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RESEARCH ARTICLE

Age differences in long-term mortality among male nonveterans, noncombat veterans, and combat veterans

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Abstract

Research documenting differences in mortality risk across the life course between veterans and nonveterans has not accounted for combat status. To address this gap in the literature, the current study examined differences in long-term mortality among midlife and older-adult male nonveterans, noncombat veterans, and combat veterans. Data were drawn from Wave 2 (2004/2005) of the Midlife Development in the United States survey and linked to 2020 mortality data ($N = 2{,}024$). Based on interpretation of a veteran-combat status by age interaction term, compared to nonveterans, noncombat veterans experienced a mortality advantage at younger ages, $OR_{\text{main effect}} = 0.12$, 95% CI [0.03, 0.54], $p = .006$, and a mortality disadvantage at older ages, $OR_{\text{interaction term}} = 1.06$, 95% CI [1.01, 1.05], $p = .004$, with the crossover occurring at 73.4 years. A similar pattern was present among combat veterans, with the mortality advantage at younger ages not reaching significance, $OR_{\text{main effect}} = 0.16$; 95% CI [0.02, 1.18], $p = .072$; a mortality advantage at older ages, $OR_{\text{interaction term}} = 1.03$, 95% CI [1.00, 1.05], $p = .040$; and the crossover occurring 4.2 years earlier at 69.2 years. The findings suggest that combat status may accelerate the age-related mortality disadvantage among veterans. Studies of health and mortality outcomes among veterans should, therefore, account for combat status. When data allow, future studies should confirm whether this pattern is present in nationally representative samples.

Nearly 18,000,000 individuals have served in the U.S. Armed Forces (Vespa, 2020), and calls have been issued to researchers to examine the potential effects of military service on a variety of outcomes, including health, across the adult life course (Settersten, 2006). Mortality is one such health outcome, with research consistently pointing to a veteran mortality disadvantage whereby the mortality risk is higher among veterans compared to nonveterans. The severity of this disadvantage, however, varies by birth cohort (Landes, Wilder, & Williams, 2017); race (Landes, Wilder, & Williams, 2017), with the disadvantage possibly eliminated for Black veterans (see Sheehan & Hayward, 2019); disability status (Landes, London, & Wilmoth, 2021); type of health insurance (Landes, London, & Wilmoth, 2018); and smoking behavior (Landes, Ardelt, & Landes, 2018). Although previous studies have been informative regarding overall mortality risk, few have examined life course changes in veteran versus nonveteran mortality.

This is a notable limitation considering the distinct life course trajectory of the veteran population (London & Wilmoth, 2006).

Prior to entry into the military, service members are routinely screened for physical and mental health conditions, and the presence of a health condition typically results in rejection from service (Liu et al., 2005; Wolf et al., 2013). This could be one reason researchers have documented a "healthy soldier effect" among World War II, Korean War, and Vietnam War veterans whereby the veteran population, on average, is healthier than the nonveteran population during early to midlife (London & Wilmoth, 2006; MacLean, 2013; Wilmoth et al., 2019). Although the healthy soldier effect may be waning for veterans who served after the Vietnam War (Hinojosa, 2018), previous cohorts appear to have benefited from this effect. Veterans may also experience a "military capital" effect, as they often benefit from health-promoting behaviors learned while in service and are afforded social capital during service and postservice, such as educational support, employment opportunities, home loans, and access to health care that can improve health outcomes (London et al., 2022; Wilmoth et al., 2019). Thus, due to the healthy soldier and military capital effects, there may be an early-life mortality advantage among individuals who serve in the military .

Two factors, however, may erode this health advantage as people grow older. The first is the heterogeneity of frailty, in which individuals with poorer health in a population die at earlier ages, resulting in more similar health outcomes at older ages between the groups who report comparatively better (e.g., veterans) and worse (e.g., nonveteran) health at younger ages (Liu et al., 2005). The second is a "military hazard" effect due to exposures experienced in service that can be detrimental to health. These include factors such as increased levels of arduous physical activity, stress, and exposure to toxic chemicals, all of which could lead to more precipitous health declines among veterans as they age (MacLean, 2013; Wilmoth et al., 2010, 2019).

An age-related crossover has been reported in comparisons of veteran versus nonveteran health outcomes, likely due to the countervailing contributions of the healthy soldier effect, military capital effect, heterogeneity of frailty, and military hazard effect. In their analysis of data from the Health and Retirement Study (HRS), Wilmoth and colleagues (2010) found that at 50 years of age, veterans reported better self-rated health and a lower number of comorbidities than nonveterans, but the reverse occurred at age 75 years. Using data from the Survey of Asset and Health Dynamics among the Oldest Old (AHEAD) on adults aged 70 years and older, Liu et al. (2005) provided the first indication that this crossover may also be present in veteran–nonveteran mortality risk patterns across the life course. The authors found a slightly higher mortality risk among veterans at age 70 years that increased with age. Based on this pattern in older age, Liu et al. suggested that veterans may have a lower mortality risk than nonveterans at younger ages. However, the age limitations of the data precluded empirical testing of this hypothesis. A veteran/nonveteran mortality risk crossover was later confirmed in a study conducted by Landes and colleagues (2017) in a sample of participants aged 18–84 years from the National Health Interview Survey (NHIS). The findings indicated a veteran mortality advantage at younger ages but a veteran mortality disadvantage at older ages, with some variation by race and birth cohort.

Although these studies are informative, only one examined the mortality crossover effect across the life course (Landes et al., 2017). More importantly, none of the veteran–nonveteran mortality studies included a measure of combat exposure. The long-term military hazard effect is of concern for all veterans, but there is increased concern regarding the long-term effects of the hazard of combat (Elder, 1987; Elder & Clipp, 1989; Settersten, 2006; Taylor et al., 2015; Ureña et al., 2017; Wilmoth et al., 2019). In addition to an increased risk of death during combat, many military service members who survive combat do so with long-term physical and/or mental health injuries due to traumatic experiences, such as engagement in firefights and exposure to death (Cesur et al., 2013; Sheffler et al., 2016; Taylor et al., 2018). Indeed, studies that account for this critical variable indicate that although nonveterans and noncombat veterans have similar mid- to late-life health outcomes, combat veterans have poorer health outcomes than both groups (MacLean & Edwards, 2017; Piazza et al., 2022; Taylor et al., 2015). Thus, compared to nonveterans, combat veterans may have even higher mortality differentials than noncombat veterans, which could result in the veteran/nonveteran mortality risk crossover occurring at earlier ages for combat compared to noncombat veterans.

No studies to date, however, have directly examined mortality differentials between combat veterans, noncombat veterans, and nonveterans. Elder and colleagues (2009) did include a combat measure in their examination of mortality outcomes for 824 men from the Stanford-Terman study ($N = 329$ World War II veterans, $n = 152$ with combat experience); however, they analyzed whether combat experience predicted mortality risk only among participants who served overseas, and they excluded nonveterans from the models that adjusted for combat status (Elder et al., 2009). Moreover, although combat status was associated with a higher mortality risk among the veterans in the study, the association was not statistically significant.

The current study addressed gaps in the literature by explicitly comparing mortality risk among nonveterans, noncombat veterans, and combat veterans. We also examined whether the crossover in mortality risk between veterans and nonveterans varied by veteran combat status. Using data from the Midlife Development in the United States (MIDUS) survey, we predicted (a) there would be a veteran/nonveteran mortality risk crossover with a veteran mortality advantage at younger ages but a veteran mortality disadvantage at older ages and (b) that the veteran/nonveteran mortality risk crossover would occur at earlier ages for combat veterans compared to noncombat veterans.

METHOD

Participants and procedure

We used data from Wave 2 of MIDUS, an ongoing national longitudinal survey of mental and physical health across the adult life course. MIDUS data collection started in 1995/1996 and included noninstitutionalized respondents between 25 and 74 years of age from four subsamples: a national random digit dialing (RDD) probability sample, oversamples in specified metropolitan areas, siblings of participants in the RDD sample, and an RDD national sample of twins. Wave 2 data were collected between 2004 and 2005 and included 5,555 participants, aged 30–85 years, from the original four subsamples (i.e., individuals contacted through RDD: $n = 2{,}257$, twins: $n = 1{,}484$, siblings of RDD sample participants: $n = 733$, oversamples from metropolitan areas: $n = 489$) as well as an added subsample of Black adults from Milwaukee ($n = 592$). All respondents were invited to complete a self-administered questionnaire (SAQ) after their phone interview, with a response rate of 81.3% for Wave 2. As questions about veteran and combat status were asked in the SAQ, only individuals who completed the SAQ were retained for the analyses ($n = 4{,}633$). Due to the low number of female veterans ($n = 45$), we only included male participants who completed the SAQ ($N = 2{,}024$). Wave 2 data were then merged with MIDUS core sample mortality data, which provided the mortality status for all participants as of December 31, 2020.

Measures

Mortality status and cause of death

Mortality status was assessed using a binary measure indicating whether the participant was alive or dead as of December 31, 2020. MIDUS ascertains the mortality status of survey participants using National Death Index (NDI) linkages, online tracing, closeout interviews, and longitudinal sample maintenance, with most deaths (95.1%) in the MIDUS sample ascertained via NDI linkage. All deaths in the analytic sample used for this study were ascertained via NDI linkage. Cause of death was determined and is reported using *International Classification of Diseases* (10th ed.; *ICD-10*; World Health Organization, 2016) chapter codes, with chapter code descriptions provided in Supplementary Table S1.

Veteran status and combat exposure

Veteran status was assessed using two measures: a binary measure of veteran status (veteran, nonveteran) and a combined measure of veteran status and combat experience (nonveterans, noncombat veterans, and combat veterans). These measures were based on two separate survey questions. First, participants were asked if they had ever entered the Armed Forces, with response options of "yes" or "no." Participants were then asked whether they had ever experienced combat, with response options of "yes" or "no." Regarding the veteran combat measures, participants who answered "no" to both questions were classified as nonveterans, those who answered "yes" to the first question and "no" to the second question were classified as noncombat veterans, and participants who answered "yes" to both questions were classified as combat veterans.

Covariates

Sociodemographic characteristics

Sociodemographic covariates included age, measured in single years; race/ethnicity (non-Hispanic White [i.e., White]; non-Hispanic Black [i.e., Black]; Hispanic; non-Hispanic other [i.e., other]); educational attainment (less than a bachelor's degree, bachelor's degree or higher); and marital status (married, divorced/separated, widowed, never married).

Physical health–related variables

Participants self-reported their health as "poor," "fair," "good," "very good," or "excellent." Functional limitations were assessed across 10 domains (i.e., carrying/lifting groceries, bathing/dressing, climbing several flights of stairs, climbing one flight of stairs, bending/kneeling/stooping, walking one block, walking more than one block, walking several blocks, moderate activity, and vigorous activity).

Participants rated their limitations in each domain on a scale of 1 (*not at all*) to 4 (*a lot*). Scores were averaged, with higher scores indicating higher levels of limitations. Smoking history (i.e., never, former, current) was also assessed, as previous research has demonstrated that poorer health, functional limitations, and smoking are more prevalent among veterans and are associated with increased mortality risk.

Mental health–related covariates

Participants were asked to indicate ("yes" or "no") whether they had experienced and/or had been treated for each of the following conditions during the past 12 months: sleep problems, alcohol or drug use, and anxiety or depression.

Data analysis

We converted the data to a person-year structure in which participants contributed 1 person year, beginning with the year of their MIDUS 2 interview (2004, 2005), until their year of death for those who died or 2020 for those who survived until the end of the study period. Participants who died during the study period were censored after death. One year was added to the participant's age for each subsequent person-year contributed to the study.

Prior to analyzing the data, we compared the distribution of all study variables by veteran and veteran combat status. Statistical analyses for between-group differences were conducted using chi-square tests for categorical variables and *t* tests for continuous variables. After examining the distribution of study measures by veteran status, we estimated two logistic regression models for the person-year data. Model 1 used the binary veteran measure; Model 2 used the veteran combat measure. Both models statistically adjusted for all covariates and included the Age x Veteran Status interaction term. Sensitivity analysis with Poisson models and Cox proportional hazards models provided similar results to those reported here. We proceeded with logistic regression models as they are more amenable to plotting results across the life course. Predicted probabilities based on fully specified models inclusive of the Veteran/Veteran Combat Status x Age interaction were used to plot mortality risk by veteran and veteran combat status across the life course. Differences in predicted probabilities at specific ages were tested using the STATA "margins contrast" command based on chi-square tests. Finally, we conducted a descriptive analysis of cause of death by veteran combat status among respondents who died during the study period.

The life course trajectories of differences in mortality risk by veteran status were central to our analyses. To ensure we had the best fit for these trajectories, we specified a model with the single measure of age, then two subsequent models: one using an age and age-squared term and one using an age, age-squared, and age-cubed term. In each of these models, we examined the interaction between the age term or terms and veteran combat status. The single measure of age and the interaction term were statistically significant. The coefficients for the age-squared term, age-cubed term, Veteran Combat Status x Age-Squared interaction, and Veteran Combat Status x Age-Cubed interaction were all not significant. In addition, per results from a postestimation examination of likelihood ratio tests and Bayesian information criterion (BIC) values, we determined that the linear age models best fit the data, indicating that differences in mortality changed uniformly with increases in age. To allow the coefficient for the main effect to provide information on the association between age and mortality at the low end of the age scale, age was not centered in the multivariate models. Sensitivity analyses of models with age centered at the mean provided the same results except, as expected, for the coefficient for the main effect of age.

Concern has been expressed by those studying the Black–White crossover in mortality regarding the accuracy of self-reported age for adults born prior to 1933, as that was the year in which the birth certification system was implemented across all U.S. states. It is possible that adults born before the establishment of birth certification may not know their actual age (Lariscy, 2011). To ensure the accuracy of estimates, researchers often exclude cases at the top end of the age range when using large data sets, such as the National Health Interview Survey (NHIS), to study the Black–White mortality crossover (Masters, 2012). Although we share this concern with the NHIS data, we do not feel it is as pressing with MIDUS data. MIDUS staff and researchers recognize that "age is probably one of the most important variables collected in a study of aging" and have engaged in extra steps involving cross-checking reported age with date of birth, including accessing public and private data sources to identify missing birth date information which makes it possible to correct errors in reported age (National Institute on Aging, 2022). Due to the extra work completed by MIDUS staff and researchers to ensure the age measure is accurate and because excluding respondents born before 1933 would greatly reduce the number of World War II veterans in the sample, we included all respondents in the study.

Due to the unique nature of the Covid-19 pandemic, we conducted sensitivity analyses on multivariate results after excluding any cases identified as having died from

COVID-19 ($n = 5$). The results were the same as those reported in the main models.

The distribution of veteran combat status was similar across MIDUS subsamples (i.e., RDD, RDD siblings, twins, and metropolitan areas) except for the Milwaukee sample, which had a lower percentage of veteran respondents. For this reason, we examined an additional model that included a variable for subsample. Subsample was not predictive of mortality status when compared with the RDD subsample, siblings: odds ratio (OR) = 0.90, twins: OR = 0.79, metropolitan areas: OR = 1.03, Milwaukee: OR = 1.14, ps = .060–.850. Odds ratios for all measures were the same or only slightly different than those presented in the main models except for non-Hispanic Black respondents. This would be expected as the majority of non-Hispanic Black respondents in the MIDUS data were from the Milwaukee sample. For this group, the odds ratio decreased but remained not statistically significant. The association between veteran combat status and mortality risk was the same as the association presented in the main models.

Finally, we conducted sensitivity analyses to determine whether accounting for the birth cohort in which study participants became eligible for war service, herein referred to as the "war-eligibility cohort," which occurs at 18 years of age, was predictive of mortality (Wilmoth et al., 2018). We modeled war-eligibility cohort in a parsimonious manner that preserved the integrity of cohorts in relation to periods of war, categorized as WWII–Korea War era (birth year: 1920–1936); Vietnam War era (birth year: 1937–1957); and post–Vietnam War era (birth year: 1958–1978). As all study participants were surveyed in either 2004 or 2005, there was a high degree of correlation between age and war-eligibility cohort. Despite the high level of autocorrelation, we examined models that adjusted for war-eligibility cohort and confirmed that doing so did not change results reported in this study nor did it improve model fit. Finally, we fit a model with a three-way Veteran Status x Age x War-Eligibility Cohort interaction term and confirmed that the Veteran Status x Age interaction did not vary across war-eligibility cohorts. Therefore, we did not include war-eligibility cohort as a covariate in the models.

Missing values for race/ethnicity (2.6% of all cases), marital status (0.1%), educational attainment (3.4%), and functional limitations (3.1%) were imputed using 10 multiple imputations by chained equations (White et al., 2011). All analyses were conducted using STATA (Version 17.0).

RESULTS

Distribution of study measures, by veteran status

As reported in Table 1, 37.4% of participants were veterans (n = 756), and 62.6% were nonveterans (n = 1,268). Specifying veteran status by combat status, 72.5% were noncombat veterans (n = 548), and 27.5% were combat veterans (n = 208). We only describe differences between noncombat and combat veterans when statistically significant, with all comparisons made to the nonveteran group. Compared to nonveterans, veterans (i.e., combined noncombat and combat) had a higher rate of death, were older, and were disproportionately White. Veterans had lower levels of educational attainment, lower rates of reported alcohol/drug problems, were more often married, reported higher levels of functional limitations, and were more likely to be former smokers. It is important to note that there was some variation in these veteran–nonveteran differences when accounting for combat status. Most notably, distinctions from nonveterans were more extreme for combat veterans than noncombat veterans with regard to death, such that the absolute risk was 18.4 percentage points higher for noncombat veterans and 30.9 percentage points higher for combat veterans, and age, which was, on average, 9.6 years older for noncombat veterans and 12.4 years older for combat veterans. In addition, compared to nonveterans, a higher percentage of combat veterans were in poor or fair health and had a higher functional limitations score than noncombat veterans. Finally, although noncombat veterans reported lower rates of anxiety/depression and current smoking than nonveterans, combat veterans had higher rates of each.

Mortality crossover, by veteran status

Multivariate results examining mortality risk using the binary veteran status measure (i.e., veteran, nonveteran) are provided in Table 2 (Model 1). The veteran status main effect, OR = 0.13, 95% CI [0.03, 0.48], indicating the association between veteran status and mortality risk at the low end of the age scale, was associated with lower mortality risk. Age, OR = 1.09, 95% CI [1.08, 1.10], and the Veteran Status x Age interaction term, OR = 1.03, 95% CI [1.01, 1.05], were associated with an increased mortality risk. To better discern these associations, Figure 1 provides a graph of the

TABLE 1 Unweighted distributions of all study variables across veteran and veteran-combat status for males, Midlife Development in the United States Wave 2

	Nonveteran		Veteran			Noncombat veteran			Combat veteran		
	(*n* = 1,268)		(*n* = 756)			(*n* = 548)			(*n* = 208)		
	M	***SD***	***M***	***SD***	***p***	***M***	***SD***	***p***	***M***	***SD***	***p***
Age years	52.04	11.07	62.41	11.52	< .001	61.65	11.35	< .001	64.40	11.75	< .001
Functional limitations	1.49	0.70	1.65	0.74	< .001	1.58	0.68	.013	1.84	0.84	< .001
	n	**%**	***n***	**%**		***n***	**%**		***n***	**%**	
Deaths	248	19.6	313	41.4	< .001	208	38.0		105	50.5	< .001
Race/ethnicity											
White	1,021	80.5	651	86.1	.002	479	87.4		172	82.7	.005
Black	197	15.5	77	9.7		50	9.1		23	11.1	
Hispanic	31	2.4	22	2.9		14	2.6		5	3.9	
Other	19	1.5	10	1.3		5	0.9		5	2.4	
Educational attainment											
Less than BA	741	58.4	486	64.3	.009	351	64.1	64.05	135	64.9	.033
BA or higher	527	41.6	270	35.7		197	36.0		73	35.1	
Marital status											
Not married	334	26.3	170	22.5	.052	127	23.2		43	20.7	.118
Married	934	73.7	586	77.5		421	76.8		165	79.3	
Reported health											
Poor	47	3.7	35	4.6	.123	24	4.4		11	5.3	.007
Fair	142	11.2	102	13.5		63	11.5		39	18.8	
Good	373	29.4	239	31.6		166	30.3		73	35.1	
Very good	486	38.3	251	33.2		191	34.9		60	28.9	
Excellent	220	17.4	129	17.1		104	19.0		25	12.0	
Smoking status											
Never	656	51.7	257	34.0	< .001	197	36.0		60	28.9	< .001
Former	465	36.7	406	53.7		293	53.5		113	54.3	
Current	147	11.6	93	12.3		58	10.6		35	16.8	
Sleep problems											
Yes	108	8.5	74	9.8	.334	48	8.8		26	12.5	.173
No	1,160	91.5	682	90.2		500	91.2		182	87.5	
Anxiety/depression											
Yes	165	13.0	87	11.5	.321	48	8.8		39	18.8	.001
No	1,103	87.0	669	88.5		500	91.2		169	81.3	
Alcohol/drug problems											
Yes	36	2.8	11	1.5	.045	6	1.1		5	2.4	.077
No	1,232	97.2	36	2.8		542	98.9		203	97.6	
Person-years	19,698		10,678			7,946			2,732		

Note: $N = 2{,}024$. Reported p values are based on chi-square tests for categorical variables and t tests for continuous variables. Column percentages may exceed 100% due to rounding. BA = bachelor's degree.

predicted probability of mortality for veterans and nonveterans across the life course based on the results from Model 1. As depicted in the figure, there was a veteran mortality advantage at younger ages but a veteran mortality disadvantage at older ages. The veteran–nonveteran mortality risk crossover occurred at 72.3 years of age. An analysis of differences in the graphed predicted probabilities (Table 3) revealed that the veteran mortality advantage was

TABLE 2 Multivariate logistic regression of mortality risk determinants for males, Midlife Development in the United States Wave 2

	Model 1		**Model 2**	
Variable	***OR***	**95% CI**	***OR***	**95% CI**
Age	1.09***	[1.08, 1.10]	1.09***	[1.08, 1.10]
Veteran status (Ref.: nonveteran)				
Veteran	0.13**	[0.03, 0.48]		
Age by veteran status (Ref.: nonveteran)				
Veteran	1.03**	[1.01, 1.05]		
Veteran combat status (Ref.: nonveteran)				
Noncombat veteran			0.12**	[0.03, 0.54]
Combat veteran			0.16[a]	[0.02, 1.18]
Age, by veteran combat status (Ref.: nonveteran)				
Noncombat veteran			1.03**	[1.01, 1.05]
Combat veteran			1.03*	[1.00, 1.05]
Race/ethnicity (Ref.: White)				
Black	1.27	[0.96, 1.67]	1.27	[0.96, 1.67]
Hispanic	0.79	[0.43, 1.43]	0.79	[0.43, 1.43]
Other	0.66	[0.24, 1.84]	0.65	[0.23, 1.83]
Educational attainment–BA or higher	0.72**	[0.59, 0.88]	0.72**	[0.59, 0.88]
Married	0.91	[0.74, 1.12]	0.90	[0.73, 1.11]
Reported health (Ref.: poor)				
Fair	0.77	[0.54, 1.09]	0.76	[0.54, 1.08]
Good	0.40***	[0.28, 0.57]	0.40***	[0.28, 0.57]
Very good	0.30***	[0.20, 0.44]	0.30***	[0.20, 0.44]
Excellent	0.27***	[0.17, 0.42]	0.27***	[0.17, 0.42]
Functional limitations	1.18*	[1.04, 1.34]	1.18*	[1.03, 1.34]
Smoking status (Ref.: never)				
Former	1.15	[0.94, 1.41]	1.15	[0.94, 1.41]
Current	2.39***	[1.78, 3.21]	2.38***	[1.77, 3.21]
Sleep problems	1.26	[0.95, 1.67]	1.27	[0.96, 1.67]
Anxiety/depression	1.17	[0.89, 1.53]	1.16	[0.89, 1.52]
Alcohol/drug problems	1.18	[0.68, 2.05]	1.18	[0.68, 2.04]
Intercept	0.03***	[0.02, 0.05]	0.02***	[0.02, 0.03]

Note. $N = 30{,}376$. *OR* = odds ratio; CI = confidence interval; Ref.: = reference group; BA = bachelor's degree.

[a] $p = .072$ (see DISCUSSION).

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

statistically significant at 40, 50, and 60 years of age, and the veteran mortality disadvantage was significant at 80 and 90 years of age. Summarizing other predictors of mortality risk from Model 1, a higher level of educational attainment was associated with a lower mortality risk, whereas fair or poor reported health, functional limitations, and current smoking were associated with an increased mortality risk.

Mortality crossover, by veteran combat status

The same multivariate analysis was repeated using the veteran combat measure (i.e., nonveteran, noncombat veteran, combat veteran), with results reported in Table 2 (Model 2). Compared to nonveterans, the mortality risk

TABLE 3 Comparison of predicted probabilities of mortality across age groups to nonveterans, Midlife Development in the United States Wave 2

Age (years)	Nonveteran		Veteran				Noncombat veterans				Combat veterans			
	PP	95% CI	PP	95% CI	χ^2	*p*	PP	95% CI	χ^2	*p*	PP	95% CI	χ^2	*p*
40	.001	[.001, .002]	.001	[.000, .001]	7.80	.005	.001	[.000, .001]	7.61	.006	.001	[.000, .001]	3.57	.059
50	.003	[.002, .004]	.002	[.001, .002]	7.24	.007	.002	[.001, .002]	6.97	.008	.002	[.001, .003]	2.43	.119
60	.008	[.006, .009]	.005	[.004, .007]	4.60	.032	.005	[.003, .007]	4.59	.032	.008	[.006, .009]	0.97	.325
70	.018	[.015, .020]	.017	[.014, .020]	0.33	.568	.016	[.013, .019]	0.62	.431	.018	[.016, .020]	0.02	.890
80	.040	[.034, .046]	.050	[.044, .056]	4.99	.026	.048	[.041, .055]	3.13	.077	.054	[.043, .064]	4.22	.040
90	.088	[.069, .107]	.138	[.115, .160]	11.32	.001	.133	[.107, .159]	8.01	.005	.143	[.106, .180]	6.73	.009

Note: $N = 30{,}376$. PP = predicted probability.

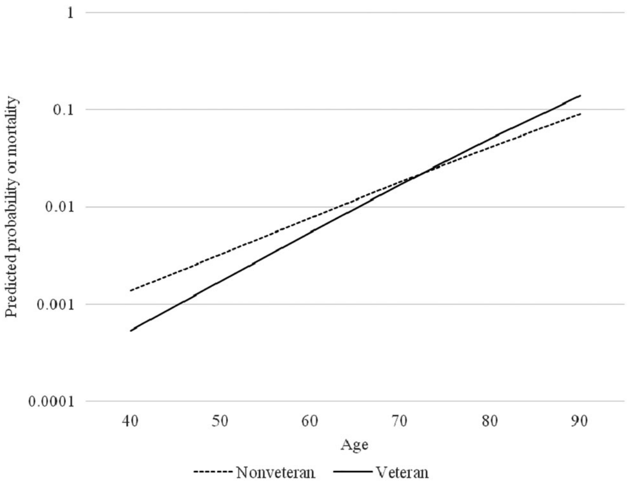

FIGURE 1 Predicted probability of mortality across ages for veterans and veterans, Midlife Development in the United States Wave 2

at the low end of the age scale was lower for noncombat veterans, *OR* = 0.12, 95% CI [0.03, 0.54], and combat veterans, *OR* = 0.16, 95% CI [0.01, 1.18]. However, although the noncombat veteran main effect was statistically significant at the $p < .01$ level, the combat veteran main effect was not, $p = .072$. Age, *OR* = 1.09, 95% CI [1.08, 1.10]; the Noncombat Veteran Status x Age interaction term, *OR* = 1.03, 95% CI [1.01, 1.05]; and the Combat Status x Age interaction term, *OR* = 1.03, 95% CI [1.00, 1.05], were all associated with an increased mortality risk. Figure 2 provides an illustration of the comparative mortality risk across the life course for all veteran combat statuses. A mortality crossover indicating a mortality advantage at younger ages and a disadvantage at older ages was present for noncombat and combat veterans. However, the mortality advantage was not statistically significant for combat veterans, and the crossover occurred at an earlier age for combat veterans (69.2 years) than for noncombat veterans (73.4 years). Analyses of the differences in the graphed predicted probabilities (Table 3) revealed that the noncombat veteran mortality advantage was statistically significant at 40, 50, and 60 years of age, and the mortality disadvantage was significant at 90 years of age. The combat veteran mortality advantage was not statistically significant at 40 years of age, $p = .059$, and the mortality disadvantage was statistically significant at 80 and 90 years of age. Other predictors of mortality risk from Model 2 were similar to those described for Model 1.

Cause of death

Cause of death, by *ICD-10* chapter code, is reported for all veteran combat groups in Supplementary Table S1.

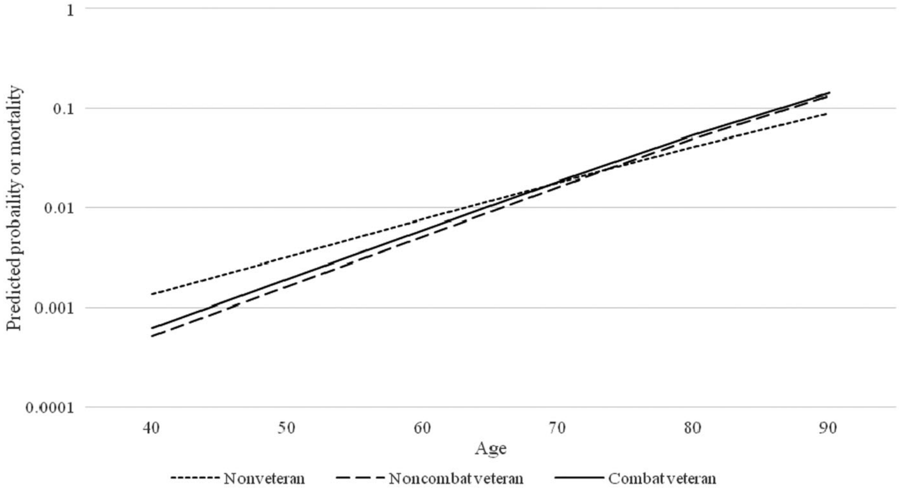

FIGURE 2 Predicted probability of mortality across ages for all veteran combat statuses, Midlife Development in the United States Wave 2

Similar to the reported leading causes of death for the entire U.S. population of men aged 35 and older who died between 2004 and 2020 (Centers for Disease Control and Prevention, 2021), the leading causes of death for all three groups, in rank order, were (1) heart diseases, (2) cancer, and (3) respiratory diseases. We conducted chi-square tests to examine the associations for each of these leading causes of death to determine whether there were differences in their prevalence by veteran combat status; none were statistically significant.

DISCUSSION

Researchers have rightly emphasized the importance of using a life course approach to examine health outcomes among individuals who have served in the military (MacLean, 2013; Settersten, 2006; Spiro et al., 2018). Previous work in this domain provides evidence of a crossover effect for health outcomes whereby veterans show better health outcomes than nonveterans at younger ages but worse health outcomes at older ages (Wilmoth et al., 2019). The current study extends this research by using a life course approach to compare mortality rates of nonveterans, noncombat veterans, and combat veterans. When compared to nonveterans, veterans showed a mortality advantage at younger ages but a disadvantage at older ages, which is akin to previous research (Landes et al., 2017). The early life advantage and age at which this crossover occurred, however, varied according to a factor for which previous studies have not accounted: combat exposure. Among noncombat veterans, the veteran mortality advantage was statistically significant at younger ages, and the crossover from mortality advantage to disadvantage occurred at 73.4 years of age. For combat veterans, however, the veteran mortality advantage at younger ages was not statistically significant, $p = .072$, and the crossover occurred at 69.2 years of age. For both noncombat and combat veterans, a veteran mortality advantage was present and statistically significant at older ages and started at earlier ages for combat veterans compared with noncombat veterans. Given that the mortality crossover occurred 4.2 years earlier among combat veterans, the current findings illustrate the importance of accounting for combat status when comparing mortality among veterans and nonveterans.

This is not the first study to illustrate the pernicious effects of combat exposure. Compared to noncombat veterans, combat veterans are at an increased risk of several mental and physical health conditions (MacLean & Edwards, 2017; Schult et al., 2019; Thomas et al., 2017). The reasons for this are varied and have been attributed to many factors. Compared to noncombat veterans, combat veterans are more likely to smoke (Cesur et al., 2013; de Silva et al., 2012), misuse alcohol (Cesur et al., 2013; Hassija et al., 2012), and engage in risk-taking behavior (Adler et al., 2011). Moreover, combat veterans show higher levels of allostatic load, a marker of cumulative biological dysregulation, at earlier ages than noncombat veterans (Piazza et al., 2022). These differential health habits and disparities could be one reason why the mortality disadvantage occurs 4.2 years earlier among combat veterans.

Supporting this hypothesis is research indicating that successful aging may be the result of acquiring and investing in health, relationships, and material resources and maintaining stability in these domains over time (Nimrod & Ben-Shem, 2015). Given the additional hazards and stressors to which combat veterans are exposed, one explanation is that it is more difficult for them to invest in and maintain the resources needed to age successfully. For example, combat veterans have a higher likelihood of reporting posttraumatic stress disorder (PTSD) than noncombat veterans (Armenta et al., 2018) and have been shown to have a more difficult time adjusting to civilian life upon their return (Schnittker, 2018). Factors such as these may make it more difficult for combat veterans to accumulate and maintain the capital needed for successful aging. More longitudinal work is needed, however, to determine whether lifelong habits and health disparities differentially and prospectively predict mortality among combat veterans, noncombat veterans, and nonveterans.

The current study documents a crossover from a mortality advantage at younger ages to a disadvantage at older ages among noncombat veterans compared to nonveterans. A similar crossover pattern was observed among combat veterans. However, the mortality advantage at younger ages did not reach statistical significance, and the veteran mortality disadvantage was present at earlier ages for combat veterans than noncombat veterans. Research on this topic is in its nascent stages, with only one study, to our knowledge, empirically documenting the mortality crossover but without accounting for combat status (Landes et al., 2017). Combined with research showing a morbidity crossover for veterans (Wilmoth et al., 2010), our work has implications for clinicians and health providers treating veterans. Compared to nonveterans, veterans report more sleep disorders, an increased likelihood of smoking, and more physical inactivity (Schult et al., 2019). As each of these factors contributes to increased morbidity and mortality with age, programs aimed at altering problematic health habits and increasing resilience (see Taylor et al., 2018) across the life course may reduce the health disparities among veterans noted across several studies.

The current study has several strengths but also some limitations. First, although MIDUS is unique in measuring both veteran and combat status, there are limitations to these measures. The question used to measure veteran status is based on self-reports of ever having entered the Armed Forces, with no additional measures of a participant's duration of military service. This means that respondents who joined the military but were entry-level separated (ELS), meaning they did not complete 180 days of continuous service, are likely coded as veterans. There are different reasons for ELS status, including but not limited to illnesses or injuries acquired during basic training, individual decisions to not continue with training, and misconduct. ELS individuals are considered eligible for veteran benefits if they obtain an "other than dishonorable" discharge, meaning they were not separated due to misconduct deemed dishonorable by the military. In addition, this measure of veteran status may have included individuals who received a dishonorable discharge regardless of their service duration. In sum, the measure of veteran status for MIDUS is broad and includes anyone who entered the Armed Forces, which is similar to data used in some other large studies, such as the NHIS, which currently measures veteran status as whether a respondent ever served in the Armed Forces, but is different from the many studies that use Veterans Affairs (VA) data and are based on samples of veterans who qualify for VA services.

Similar limitations exist with the combat status measure used in MIDUS. Although respondents reported whether they had ever experienced combat, the location, duration, severity, and frequency of combat exposure are unknown. Because certain types of combat experiences are more likely to be associated with adverse outcomes such as suicide (LeardMann et al., 2013), this is an important question to examine in datasets that have more comprehensive measures of combat status. Finally, MIDUS does not include a measure for deployment, a status that could be present among noncombat and combat veterans.

We also were not able to address possible selection effects associated with the drafts that were used prior to the All Volunteer Force (Wolf et al., 2013), as MIDUS does not include any measures on draft status. In addition, it is not possible to ascertain whether other types of traumatic events, such as military sexual trauma (MST), occurred during participants' time in service, as these questions were not assessed in the MIDUS survey. Similarly, PTSD was not assessed in the MIDUS survey. The MIDUS sample is a primarily White and fairly well-educated national U.S. sample that is relatively small compared to surveys such as the NHIS. It is, unclear, therefore, whether these results would apply to a larger, more diverse, and/or nationally representative sample. Finally, the number of female veterans in the MIDUS survey was not sufficient to conduct analyses. Future examinations of the associations between veteran status and mortality risk among women would further advance this important area. When data allows, this line of research should adjust models for the disproportionately high percentage of female veterans who experience trauma (e.g., PTSD, MST) while in service. Data from the NHIS may prove to be more amenable to addressing some of these limitations due to the larger number of cases and the ability to combine multiple years of survey data. Although the NHIS included a binary veteran measure for many years, it did not begin to include a measure of combat status until 2021. Thus, it is not currently possible, and will not be for some time, to use NHIS data to examine whether the veteran–nonveteran mortality risk crossover varies by combat status.

The current study reveals that there is a basic similarity in mortality risk among noncombat and combat veterans, but there is also an important distinction that reveals that military service is not a homogeneous experience. Likely due to a healthy soldier effect, noncombat veterans appear to have a mortality advantage that extends through mid- to late-life, dissipates with each passing year, and crosses over to a late-life mortality disadvantage. However, the results from this study underscore that a subgroup of veterans (i.e., those who have experienced combat) may not experience this early-life mortality advantage, either at all or as robustly, and may experience the later-life veteran mortality disadvantage at an earlier age than noncombat veterans. For this reason, combat veterans may be most in need of targeted evaluations and interventions during and following military service. These interventions should be aimed at maximizing health and reducing premature mortality, especially in midlife and older age.

Providers who serve military veterans in midlife to late life should be aware of their increased risk of mortality compared to nonveterans as well as the possibility that this increased mortality risk may occur at earlier ages for combat veterans. The results of this study also highlight the importance of examining distinct groups of veterans. When the data allow, future research should not conflate veterans who have experienced combat with those who have not experienced combat. When the data do not permit this important differentiation, it is imperative that researchers readily acknowledge this limitation in the study. Finally, nationally representative surveys focused on population health outcomes that include measures of veteran status should also include additional measures of combat status to provide the best opportunity to confirm whether the results of this study are present in nationally representative data.

OPEN PRACTICES STATEMENT

The study reported in this article was not formally preregistered. Data used in the study is available from MIDUS.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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