

Service-Connected Disability and the Veteran Mortality Disadvantage

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Abstract

Research consistently reports a veteran mortality disadvantage relative to non-veterans, but has not considered the contribution of service-connected disability to this differential. We use data from the 1986 and 1989 National Health Interview Survey-2011 Linked Mortality Files ($N = 124,122$) to estimate multivariate Cox regression models of the association between veteran status and mortality, taking service-connected disability status into account. Bivariate analyses demonstrate higher mortality risk, lower socioeconomic status, and poorer health and functioning among veterans with a service-connected disability than among nonveterans and veterans without a service-connected disability. Multivariate models confirm a mortality disadvantage for all veteran service-connected disability subgroups, which is reduced by the inclusion of exogenous sociodemographic variables and substantially mediated by the health/functional limitation status measures. Results indicate that service-connected disability status accounts for some variation in, and may have a cumulative effect on, the veteran mortality disadvantage. When possible, future research should account for service-connected disability status when studying veteran–nonveteran mortality differentials.

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Keywords

veterans, mortality, service-connected disability, socioeconomic status, health, functional limitation

Recent studies comparing mortality risk among veterans and nonveterans generally find a veteran mortality disadvantage, meaning veterans have an overall higher mortality risk than nonveterans (Kaplan, Huguét, McFarland, & Newsom, 2007; Landes, Ardel, & Landes, 2018; Landes, London, & Wilmoth, 2018; Landes, Wilder, & Williams, 2017; Liu, Engel, Kang, & Cowan, 2005; London & Wilmoth, 2006). The veteran mortality disadvantage in these studies is partially to fully explained by various sociodemographic and/or health characteristics including age, race, war cohort, combat experience, type of military-veteran health care coverage, smoking behavior, and suicidality. One salient characteristic that has not been taken into consideration in analyses of the veteran mortality disadvantage is service-connected disability status.

While policy briefs and reports based on American Community Survey (ACS) data provide estimates of the prevalence of service-connected disability among U.S. military veterans (Duggan, 2014; U.S. Census Bureau, 2016; U.S. Department of Veterans Affairs, 2015c), these resources do not examine differentials in life-course and health outcomes among those with and without service-connected disability. Therefore, we begin by using data from the 1986 and 1989 (2011) National Health Interview Survey-Linked Mortality Files (NHIS-LMF) to describe the characteristics of four veteran service-connected disability status subgroups: nonveterans; veterans with no service-connected disability; veterans with a service-connected disability, but no Veterans Affairs (VA) compensation; veterans with a service-connected disability and VA compensation. We then use Cox regression models to analyze the contribution of service-connected disability to the veteran mortality disadvantage. Drawing on a conceptual model of the life-course consequences of military service (Wilmoth & London, 2013a, Figure 1.2), we also examine the extent to which the association between service-connected disability and mortality is explained by mediating social/economic and/or health/functional limitation variables.

Background***Service-Connected Disability Status***

Veterans with a service-connected disability “are determined by the U.S. Department of Veterans Affairs to be disabled by an injury or illness that was incurred or aggravated during active military service” (U.S. Department of Veterans Affairs, 2015a). Since most military service occurs in early adulthood, from a life-course

perspective, service-connected disability represents some degree of early-adult disablement that could be related to subsequent cumulative disadvantage in social, economic, and/or health domains. From 1985 to 2001, the VA estimates that the percentage of veterans with service-connected disability was consistently between 7% and 8%. Then, beginning in 2001, the percentage of veterans with service-connected disability began steadily increasing, reaching 18% in 2014 (U.S. Department of Veterans Affairs, 2015c). Using data from the ACS, the U.S. Census Bureau (2016) reports that the percentage of veterans with a service-connected disability increased from 15.1% in 2008 to 21.7% in 2016. The ACS did not include a question for service-connected disability in years prior to 2008.

In order to understand the potential consequences of service-connected disability for mortality, it is essential to understand that the VA's protocol for designating a service-connected disability and the assignment of service-connected disability status has varied across historical periods and in relation to specific subpopulations. Service-connected disability is based upon a rating "schedule" that serves as a "guide in the evaluation of disability resulting from all types of diseases and injuries encountered as a result of or incident to military service" ("Schedule for Rating Disabilities," 1994, p. 4.1-2). When evaluated for service-connected disability, veterans are assigned a "percentage rating," which represents "as far as can practicably be determined the average impairment in earning capacity resulting from such diseases and injuries and their residual conditions in civil occupations" ("Schedule for Rating Disabilities," 1994, p. 4.1-2). Service-connected disability ratings range from 0% to 100% and are assigned in 10% increments (U.S. Department of Veterans Affairs, 2017c).

The VA utilizes different rating schedules for different parts of the body that may have incurred injury, illness, or impairment during military service. The VA evaluates veterans for service-connected disability related to the musculoskeletal system, visual impairment, hearing impairment, infectious diseases, immune disorders, nutritional deficiencies, the respiratory system, the cardiovascular system, the digestive system, the genitourinary system, gynecological conditions, disorders of the breast, the hemic and lymphatic systems, the skin, the endocrine system, neurological conditions, convulsive disorders, mental disorders, and dental and oral conditions ("Schedule for Rating Disabilities", 2017). Specific examples from these schedules prove informative. In the schedule of ratings for muscle injuries, injury to the shoulder girdle and arm is rated in 10% increments from 0% for "slight" limitation in rotation of the shoulder to 40% for those with "severe" limitation in rotation of the shoulder. In the schedule of ratings for the digestive system, chronic liver disease without cirrhosis is rated in 10% increments from 0% for "nonsymptomatic" to 100% for "near-constant debilitating symptoms." The schedule of mental disorders provides a list of diagnostic categories from the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV). Mental disorders are rated in 10% increments from 0% if the mental disorder has "been diagnosed, but symptoms are not severe enough either to interfere with

occupational and social functioning or to require continuous medication” to 100% if the mental disorder causes “total occupational and social impairment.” As these examples illustrate, a service-connected disability can be designated due to physical or mental injury or illness that resulted in functional limitation, and an increase in the percentage rating reflects increased severity of symptoms that limit participation in the civilian workforce.

All veterans with a service-connected disability rating, no matter the percentage of the rating, receive increased priority for VA services, no-cost service-connected disability-related health care and medications, a travel allowance for VA appointments, VA housing grants, Service-Disabled Veterans Insurance, and life insurance benefits (U.S. Department of Veterans Affairs, 2015b, 2017a, 2017b, 2017c). In addition, the percentage rating assigned to the service-connected disability coincides with benefit tables that designate the dollar amounts that service-disabled veterans receive in monthly compensation (U.S. Department of Veterans Affairs, 2017a). A financial benefit is provided in order to compensate veterans for possible losses to civilian earnings due to the service-connected disability (Duggan, 2014). Only those veterans with a service-connected disability rating of 10% or higher receive monetary compensation for a service-connected disability, with dollar amounts increasing with each 10-point increase in percentage rating (U.S. Department of Veterans Affairs, 2017a). Additionally, extra allowances are provided to veterans with dependents if their service-connected disability rating is 30% or higher. Veterans with more than one 0% service-connected disability rating receive compensation at the 10% rating level. However, it is important to understand that a veteran with only one 0% service-connected disability rating is considered to have a service-connected disability but does not receive any monetary compensation for this disability. Thus, a veteran can have a service-connected disability rated at 0% and not receive VA monetary compensation.

Duggan (2014) reports that the percentage of veterans who were designated with a service-connected disability with VA monetary compensation declined from 10.5% in 1950 (the first year of the Korean War) to 8% by 1964 (the first year of the Vietnam War), was consistently around 7.5–9% from 1964 to 2001, and then increased steadily from 8.9% in 2001 to 18% in 2014. The increase in the percentage of veterans with a service-connected disability with compensation that began in 2001 resulted from more liberal VA rating policies that took into account the increased prevalence of Type-2 Diabetes among Vietnam Veterans exposed to Agent Orange; the increased diagnosis of chronic fatigue, fibromyalgia, and environmentally induced illnesses among Gulf War veterans; and greater understanding and diagnosis of post-traumatic stress disorder (PTSD) symptomatology among veterans of all war eras (Duggan, 2014). Although covering only the years 2008–2016, data from the ACS show the percentage of veterans with service-connected disability without VA compensation (those with one 0% service-connected disability rating) remained consistent at 1.1–1.2% (U.S. Census Bureau, 2016).

Service-Connected Disability Status and Disability Due to Limitations

There is evidence that the correlation between service-connected disability and the presence of a current activity and/or functional limitation is imperfect. Using data from the 2014 ACS, Holder (2016) found that an association between service-connected disability and ACS-defined disability, which is based on measures of activity and functional limitations. However, not all veterans with a service-connected disability have activity and/or functional limitations: In the ACS, approximately 40% of veterans with a service-connected disability rating of 50% or higher did not report a disability based on the available measures. Thus, while there is an association between service-connected disability and ACS-defined disability, these are not necessarily “interchangeable” designations (Holder, 2016, p. 15). This makes sense given that service-connected disability rating is based on the VA’s assessment of the impact that an injury or illness incurred during military service has on postmilitary service earnings capacity, while activity and/or functional limitations are typically based on a self-report of ability to perform a range of tasks. Thus, it is possible for a veteran with a service-connected disability rating from 10% to 100%, which indicates impaired earnings capacity, to report no activity or functional limitation. For example, a veteran with a 50% service-connected disability for PTSD might not report any activity and/or functional limitation as measured by the ACS. It is also possible that a veteran with a service-connected disability rating of 0%, indicating no impaired earnings capacity, may report limitations due to an injury or illness that occurred postmilitary service. For instance, a veteran with a service-connected disability for a shoulder injury that is rated at 0% may develop chronic heart disease later in life that causes severe activity and/or functional limitation. If the VA does not recognize the heart disease as being service-connected, then the veteran would remain rated at a 0% rating for service-connected disability despite exhibiting severe functional limitation. Finally, it is possible for a veteran to not have a service-connected disability rating but still report a disability due to a post-service injury or illness that is not associated with military service.

Another issue related to equating ACS-defined disability with overall disability is the extent to which ACS-defined disability adequately measures mental health- and substance use-related disabilities. Only three of the six measures of activity and functional limitation used in the ACS explicitly reference mental conditions: independent living limitation, self-care limitation, and cognitive limitation. The other three measures are more explicitly related to sensory impairment (hearing and vision) and mobility limitation (i.e., a condition that substantially limits one or more basic physical activities such as walking, climbing stairs, reaching, lifting, or carrying). None of the measures explicitly reference substance use.

Service-Connected Disability and Mortality

Based upon the variance in percentage ratings of service-connected disability and the fact that service-connected disability only designates degree of impairment in

earnings capacity due to a disability from an injury or illness incurred during military service, we contend that it is best not to consider service-connected disability a comprehensive measure of disability status. Nevertheless, it is important to consider the effect of service-connected disability on mortality risk because a service-connected disability indicates that a veteran incurred an injury or illness due to military service that resulted in some level of functional limitation. This is important, from a life-course perspective, because it generally, albeit not always, indicates early-adulthood disablement. Although a crude cut point, whether the veteran with service-connected disability does/does not receive VA compensation provides a basic differentiation between veterans whose service-connected disability is associated with some level of increased functional limitation that impairs earnings and veterans whose service-connected disability is not associated with a functional limitation that impairs earnings. In either case, the veteran was harmed by military service, but the severity of the harm, the potential impact on the veteran's life course, and the compensatory and ameliorative resources available to the veteran are reflected in the level of the service-connected disability rating. Veterans with a service-connected disability rating of 10% or higher would have some level of functional limitation that is considered by the VA to impair earnings and consequently might be expected to have poorer life-course outcomes. However, such veterans also have access to enhanced VA resources that could promote health and well-being. In contrast, veterans with a service-connected disability rating of 0% do not have a functional limitation that is considered by the VA to impair earnings and, therefore, they have more limited access to VA resources. Although they were harmed by their service in ways that might be consequential to their lives, the impact should not be as great as those with service-connected disability ratings of 10–100%.

As military service typically occurs during early adulthood (Kelty & Segal, 2013), a service-connected disability indicates an injury or illness resulting in early-onset functional limitation. Research shows that individuals with earlier-onset disability are at increased risk of "accelerated aging" (Campbell, Sheets, & Strong, 1999, p. 107), which may result in increased morbidity and earlier mortality (Campbell, Kemp, & Brummel-Smith, 1994; Campbell et al., 1999; Majer, Nuselder, Mackenbach, Klijs, & Baal, 2011). Thus, a service-connected disability may increase mortality risk directly because it generally indicates an injury or illness that results in functional limitation that was acquired early in adult life. Furthermore, all service-connected disability, despite their level of severity, may indirectly increase mortality risk via their effects on social and economic outcomes. Thus, directly and through processes of cumulative disadvantage across the life course (MacLean, 2013; Wilmoth & London, 2013a), there is good reason to expect that service-connected disability status contributes to the veteran mortality disadvantage.

To some extent, it may be that service-connected disability has countervailing effects on mortality outcomes. On the one hand, living with some level of functional limitation from injury or illness incurred during military service may lead to the development of additional health problems via physiological and/or social and

economic pathways. Early-onset disability among veterans with service-connected disability may have reduced earnings within the civilian workforce. There is evidence that households that include disabled veterans experience more poverty and material hardship than households that include nondisabled veterans (Heflin, Wilmoth, & London, 2012; London, Heflin, & Wilmoth, 2011; Wilmoth, London, & Heflin, 2015a). The increased health risk emanating from lower socioeconomic status may translate into higher mortality risk. On the other hand, for those veterans receiving VA compensation for their service-connected disability, the monetary supplements provided from the VA may offset these losses or even provide the veteran with service-connected disability better economic standing than veterans without service-connected disability (Buddin & Han, 2012; Wilmoth, London, & Heflin, 2015b). Studies of the general population report that increased socioeconomic standing is associated with better health and lower mortality risk (Adler & Newman, 2002; Marmot, 2005; Rogers, Hummer, & Nam, 2000). This might be the case for veterans with service-connected disability with VA compensation, but it may also be true for veterans with service-connected disability without VA compensation. The increased access to health care and other resources afforded to all veterans with service-connected disability, with or without VA compensation, may also lead to somewhat better morbidity and mortality outcomes compared to nondisabled veterans and nonveterans who do not have access to these VA resources.

Two recent studies by Maynard and colleagues report that service-connected disability increased 1-year mortality risk among veterans (Maynard, Nelson, & Fihn, 2018) and that veterans with service-connected disability who were younger, or who had service-connected disability with PTSD or severe depression, had higher risk of death from external causes (Maynard, Nelson, Fihn, & Trivedi, 2018). These studies are informative and emphasize the need to devote more attention to understanding the ability of service-connected disability to predict mortality risk among veterans. However, because the samples utilized in these studies do not include nonveterans, the available evidence does not allow for an assessment of the extent to which service-connected disability accounts for the veteran mortality disadvantage relative to nonveterans (Wilmoth, Landes, & London, 2019). Recent studies comparing the mortality risk of veterans to nonveterans generally find a veteran mortality disadvantage (i.e., higher mortality among veterans; Kaplan et al., 2007; Landes, Ardel, & Landes, 2018; Landes, London, & Wilmoth, 2018; Landes et al., 2017; Liu et al., 2005; London & Wilmoth, 2006). To the best of our knowledge, studies comparing the mortality risk of veterans with that of nonveterans have not taken service-connected disability into account. We build on prior research and address this gap in the literature by analyzing whether service-connected disability explains the veteran mortality disadvantage.

Based upon our understanding of service-connected disability and the pathways between negative health events and functional limitation in early adulthood and mortality, we hypothesize that the veteran mortality differential will vary by service-connected disability status. Specifically, we expect that a veteran mortality

disadvantage will be present for each of the veteran service-connected disability status subgroups that we identify. We also expect that the extent of the disadvantage will vary from less to more severe in the following order: veterans without a service-connected disability, veterans with a service-connected disability without VA compensation, veterans with a service-connected disability and VA compensation. Finally, we expect that the differences across these subgroups will be partially, but not fully, explained by background sociodemographic characteristics and potentially mediated by social/economic and health/functional limitation statuses.

Method

Data

We limit analyses to data from the 1986 and 1989 (2011) NHIS-LMF because service-connected disability was measured only in these two years. Data were acquired from the Integrated Public Use Microdata Series (IPUMS; Blewett, Drew, Griffin, King, & Williams, 2016). The NHIS is a nationally representative annual survey that provides sociodemographic and health information about the noninstitutionalized U.S. adult population. The LMF were created by the National Center on Health Statistics (NCHS) with a probabilistic algorithm that utilized key identifying information to match NHIS cases to National Death Index (NDI) data through 2011. While researchers have utilized the NHIS-LMF data to analyze the veteran mortality disadvantage (Landes, Ardelt, & Landes, 2018; Landes, London, & Wilmoth, 2018; Landes et al., 2017; Sheehan & Hayward, 2019), these studies have not taken service-connected disability into account.

Study Population

We excluded 4% of participants because of missing data on mortality status, veteran status, or service-connected disability status for veterans. As a result, the sample included 124,122 adults aged 18 and over—19,179 veterans and 104,943 nonveterans. As the dates of participation in the NHIS survey were 1986 and 1989, it is important to recognize that veterans in the sample would have served prior to the Gulf War, either during World War II, the Korean War, the Vietnam War, or during the interim periods between these wars (Wilmoth, Landes, London, & MacLean, 2018). Thus, results cannot be generalized to veterans who served during or after the Gulf War.

Measures

The dichotomous dependent variable indicates mortality status through December 31, 2011 (*deceased* = 1, *alive* = 0). Veteran service-connected disability subgroups were constructed by combining distinct, self-reported measures of veteran status (yes/no), service-connected disability status (yes/no), and service-connected

disability-related compensation status (yes/no). The combination of these measures resulted in a four-category variable: nonveterans (reference group), veterans without service-connected disability, veterans with service-connected disability without VA compensation, and veterans with service-connected disability with VA compensation.

We include exogenous sociodemographic variables and potentially mediating social/economic and health/functional status variables in our analyses. The background sociodemographic variables, which control for selection into military service to the extent possible with the NHIS data and are associated with mortality, include age (centered at the mean = 44.08 years); age-squared; biological sex (1 = *female*, 0 = *male*); and race-ethnicity (Non-Hispanic White [reference category], Non-Hispanic Black, Non-Hispanic Other, Hispanic). Socioeconomic status measures include marital status (married [reference category], previously married, never married), education (0–11 [reference category], 12, 13+ years), work status (1 = *working*, 0 = *not working*), and family income less than \$20,000 per year (1 = *yes*, 0 = *no*). While a demarcation point of \$20,000 seems low according to current income standards, as a point of reference, median U.S. household income in 1987 was \$25,990 (U.S. Bureau of the Census, 1989).

Self-reported health was measured with the standard five categories, from which we constructed a dichotomous perceived health variable (1 = *fair-poor*, 0 = *good-very good-excellent*). It is possible that nonveterans in the sample had disabilities that would be similar to those of veterans with service-connected disability. However, the NHIS does not include a specific measure of disability status. In lieu of a measure of general disability status, we include a measure of functional limitation (not limited [reference category], limited, unable to perform activity). This measure is based upon the following NHIS question: “Is respondent limited in ANY WAY in any activities because of an impairment or health problem?” We recognize that not all veterans with service-connected disability will have a functional activity limitation (Holder, 2016) and that measures of functional limitation and disability are often imperfectly correlated (Palmer & Harley, 2011). Despite these limitations, including this measure of functional limitation in multivariate models allows us to estimate the extent to which impairment(s) or health conditions that cause functional activity limitations mediate differences in mortality risk across the four veteran service-connected disability subgroups that are the focus of our analysis.

Analytic Strategy

All analyses are conducted with Stata Version 15.1. We use proportional weights and account for the complex design of the NHIS. As recommended in the IPUMS (2019) documentation, because of variance in NCHS procedures in 1986 and 1989 that led to weight noncomparability, we utilized “perweight” for the 1986 data and “mortwt” for the 1989 data. Survival time was calculated using the NHIS survey date, 1986 or 1989, as the start time, and year of death or 2011 as the end

time. Survival times of those who were alive as of December 31, 2011, were right censored. Missing values for sociodemographic, social/economic, and health/functional limitation variables were imputed with 10 multiple imputations. Descriptive analyses used data from one multiple imputation. Hazard ratios from Cox regression models are interpreted using mortality risk language.

We conduct bivariate analyses to examine the distribution of mortality risk, sociodemographic characteristics, social/economic statuses, and health/functional limitation statuses by veteran service-connected disability group. We then estimate a series of Cox proportional hazard regression models using the “failure” command to designate the failure event (death) and right censor data. Model 1 estimates the total bivariate association by regressing mortality status through 2011 on the veteran service-connected disability subgroup variable. The subsequent three Cox models provide further specification of this relationship by adding the sociodemographic, social/economic, and health/activity limitation status variables in steps. Recognizing the possibility that service-connected disability status could change over time, we conduct sensitivity analysis by comparing overall results to models of 5-year and 10-year mortality risk. In preliminary analysis, we also modeled 1-year mortality risk, but there was not a sufficient number of deaths in all service-connected disability categories to generate reliable estimates.

Results

We present distributions for all study variables by veteran service-connected disability group in Table 1. Veterans accounted for 15.9% of the population. Among veterans, 88.5% did not have a service-connected disability, 4.4% had a service-connected disability without VA compensation, and 7.1% had a service-connected disability with VA compensation. Compared to nonveterans, the absolute mortality risk among veterans was 1.7 times higher for veterans with no service-connected disability, 2.0 times higher for veterans with service-connected disability without VA compensation, and 2.5 times higher for veterans with service-connected disability and VA compensation. It is likely that the observed variation in mortality risk is partially the result of compositional differences across the groups. For example, compared to nonveterans, the average age of veterans was higher in each service-connected disability subgroup. Reflecting the cohorts included in the sample, all veteran subgroups were 96–97% male, which is double the percentage of males among nonveterans. While a higher percentage of all veteran subgroups were White, race–ethnic differences did not vary substantially across the veteran service-connected disability subgroups.

A higher percentage of nonveterans were never married. Both veteran subgroups with a service-connected disability were more likely to have been previously married than veterans without a service-connected disability. Results for level of education were mixed. Specifically, a higher percentage of veterans with service-connected disability and VA compensation had 0–11 years of education than all

Table 1. Weighted Distributions of All Study Variables by Veteran Service-Connected Disability Status Categories, 1986, 1989 (2011) National Health Interview-Survey Linked Mortality Files.

Variable	Veteran SCD VA comp (N = 1,376)	Veteran SCD no VA comp (N = 822)	Veteran no SCD (N = 16,981)	Nonveteran (N = 104,943)
Mortality status (%)				
Deceased	62.2	49.8	41.6	24.7
Alive	37.8	50.2	58.4	75.3
Age (mean)	56.9	52.3	50.9	42.1
Biological sex (%)				
Male	97.4	97.5	96.4	47.1
Female	2.6	2.5	3.7	52.9
Race-ethnicity (%)				
Non-Hispanic White	85.1	86.2	87.0	77.5
Non-Hispanic Black	10.5	7.8	7.9	11.2
Non-Hispanic Other	1.2	2.3	1.7	3.5
Hispanic	3.2	3.7	3.4	7.7
Marital status (%)				
Married	77.0	78.4	79.8	61.3
Previously married	17.5	14.4	12.7	17.3
Never married	5.5	7.3	7.6	21.4
Education (%)				
0–11 years	27.3	23.0	18.3	24.2
12 years	33.6	36.6	39.7	38.7
13+ years	39.1	40.5	42.0	37.9
Work status (%)				
Working	47.2	59.5	72.2	63.6
Not working	52.8	40.2	27.8	36.4
Family income less than 20k (%)				
Less than 20k	39.8	39.1	27.4	39.0
Greater than or equal to 20k	60.2	60.9	72.6	61.0
Self-reported health (%)				
Fair, poor	34.5	25.8	12.0	12.2
Good, very good, excellent	65.5	74.2	88.0	87.8
Functional limitation status (%)				
Not limited	48.1	61.5	81.6	83.5
Limited	26.9	25.0	11.5	11.8
Unable	25.0	13.5	7.0	4.7

Note. N = 124,122. SCD = service-connected disability. VA = Veterans Affairs; comp = compensation.

other veteran and nonveteran subgroups. However, a higher percentage of veterans without service-connected disability had either 12 or 13+ years of education than all other veteran and nonveteran subgroups. Regarding work status, compared to non-veterans, a higher percentage of veterans without service-connected disability were

working, while a lower percentage of veterans with service-connected disability, both with and without VA compensation, were working. The percentage of veterans who had a family income less than \$20,000 was lowest among veterans without a service-connected disability, and similar among veterans with a service-connected disability, with and without VA compensation, and nonveterans. Nonveterans and veterans with no service-connected disability were similar with respect to health/activity limitations. Veterans with service-connected disability with and without compensation had drastically poorer health and increased levels of functional limitation, though these differences were more pronounced among veterans with service-connected disability with VA compensation. These patterns are broadly consistent with what would be expected based on policies and procedures for assigning service-connected disability ratings.

Results from the Cox regression analyses are reported in Table 2. Model 1 provides the total bivariate association between the veteran service-connected disability variable and mortality. Consistent with other evidence of a veteran mortality disadvantage, mortality risk was higher for all veteran subgroups than among nonveterans: 1.84 times higher for veterans with no service-connected disability, 2.36 times higher for veterans with service-connected disability without VA compensation, and 3.32 times higher for veterans with service-connected disability with VA compensation. In addition to increasing mortality risk relative to nonveterans, this gradient pattern suggests that the presence of service-connected disability elevates risk relative to veterans with no service-connected disability. Specifically, the greater severity of service-connected disability, which is signaled by VA compensation, is associated with increased mortality risk.

Model 2 adds the exogenous sociodemographic characteristics, which vary considerably across the veteran service-connected disability subgroups (see Table 1). Controlling for the exogenous demographic variables reduces the veteran mortality disadvantage substantially, but the gradient by service-connected disability status remains largely intact. Compared to nonveterans, mortality risk is 1.01 times higher for veterans without service-connected disability but is no longer statistically significant. For the two service-connected disability subgroups, the mortality risk is significantly higher than that of nonveterans, 1.17 times higher for veterans with service-connected disability without VA compensation, and 1.27 times higher for veterans with service-connected disability with VA compensation.

Our analysis of potential mediating pathways in Models 3 and 4 suggests that health/functional limitation statuses explain the elevated risk of mortality among those with service-connected disability more so than social/economic factors. However, even after taking all of the potential mediators into account, a significant veteran status mortality disadvantage remains. Specifically, comparing Model 3, which adds the potentially mediating social/economic variables, to Model 2, it is clear that the hazard ratios remain virtually unchanged for veterans with service-connected disability, as mortality risk was 1.12 (vs. 1.05) times higher for veterans without service-connected disability, 1.15 (vs. 1.17) times higher for veterans with

Table 2. Cox Regression Models for Mortality Risk, 1986, 1989 (2011) National Health Interview-Survey Linked Mortality Files.

Variable	Model 1 HR [95% CI]	Model 2 HR [95% CI]	Model 3 HR [95% CI]	Model 4 HR [95% CI]
Veteran-disability status (Ref: Nonveteran)				
Veteran-no SCD	1.84*** [1.78, 1.90]	1.01 [0.97, 1.04]	1.08*** [1.04, 1.12]	1.08*** [1.04, 1.12]
Veteran-SCD-no VA comp	2.36*** [2.15, 2.58]	1.17** [1.04, 1.30]	1.15* [1.03, 1.29]	1.06 [0.95, 1.18]
Veteran-SCD-VA comp	3.32*** [3.08, 3.58]	1.27*** [1.18, 1.37]	1.27*** [1.18, 1.37]	1.12** [1.03, 1.21]
Age		1.09*** [1.09, 1.10]	1.09*** [1.09, 1.09]	1.09*** [1.09, 1.09]
Age ²		1.00*** [1.00, 1.00]	1.00*** [1.00, 1.00]	1.00*** [1.00, 1.00]
Female		0.67*** [0.65, 0.69]	0.61*** [0.59, 0.63]	0.62*** [0.60, 0.64]
Race-ethnicity (Ref: Non-Hispanic White)				
Non-Hispanic Black		1.26*** [1.21, 1.32]	1.08*** [1.04, 1.13]	1.02 [0.97, 1.07]
Non-Hispanic Other		0.72*** [0.64, 0.80]	0.70*** [0.63, 0.78]	0.71*** [0.64, 0.80]
Hispanic		0.86*** [0.82, 0.90]	0.76*** [0.73, 0.80]	0.75*** [0.71, 0.79]
Marital status (Ref: Married)				
Previously married			1.17*** [1.13, 1.22]	1.15*** [1.11, 1.20]
Never married			1.34*** [1.27, 1.41]	1.33*** [1.25, 1.41]
Education (Ref: 0-11 years)				
12 years			0.88*** [0.85, 0.91]	0.93*** [0.90, 0.96]
12+ years			0.74*** [0.71, 0.77]	0.80*** [0.77, 0.84]
Working			0.71*** [0.68, 0.73]	0.79*** [0.77, 0.82]
Family income less than 20k			1.24*** [1.20, 1.28]	1.16*** [1.12, 1.21]
Fair-poor health				1.37*** [1.33, 1.42]
Functional limitation (Ref: Not limited)				
Limited				1.28*** [1.24, 1.32]
Unable				1.55*** [1.44, 1.66]

Note. N = 124,122. SCD = service-connected disability; HR = hazard ratio; CI = confidence interval; VA = Veterans Affairs; comp = compensation.
 *p < .05, **p < .01, ***p < .001.

service-connected disability without VA compensation, and 1.27 (vs. 1.27) times higher for veterans with service-connected disability with VA compensation. In contrast, in Model 3, mortality risk for veterans without service-connected disability was 1.08 times higher and statistically significant (vs. 1.01 and nonsignificant in Model 2).

Much, but not all, of the association between service-connected disability and mortality is explained by the addition of the health/functional limitation variables to Model 4. Specifically, the veteran mortality disadvantage was substantially reduced to 1.06 times higher for veterans with service-connected disability without VA compensation and is no longer statistically significant. By contrast, mortality risk for veterans without service-connected disability remained unchanged at 1.08 times higher. The fact that the coefficients for veterans with service-connected disability without VA compensation (i.e., those with a single 0% rating) and veterans without service-connected disability were similar, but the coefficient for veterans with service-connected disability without VA compensation was not statistically significant in the fully specified model likely reflects imprecise estimation (i.e., the standard error was the largest among the veteran service-connected disability subgroups) due to the small size of this subgroup (Table 1). Although reduced in magnitude when the health/functional limitation variables were included in Model 4, the veteran mortality disadvantage remained more pronounced, 1.12 times higher, for veterans with service-connected disability with VA compensation than for the other veteranservice-connected disability subgroups.

Overall, these results suggest that much of the influence of service-connected disability on differential mortality risk is operating through pathways linked to health/functional limitation rather than through pathways linked to social/economic factors. This is particularly the case for veterans without VA compensation. By contrast, the service-connected disability rating for veterans with VA compensation is only partially mediated by health/functional limitation. For these veterans, the service-connected disability rating also appears to be capturing a level of increased severity of disability that is not accounted for solely by poorer health/functional limitations statuses. For veterans without service-connected disability, mortality risk is equivalent to that of nonveterans when only controlling for demographic characteristics (Model 2). However, we find evidence of suppression since veterans with no service-connected disability had a slightly higher mortality risk than nonveterans when controlling for socioeconomic status (Model 3). This higher risk is unchanged when the health/functional limitations variables are added (Model 4). These results point to factors that are linked to veteran status and increase mortality risk but are not related to service-connected disability.

We report the influences of other study variables on mortality risk using the fully specified Model 4 in Table 2.¹ Consistent with well-documented patterns, mortality risk: increased with age; decreased with each increase in level of education; was lower for females, Hispanics, Non-Hispanic Others, and those who were employed; and was higher for persons who were previously or never married, persons whose

family income was less than \$20,000, persons reporting fair–poor health, and persons with any level of functional limitation. The mortality risk of Non-Hispanic Whites and Blacks did not differ significantly.

Overall, trends in the association between service-connected disability and mortality risk were similar in sensitivity analyses of 5-year and 10-year mortality (Table 3). There was a distinct veteran mortality disadvantage for all veteran groups, with the comparatively elevated mortality risk for veterans with service-connected disability substantially explained by health/functional limitation statuses. In addition, comparison of the hazard ratios from analyses of mortality through 2011 to those from the 5-year and 10-year sensitivity analysis suggests a cumulative effect of service-connected disability on mortality risk for veterans with VA compensation. For veterans without service-connected disability and veterans with service-connected disability without VA compensation, comparative mortality risk to non-veterans was similar in the 5-year, 10-year, and 2011 analysis. However, for veterans with service-connected disability with VA compensation, hazard ratios consistently increased with from the 5-year through the 2011 analyses.

Discussion

Social scientists have increasingly given attention to the enduring effects of military service on various aspects of the life course (Spiro, Settersten, & Aldwin, 2018; Wilmoth & London, 2013b). Military service was a normative part of the life course for American men who came of age in the middle of the 20th century, and it remains a salient pathway to adulthood for current cohorts of men and women (Bennett & McDonald, 2013; Keltly & Segal, 2013; London & Wilmoth, 2016). For most veterans, participation in the military, which typically occurred during young adulthood, contributed directly and indirectly to the socioeconomic, family, and health outcomes that they experienced in middle age and later life. While some aspects of military service are health promoting (e.g., fitness requirements and routines, enhanced social networks, access to benefits), military service also exposes individuals to the risk of injury and illness that can lead to a VA designation of a service-connected disability (MacLean, 2013). Service-connected disability may have detrimental mortality implications due to cumulative disadvantage processes in social, economic, and/or health domains (Wilmoth & London, 2013a). Recent research suggests military service is associated with increased mortality (Kaplan et al., 2007; Landes, Ardel, & Landes, 2018; Landes et al., 2017; Liu et al., 2005; London & Wilmoth, 2006), but to our knowledge, variation in mortality by service-connected disability status has not been examined.

We used nationally representative data, inclusive of veterans who served in the military prior to the Gulf War, to prospectively examine mortality differences between nonveterans, veterans without service-connected disability, veterans with service-connected disability without VA compensation, and veterans with service-connected disability with VA compensation. Our bivariate results highlight the

Table 3. Cox Regression Models for 5-year and 10-year Mortality Risk, 1986, 1989 (2011) National Health Interview-Survey Linked Mortality Files.

Variable	Model 1 HR [95% CI]	Model 2 HR [95% CI]	Model 3 HR [95% CI]	Model 4 HR [95% CI]
5-year mortality risk				
Veteran-disability status (Ref: Nonveteran)				
Veteran-no SCD	1.72*** [1.67, 1.77]	1.04** [1.01, 1.07]	1.09*** [1.07, 1.12]	1.09*** [1.07, 1.12]
Veteran-SCD-no VA comp	2.10*** [1.95, 2.25]	1.15*** [1.07, 1.24]	1.15*** [1.06, 1.23]	1.08 [1.00, 1.16]
Veteran-SCD-VA comp	2.71*** [2.56, 2.87]	1.19*** [1.13, 1.25]	1.17*** [1.11, 1.24]	1.06* [1.00, 1.11]
10-year mortality risk				
Veteran-disability status (Ref: Nonveteran)				
Veteran-no SCD	1.76*** [1.71, 1.81]	1.03* [1.00, 1.06]	1.09*** [1.06, 1.12]	1.09*** [1.06, 1.12]
Veteran-SCD-no VA comp	2.19*** [2.02, 2.38]	1.17** [1.07, 1.28]	1.16** [1.06, 1.27]	1.07 [0.98, 1.17]
Veteran-SCD-VA comp	2.97*** [2.78, 3.18]	1.24*** [1.16, 1.32]	1.23*** [1.15, 1.31]	1.09* [1.02, 1.16]

Note. N = 124,122. Model 2 adjusts for age, biological sex, and race-ethnicity; Model 3 adds measures for marital status, education, working status, and family income; Model 4 adds measures for health status and functional limitation status. SCD = service-connected disability; HR = hazard ratio; CI = confidence interval; VA = Veterans Affairs; comp = compensation.

*p < .05. **p < .01. ***p < .001.

importance of distinguishing veterans by service-connected disability status. Veterans with no service-connected disability had better socioeconomic standing than nonveterans and similar levels of health and functional limitation. In contrast, veterans with service-connected disability had lower socioeconomic standing, poorer health, and more functional limitation than veterans without service-connected disability and nonveterans. Our multivariate findings also reveal variation in mortality risk among veterans based on service-connected disability compensation status: Veterans who received compensation from the VA for a service-connected disability had the highest mortality risk across all models, indicating an independent effect of their service-connected disability status. Mortality risk was also elevated for veterans with a service-connected disability who received no VA compensation when controlling for demographic characteristics and socioeconomic status. However, once we controlled for health/functional limitations, mortality risk for veterans with service-connected disability without VA compensation was similar to that of veterans without service-connected disability.

It is somewhat surprising to us that achieved social and economic statuses did not mediate the veteran mortality disadvantage for veterans with service-connected disability. For veterans without service-connected disability, mortality risk slightly increased when controlling for social and economic statuses, then remained steady in subsequent models. This likely reflects the fact that veterans without service-connected disability had better social and economic standing than nonveterans (see Table 1). The introduction of social and economic variables to the model did not change the mortality disadvantage for veterans with service-connected disability. This result may reflect an offset to service-connected disability for these veterans. In the United States, access to health care, which may influence mortality risk, has primarily been associated with employment and level of income (Wilper et al., 2009). However, veterans with service-connected disability without and with VA compensation have access to a full array of VA health-care services regardless of their employment status or income. It may be that access to VA care for all veterans with service-connected disability, and the monetary compensation afforded those with higher service-connected disability ratings, precludes social and economic statuses from operating as a mediating pathway. However, we cannot empirically test this contention, and the absence of an expected mediating socioeconomic pathway suggests the need for additional research to further parse out different socioeconomic status variables that may have countervailing effects on mortality risk among veterans. In addition, it is important to remember that the NHIS measures for socioeconomic status are cross-sectional. Thus, we were not able to analyze whether changes in socioeconomic status over time mediated the relationship between service-connected disability and mortality risk.

Our results do point to an independent effect of service-connected disability on mortality risk for veterans receiving VA compensation. However, since the NHIS does not include measures of level of service-connected disability rating or level of VA compensation, we cannot assess the extent to which this relationship varies

across the full service-connected disability rating scale. Furthermore, we are aware that changes in level of compensation, as well as the policies the VA utilizes to define and adjudicate a service-connected disability designation, may have occurred between baseline in 1986/1989 and 2011. Some service-connected disability emerges later in the life course and may not have given rise to functional limitation leading to VA compensation by the time of the NHIS. Some impairments that did not qualify as service-connected disability in 1986 or 1989 may have, due to changes in VA policies, subsequently been determined to qualify as service-connected disability. In addition, veterans whose service-connected disability claims are denied or rated at a low percent may appeal the decision, possibly resulting in a higher percent service-connected disability rating (Frueh et al., 2003; U.S. General Accounting Office, 2000). Thus, it is possible that veterans in our study transitioned from the veteran with no service-connected disability to either of the veteran with service-connected disability categories or that veterans with service-connected disability and no VA compensation moved to the veterans with service-connected disability with VA compensation category during the course of the study. The fact that we found similar results in sensitivity analyses that focused on 5-year and 10-year mortality suggests that such change is not likely to undermine our main analyses and conclusions.

Beyond these concerns with service-connected disability rating and level of compensation, it is possible that the veteran mortality disadvantage reported in this study reflects unmeasured aspects of military service. This is most apparent with respect to the increased mortality risk for veterans without service-connected disability but is also applicable to veterans with service-connected disability. It may be that the veteran mortality disadvantage is due to differences among veterans in such factors as length of military service, rank, toxic environmental exposures, and combat experience. It is an admitted limitation of our study that the 1986 and 1989 NHIS do not include these measures. These data limitations should be addressed in future research. Future research should also consider the extent to which the elevated risk of mortality across all veteran groups is related to the shared influence of the military on health behaviors that differentiate veterans from nonveterans, such as smoking, alcohol consumption, and body mass index (Landes, Ardel, & Landes, 2018; London, Herd, Miech, & Wilmoth, 2017; Wilmoth, London, & Himes, 2015).

Conclusion

Our results further emphasize the need for researchers to take service-connected disability into account, including measures of VA compensation for service-connected disability, when studying mortality risk among veterans and between veterans and nonveterans. In bivariate analyses, a veteran mortality disadvantage was observed for all veteran service-connected disability subgroups, but it was more severe among veterans with a service-connected disability and most severe among veterans with service-connected disability with VA compensation. To a substantial

extent, among veterans with a service-connected disability without VA compensation, the veteran mortality disadvantage operated through poorer health and increased levels of functional limitation. In contrast, even when service-connected disability, exogenous sociodemographic, and potentially mediating social/economic and health/functional limitation variables were taken into account, veterans with service-connected disability with VA compensation had a statistically significant 12% higher risk of mortality than nonveterans. The finding that the association between service-connected disability and mortality risk operated fully to partially through health/functional limitations, as opposed to socioeconomic status, points to the need for policy makers and legislators to ensure that the VA and other health providers have the resources necessary to continue attending to the health and functional needs of veterans with service-connected disability. While the data for our study limit generalization to veterans with service-connected disability who served prior to the Gulf War, we believe that future research should examine the association between service-connected disability and mortality among those who served during and subsequent to the Gulf War.

The persistent veteran mortality disadvantage observed among all veterans in our study highlights the need for additional research that aims to better understand the factors that generate the detrimental association between military service and post-service mortality risk for all veterans. Unfortunately, 1986 and 1989 are the only years the NHIS included a measure for service-connected disability. We recommend the collection of new, more comprehensive data sets that include detailed measures of military service experiences and linkage to the NDI. Further analyses of existing data sets, such as the Health and Retirement Study, and ongoing data collection efforts, such as the Million Veteran Program, may allow for additional insights into the causes of the veteran mortality disadvantage.


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Note

1. We also estimated the full model without the service-connected disability measure. We closely compared the coefficients for the variables in the model to those reported in Table 2, Model 4 and concluded that the hazard ratios for the control variables in this reduced-form model were similar to those we report in Table 2, Model 4.

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