, rheumatic fever, measles, diarrhea, insanity, malaria, fever, syphilis, gonorrhea, hepatitis, and cardiovascular disease); quarter-of-birth dummy variables (including one for missing); and state-of-regiment fixed effects. Numbers in parentheses are clustered standard errors. 2,821 observations in the arteriosclerosis regression and 2,592 observations in the bounding pulse regression.

† $p < .10$; ** $p < .01$

Bounding pulse is often associated with high blood pressure or fluid overload. Although we present results for arteriosclerosis and bounding pulse in the same table, they can be almost considered mutually exclusive physical findings because arteriosclerosis is accompanied by occlusive disease and hence decreased pulse on examination. We find that while 27% of men with arteriosclerosis in 1915 had ever had bounding pulse in an examination, 73% of them had ever had a weak pulse in an examination.

There are no differences in the rates of developing valvular heart disease, congestive heart failure, or other heart rate abnormalities by company cohesion. As a falsification exercise, we examine the effects of company cohesion and stress on the probability of developing a hernia between 1900 and 1915 among men who did have a hernia in 1900 (4,430 observations). Because hernias result from unusual pressure on the abdomen, such as that due to heavy lifting, obesity, or even aging, there should be no effects, and we find none. The derivatives on the fraction of the company that was wounded and the interaction term between the fraction of the company that was wounded and company cohesion are –0.061 ($\hat{\sigma}$ = 0.126) and –0.036 ($\hat{\sigma}$ = 0.159), respectively. Company cohesion mitigates the effects of stress largely through birthplace and age cohesion effects. When we run a specification in which we include measures of whether a company was below the mean in birthplace, occupation, and age homogeneity and interact these with our measures of wartime stress, we find that the coefficient on the fraction of the company dying of wounds is 1.968 ($\hat{\sigma}$ = 0.784) and that the interaction terms on birthplace and age homogeneity are 0.789 ($\hat{\sigma}$ = 0.209) and 0.707 ($\hat{\sigma}$ = 0.164), respectively. In contrast, the interaction term on occupation homogeneity is 2.150 ($\hat{\sigma}$ = 0.423).

CONCLUSION

We find that being in a more cohesive company reduced the negative, long-term consequences of wartime stress. The strongest effect of wartime stress on older age mortality and on the probability of developing specific conditions was observed for ischemic and stroke causes of death and the probability of developing arteriosclerosis and bounding pulse. Men exposed to wartime stress were less likely to develop cardiovascular disorders later in life if they were in more cohesive companies than if they were in uncohesive companies.

We suspect that men under stress who developed cardiovascular conditions later in life suffered from undiagnosed psychiatric conditions. Why might men who faced similar stress levels but were in more cohesive companies never develop psychiatric conditions? We can rule out a positive effect of peers on risk avoidance. Because men in more cohesive companies were less likely to desert, they also faced a higher risk of death. Having a social support network may have led men to reappraise battlefield threats or provided emotional consolation after battle. Although our results are derived from a past population, it is one of the few human populations to provide us with measures of stress, of long-run outcomes, and of exogenous social networks.

Studies of the negative health effects of stress in recent populations have attracted a great deal of attention (e.g., Geronimus 1992; Marmot and Wilkinson 1999). Stress was by no means the most important predictor of older age mortality in past populations. For example, the negative impact of growing up in a large city (where infectious diseases were common and nutritional status was poorer) was much greater than the effect of wartime stress (Costa and Lahey 2005). Although our results suggest that declines in psychological stress played at most a small role in long-run improvements in elderly health and longevity, stress may become a relatively more important factor in developed-country populations as early-life conditions have improved.

DATA APPENDIX

Our index of cohesion is based on the regression described below and given in Appendix Table A1 (see Costa and Kahn 2003b for further details).

Appendix Table A1. Competing-Risk Hazard Model for Desertion

Variable	Desertion Hazard Ratio	Desertion SE
Dummy Variable = 1 if Occupation Is		
Farmer		
Artisan	1.435**	0.093
Professional or proprietor	1.359**	0.105
Laborer	1.572**	0.121
Dummy Variable = 1 if Born in		
United States		
Germany	0.884	0.146
Ireland	1.310**	0.103
Great Britain	1.396**	0.148
Other	1.245*	0.120
Age at Enlistment	0.985**	0.003
Dummy Variable = 1 if Married	1.382**	0.128
Log(Total Household Personal Property), 1860	0.950**	0.017
Dummy Variable = 1 if Illiterate	1.601**	0.243
Company-Level Measures		
Birthplace fragmentation	1.405	0.496
Occupational fragmentation	3.428*	1.682
Coefficient of variation for age × 100	1.032†	0.017
Log(Population) City Enlistment	1.058*	0.028
Dummy Variable = 1 if mustered in		
1861		
1862	1.632**	0.200
1863	2.338**	0.437
1864	1.472**	0.196
1865	2.628**	0.437
Dummy Variable = 1 if Volunteer	0.749*	0.100
Percentage in County of Enlistment Voting for Lincoln	0.995*	0.003
Percentage in Company Dying (time-varying)	1.036**	0.011
Fraction Union Victories (time-varying)	0.610**	0.075
Duration Dependence Parameter	0.682	0.027
χ^{33} for Significance of all Coefficients	784.32	

Notes: Days until desertion are measured from first mustering-in. Standard errors are clustered on the company. Significance of all coefficients is for equality of all coefficients to 1. Men who died, became POWs, were discharged, were missing in action, or changed companies before first desertion are treated as censored. Covariates include height in inches and dummy variables indicating missing information for occupation, the 1860 census, literacy, and county voting. Included region fixed effects are for Middle Atlantic, East North Central, West North Central, Border, and West (with New England as the omitted category).

Source: Costa and Kahn (2003b).

†$p < .10$; *$p < .05$; **$p < .01$

We use a time-varying independent competing risks hazard model to estimate days from entry into the company (muster-in) until the first case of desertion. We treat men as censored if they died, were discharged, changed companies, became prisoners of war, or were missing in action. Our estimated hazard, $\lambda(t)$, is

$$\lambda(t) = \exp(x_I'\beta_I + x_C'\beta_C + x_D'\beta_D + x_M'\beta_M) + \lambda_0(t),$$

where I indexes the individual variables, C indexes the community variables, D indexes the ideology variables, M indexes the morale variables (some of which are time-varying), and $\lambda_0(t)$ is the baseline hazard, which we assume to be Weibull. The survival function thus takes the form $\exp(-\lambda_j t_j)^p$ for subject j, where p is the duration-dependence parameter and can be interpreted as representing whether men who were in the war longer became more committed or less committed soldiers. We cluster on companies.

Our independent variables are listed below.

Socioeconomic and Demographic Characteristics

Occupation. Dummy variables indicating whether at enlistment the recruit reported his occupation as farmer, artisan, professional or proprietor, or laborer. Farmers' sons who were not yet farmers in their own right would generally report themselves as farmers.

Birthplace. Dummy variables indicating whether at enlistment the recruit reported his birthplace as the United States, Germany, Ireland, Great Britain, or other.

Age at enlistment. Age at first enlistment.

Height in inches. Height in inches at first enlistment.

Married in 1860. This variable is inferred from family member order and age in the 1860 census. This variable was set equal to 0 if the recruit was not linked to the 1860 census.

Log(total household personal property) in 1860. This variable is the sum of personal property wealth of everyone in the recruits' 1860 households. This variable is set equal to 0 if the recruit was not linked to the 1860 census.

Missing census information. A dummy variable equal to 1 if the recruit was not linked to the 1860 census. Linkage rates from the military service records to the 1860 census were 57%. The main characteristic that predicted linkage failure was foreign birth.

Illiterate. This variable is from the 1860 census and provides illiteracy information only for those aged 20 and older.

Missing illiteracy information. A dummy variable equal to 1 if we do not know whether the recruit was illiterate, either because he was not linked to the 1860 census or because he was younger than age 20 in 1860.

Region effects. Our region dummy variables are New England, Middle Atlantic, East North Central, West North Central, Border, and West.

Community Characteristics

Birthplace fragmentation. We calculated, by company, the fraction of individuals born in the United States in New England, in the Middle Atlantic, in the East North Central, in the West North Central, the Border states, the South, and the West; and born abroad in Germany, Ireland, Canada, Great Britain, Scandinavia, northwestern Europe (France, Belgium, Luxembourg, the Netherlands), other areas of Europe, and other areas of the world. Our birthplace fragmentation index, f_i, is then

$$f_i = 1 - \sum_k s_{ki}^2,$$

where k represents the categories and s_{ki} is the share of men of born in place k in company i.

Occupational fragmentation. We calculated, by company, the fraction of individuals who were farmers, higher-class professionals and proprietors, lower-class professionals and proprietors, artisans, higher-class laborers, lower-class laborers, and unknown. Our occupational fragmentation index is then calculated similarly to our birthplace fragmentation index.

Coefficient of variation for age. We calculated, by company, the coefficient of variation for age at enlistment.

Population in city of enlistment. We obtained population in city of enlistment from *Union Army Recruits in White Regiments in the United States, 1861–1865 (ICPSR 9425)*, Robert W. Fogel, Stanley L. Engerman, Clayne Pope, and Larry Wimmer, Principal Investigators. Cities that could not be identified were assumed to be cities of population less than 2,500.

Ideology Variables

Year of muster. Dummy variables indicating the year that the soldier was first mustered in.

Volunteer. A dummy variable equal to 1 if the recruit was a volunteer instead of a draftee or a substitute.

Percent of vote in 1860 presidential election. We obtained by county of enlistment the fraction of the vote cast for Lincoln and for other candidates from *Electoral Data for Counties in the United States: Presidential and Congressional Races, 1840–1972 (ICPSR 8611)*, Jerome M. Clubb, William H. Flanigan, and Nancy H. Zingale, Principal Investigators. Because we cannot attribute a county to each recruit, our categories are percent in county of enlistment voting for Lincoln, other candidate, and unknown.

Morale Variables

Fraction in company dying. We calculated, by company, the fraction dying overall and the fraction dying (among all men at risk to die) within all half-years that each recruit served. Our means present the fraction dying overall. Our regression results use the time-varying covariate fraction of men at risk of dying during all half-years that each recruit served.

Fraction of major Union victories. This is a time-varying variable that indicates for each half-year that the recruit was in the service the fraction of major Union victories to all major battles in that half-year. It takes the value 0 if there were no major battles.

Our cohesion index uses the coefficients on birthplace fragmentation, on occupation fragmentation, and of variation for age. We tested whether measures of county-level fragmentation for the male population of military age perform better than our company fragmentation measures. Higher birthplace fragmentation in county of enlistment increased desertion rates, but the effect is not statistically significant. We find no effect at all of county-level occupational fragmentation.

We also investigate using alternative measures of birthplace and occupational diversity, such as percentage of own nativity or occupation and concentration ratios. Concentration ratios for birthplace and occupation are collinear, but individually, a higher concentration ratio significantly decreases the probability of desertion. Measures such as percentage of own nativity or occupation are not suited to the Union Army data because there was no dominant ethnic group. However, we find that laborers were more likely to desert if the proportion of laborers in the company was high.

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