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# The Life-Long Mortality Risks Of World War II Experiences

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## Abstract

**Objective—**This longitudinal study of American veterans investigated the mortality risks of five World War II military experiences (i.e., combat exposure) and their variation among veterans in the post-war years.

**Methods—**The male subjects (N=854) are members of the Stanford-Terman study, and 38 percent served in World War II. Cox models (proportional hazards regressions) compared the relative mortality risk associated with each military experience.

**Results—**Overseas duty, service in the Pacific and exposure to combat significantly increased the mortality risks of veterans in the study. Individual differences in education, mental health in 1950, and age at entry into the military, as well as personality factors made no difference in these results.

**Conclusions—**A gradient is observable such that active duty on the home front, followed by overseas duty, service in the Pacific, and combat exposure markedly increased the risk of relatively early mortality. Potential linking mechanisms include heavy drinking.

### Keywords

Life course; Military; World War II; Mortality Risks

## INTRODUCTION

When wars come to an end, their legacy reverberates through political institutions, the generations, and individual lives. Studies of Vietnam and Israeli veterans have documented the enduring negative effects of exposure to combat and POW conditions, expressed in symptoms of haunting memories, health-risk behavior, and chronic diseases that impair prospects for longevity (Fontana and Rosenheck 1993; Boscarino 2006; Solomon and Ginzburg 1998). Among World War II veterans, the shadows of combat persist across 40 years in

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symptoms of post-traumatic stress (Elder and Clipp 1989) and cardiovascular disease (Johnson et al. Forthcoming). Wartime experience may fade in memories, but it can set in motion behavioral and physiological changes that affect late-life health (Schnurr et al. 1998) and longevity.

This life course study (Elder and Johnson 2003; Friedman and Martin 2007) focuses on a longitudinal cohort of American men from the Stanford-Terman study (Holahan and Sears 1995) who served in World War II. Using this long-term panel of veterans, we investigate mortality risks in the postwar years (after 1949) of five wartime experiences that entail potentially stressful experiences: variations in age at entry (whether early or late), active duty only on the homefront, overseas service, duty in the Pacific theater, and exposure to combat. To assess these wartime experiences as potential risks for impaired longevity, we draw upon empirically documented sequences of pathogenesis in the adult years that suggest pathways from war stresses to a foreshortened life span. To date, no longitudinal study has investigated the "chain of risks" that offers a plausible connection between war stresses and a shorter life span many years later.

Currently, knowledge about World War II influences in the lives of veterans pertains mainly to their subsequent health and well-being (see Bedard and Deschênes 2006; Schnurr et al. 1998). However, impaired health outcomes represent a key element along a path that is likely to increase the risk of a shorter life span. Thus in the well-known ARIC study, combat exposure among World War II veterans significantly enhanced the likelihood of life-threatening chronic disease in their middle years (Johnson et al. Forthcoming). This pathway is also noted in the lives of Vietnam theater veterans. Boscarino (2006) found that post-traumatic stress disorder, with empirical links to combat (see Elder and Clipp 1989), is significantly associated with postwar mortality. As in other studies (Elder and Liker 1982) that extend across the life course, we must piece together sequences of pathogenesis to construct a rationale for expecting mortality risks to be associated with war stresses among the veterans of World War II. Cardiovascular disease has been most fully investigated in terms of its implications for veteran mortality, but the small size of our sample restricts our perspective to all causes.

Before turning to plausible linkages, we discuss the war stress relevance of military or wartime experience. Little needs to be said about combat exposure since it is well documented by the research literature (Johnson et al. Forthcoming), along with the mortality risks of service in the Pacific Theater, as described in John Dower's *War without Mercy* (1987). These include the tropical diseases of this region, such as malaria. Kang, Bullman, and Taylor (2006) note that the mortality rate among POWs from Japanese-administered Philippine camps was 40%, compared to less than 2% among POWs from European theater. We follow this review with a description of the sample and measures, and then present the statistical analysis.

## War Stress and its Mortality Risks

Three indicators of wartime experience warrant more documentation as a war stress than the research literature has provided up to this point: (1) the life course timing when men entered the armed forces, whether right out of high school or out of careers and a family in their late 20s and 30s; (2) military duty only on the home front; and (3) some military duty overseas, through not necessarily involving service on the war front and active combat. None of these wartime experiences compare to the stress and life-threatening aspects of service in the Pacific theater and exposure to combat (Dower 1987; Schnurr and Green 2004). But they all experienced the disrupted lives, uncertainty, and challenge of military recruitment.

The potential stressfulness of becoming a member of the Armed Forces is related to the timing of this event (Elder, Shanahan and Clipp, 1994). In World War II, for example, entry into military duty generally ranged from the age of 18 to the late 30s. The study men averaged 31

years of age when the U.S. entered the war, indicating that at least half of the veterans were likely to have been pulled out of families and careers. The recorded experiences and letters of war brides (Litoff et al. 1990) provide vivid documentation of the stresses of family separation and the risk of divorce. Indeed, men who entered the service in their 30s were at greater risk of divorce than the early entrants Pavalko and Elder 1990). The disruption of established work lives occurred through the obsolescence of job skills and the return to uncertain employment (Elder, Shanahan and Clipp 1994). We hypothesize that these social disruptions could well impair late-life health and longevity among the Stanford-Terman veterans who had entered the service at a late age (but see London and Wilmoth 2007).

Compared to active duty only on the home front, overseas duty during the Second World War, even if well behind the war front, involved the prolonged family separation, uncertainty, and some of the danger experienced by men in combat units. Men overseas were also exposed to the risk of disease and enemy attacks by air and sea. However, overseas duty in the Pacific theater involved far greater mortality risks than did service in the European theater (Page 2001). The empirical evidence suggests the hypothesis that service in the Pacific theater and combat exposure, along with a later entry to military service, entailed the highest mortality risk among the factors in this study. Apart from age at military entry, our indicators of war stress can be arrayed on a hypothesized mortality gradient of risk, from service only on the home front to overseas duty, then service in the Pacific theater, and finally, exposure to combat.

Linking events and processes between war stress and mortality risks extend beyond the empirical reach of this longitudinal study. However three such processes warrant special notice as risk dynamics for longevity: explosiveness, fatigue and cardiovascular disease, and a compromised immune function. The tendency towards explosive and aggressive reactions among war veterans was noted by Kardiner (1941) more than 60 years ago as a hallmark symptom of war neurosis and currently appears in DSM-IV-TR and as a feature of PTSD (that is, persistent symptoms of increased arousal as irritability and anger outbursts). Anger and hostility are key elements in the pathogenesis of cardiovascular disease (see Lynch and Smith 2005), and they may play a major role in the association of PTSD and the mortality of veterans.

Persistent war stress may generate a symptom configuration known as vital exhaustion (Appels and Mulder 1988), defined by fatigue, demoralized feelings, and irritability/explosiveness. The complex has significantly predicted cardiovascular events in healthy populations. This concept brings to mind Swank's observations (1949) of combat exhaustion. Decades of military studies (Clipp and Elder 1996) and clinical cases have noted syndromes resembling vital exhaustion that tended to mark veterans' lives during wartime and over the longer term, perhaps as post-traumatic stress disorder.

Loss of some measure of personal control contributes to the stressfulness of situations, and sudden losses of control are known to be predictive of mortality (Eizenman et al. 1997). These processes could promote arterial lesions that compromise the immune system's ability to disable malignant cells (Adams 1994). The immune system is responsive to changing behaviors and moods, and trauma studies postulate a weakening of previously adequate defenses in the course of aging (Lipton and Schaffer 1986). However, it is unclear whether such changes can be linked to disease vulnerability among veterans with battlefield experiences. War stress may compromise immune function through the somatization of trauma. From this perspective certain veterans' encounter environmental stress and their heightened arousal is expressed through somatic pathways, diminishing immuno-competence and increasing the risk of cancer.

One might also assume that certain kinds of men were exposed to combat, and that this interaction of life history and combat trauma sharply increased mortality risks during and after the war. This selection interpretation is consistent with evidence on men who served in combat

during the Vietnam War. Specifically, Vietnam studies (Kulka et al. 1990; Gimbel and Booth 1996) show that veterans with backgrounds of conduct and academic problems, drug use, difficulties with authority figures, and unstable family lives were exposed to heavier combat or more abusive violence during the war years. In this study, we shall determine whether wartime experiences during World War II are associated with significantly greater mortality risk for veterans in the postwar years, controlling for differences in educational level (a proxy for SES), and whether these wartime experiences predicted specific cause of death.

Studies of the Stanford-Terman men have identified both childhood personality and marital stability as key factors in their mortality. Friedman and associates (1993(1995b) found that study members who were characterized as "conscientious, dependable" in childhood were more likely than other members of the sample to have a long life-span. They were less likely to smoke and drink heavily across the adult years, both risks for cardiovascular disease. The researchers also found that an index of poor mental health status significantly predicted a shorter life span (Martin et al. 1995). We shall investigate the effect of both factors on longevity. Among social influences, Friedman found that marital instability among parents in the Terman project increased the mortality risk of study members, as did their own marital instability, but the number of cases with unstable relationships is too small for detailed examination.

## METHODS

### Sample

To investigate the relation between wartime stress in World War II and mortality risks, we use the Stanford-Terman data archive. These data are based on a prospective, longitudinal sample of talented men who were born between 1900 and 1920 (Holahan and Sears 1995). Howard Friedman and his collaborators collected all of the death records of the study members. Nearly 40 percent of the men entered World War II, some in their mid- to late-20s, others in their 30s. Despite the selective nature of this group, comparative studies have shown much correspondence between the Terman men and other men from U.S. samples on age at first marriage and percent divorced (Pavalko and Elder 1990), causes of death (Clipp, Pavalko and Elder 1992), and on family patterns and worklife (Elder and Chan 1999). Moreover, the study is virtually unique in providing prospective records on World War II experience and its lifelong effects.

The Stanford-Terman longitudinal study began data collection in 1922 under the management of Lewis Terman, professor of psychology at Stanford University. The aim was to determine the life careers of talented or gifted children. Initially, 1,528 study members (856 males, of which 854 had military service data, and 672 females) were recruited, primarily from large public schools in California (grades 3–8) on the basis of intelligence assessments. Questions that focused on matters of family, education, and work were administered by mail on four separate occasions before the war (1922, 1928, 1936, and 1940). Military experiences were the main subject of questionnaires in 1945 and 1950. Since then, survey data have been collected in seven waves, timed approximately 5–10 years apart, for a total of 13 waves of data that span some 70 years.

In order to study talented children and their lives, Terman selected subjects with an IQ in childhood of 135 or greater. Their educational attainment was high. Few study members had only a high school diploma, and nearly half had a professional or graduate degree. The study members were also advantaged in socioeconomic status. Virtually all were white and from middle- to upper middle-class households. However, the sample reflected the general white population on marriage, careers, cause of death, family patterns, and worklife.

How might this sample's SES and higher intelligence affect a study of wartime experience and mortality risks? To the extent that the sample is biased, one would expect a lower mortality risk from the war, when compared to the general population, given the study members' higher class background and the protective effects of SES. Despite the differences between this group and U.S. white males in general, especially in terms of SES and cognitive ability, the Stanford-Terman archives provide a rare opportunity to investigate the mortality risks of service in World War II.

In the Stanford-Terman sample, 206 men are known to have been overseas during the war, and 88 remained in the United States. The service location of 35 men could not be determined. To gauge the possibility of bias, we compared the missing data Ss with the other men on all variables included in the models as well as on background characteristics. Results of these analyses revealed that Ss with missing data did not differ in terms of mean levels (for continuous variables) or distributions (for dichotomous variables).

## Measurement

**Wartime Experiences and Combat—**In order to depict the war experiences of the Terman men, we drew upon the full range of archival data (e.g., surveys, correspondence, staff notes, and field-worker reports). A team of coders with experience in survey research and American military history constructed life records that described the wartime experience of each veteran. From these records, we obtained measures of veteran status and periods of service: age at entry into military service in World War II, overseas duty and its duration, theater of service, and exposure to combat. Service in the Pacific theater includes only men who spent significant portions of their overseas duty in this region.

Especially important to our efforts is the combat variable, which indicates whether the veteran had experienced combat situations during the war. In 206 cases, the histories made explicit reference as to whether the veteran experienced combat or not. The combat experiences mentioned included being fired upon, witnessing injury and death or being injured, missing in action or a prisoner of war. The inter-rater reliability on these various combat dimensions is quite high, exceeding 90 percent agreement. An alternative measure (Scott's PI) confirmed this inter-rate reliability (Scott 1955). In other cases (N=71), a detailed understanding of the war's history proved useful for inferring combat experiences (such as the respondent who reported having received a Silver Star or Purple Heart) or service on a particular ship at a particular time. The archives thus enabled us to measure combat exposure, although no reliable distinction could be made between severity or duration of such exposure.

**Personality Predictors of Mortality—**Personality characteristics play an important role in individuals' stress reactions, health behaviors, and coping. In particular, conscientiousness has been linked in the literature to a variety of health-related behaviors and outcomes (Friedman and Martin 2007).

**Childhood conscientiousness:** Friedman and his collaborators constructed a measure of childhood conscientiousness (Friedman et al. 1993; Friedman et al. 1995a, b) which functions as a protective factor for longevity. This personality measure is based on a factor analysis of 25 trait ratings which were made by parents and teachers. The ratings include prudence-forethought, freedom from vanity-egotism, conscientiousness, and truthfulness (alpha = .76).

**Adult neuroticism:** A negatively related adult measure is comprised of 17 items which were administered to participants in the 1940 follow-up with a self-report questionnaire. The scale was derived by factor analysis and validity tested, with an alpha of .85 (Martin and Friedman 2000).

**Linking Factors—**The Terman data archive does not enable us to investigate in adequate detail health risk pathways that link war stress and foreshortened longevity. But we take into account three potential postwar linkages – education, mental health status, and the heavy use of alcohol.

**Education:** Measured by self-reported cumulative level of education through 1950.

**Mental health status:** Interview queries in 1936, 1940, 1945, and 1950 asked the study members whether they had any tendency toward nervousness, special anxieties, worry, or a nervous breakdown in recent years. If so, they were asked about the nature of such difficulties. On the basis of this information and the total case history, Terman and his staff classified the study members into one of three mental adjustment categories –satisfactory adjustment, some maladjustment, and serious maladjustment. The first category included members of the study who were able to cope normally with everyday problems. The second category included those who had mental problems, but were able to function in their life. The third category included those who could not function – they had shown marked symptoms of anxiety, depression, personality maladjustment, psychopathic personality, or nervous breakdown. Martin and associates (1995) scored satisfactory adjustment as 0, some maladjustment as 0.5, and serious mental health problems as 1.0.

**Heavy use of alcohol:** Level of usage was self-reported in the 1950 survey: 1) never drinks or only rarely; 2) drinks moderately, never or seldom intoxicated; 3) fairly heavy drinker; and 4) alcohol is a serious problem. Heavy use is measured by response categories 3 and 4; the remaining categories were combined to measure infrequent or no use. This measure is correlated .60 with use of alcohol reported in the 1960 follow-up.

**Death Rate and Cause of Death—**These data were obtained from death certificates, most of which were collected from 1991 through 2000; by 2000, 607 of the men in this sample (71%) had verified deaths. By 1960, approximately two out of five study members had died – veterans were similar to non-veterans on this percentage (only one percent higher). The death rate of veterans and non-veterans remained the same across the next forty years. A certified nosologist, supervised by Howard Friedman's research team's physician (Michael H. Criqui), determined the underlying cause of death from each certificate, using the ninth revision of the International Classification of Diseases. When death certificates were not available, information from next of kin was used by Dr. Criqui to classify deaths. Causes of death were divided into the following categories: (1) CVD, (2) cancer, (3) accident, injury, or violence, (4) other causes, and (5) unknown causes.

## Analytic Strategy

In order to examine the effects of differential military service on mortality risk, we used a series of Cox Proportional Hazards regressions. Specifically, we used Cox's semi-parametric model[1] in the analysis of survival data to assess the effect of military service on hazard rates. We assume that the survival time of each sample member follows its own hazard function, $\lambda_i(t)$, expressed as:

[1]The Cox model assumes that the ratio of the hazard functions for participants with different values of the covariates does not vary with age (time) and, therefore, that the effects of the covariates on the hazard rates can be expressed as a log-linear function. The Gompertz model assumes that the risk of death at any particular time (described by the hazard function) can be represented by an exponential function that includes age; thus, this strategy is better able to determine the relative strength of a predictor at different ages. In this paper we present results from Cox models, and in each case have replicated the analysis using the Gompertz model (results from the two procedures were very similar in every case).

$$\lambda_i(t)=\lambda_0(t)\exp(\beta_k Z'_{ik})$$

where $\lambda_0(t)$ is an unspecified baseline hazard function, Z′ is the vector of military service measures for the *i*th individual, and $\beta_k$ is a vector of unknown regression parameters associated with those measures (see Yamaguchi 1991). To clarify possible pathways between types of military experience and mortality risk, Gompertz modeling was used to predict cause-specific versus all-cause mortality risk by comparing a model in which predictive power was constrained to be equivalent across all causes of death with an unconstrained model.

A comparison of results from the Cox and Gompertz models enables us to address the question of whether the impact of war stress is constant across age/time, as assumed by the Cox model, or changes as veterans age. As noted in Endnote 1, the Gompertz model does not assume a constant level of predictive power across age/time, as the Cox model does. Our results turned out much the same for both models, indicating that the predictors do not change in their effect by age/time. With this replication in mind, we present results from a series of Cox Proportional Hazards regressions.

Table I describes the sample of men on the five war stress measures. A total of 38 percent of the men entered the service in World War II. Their mean age at entry was 31 years; a small number of men entered in the 1930s. Most of the veterans for whom data on location of service are available served overseas (70%), with over a third of those ending up in the Pacific Theater. Our records show that about three-fourths of the veterans were exposed to combat conditions. Do these military variations make a difference in the mortality risk of veterans, taking into account their level of education, early mental health status, and heavy use of alcohol in the postwar era?

## RESULTS

Before assessing the potential role of various aspects of WWII military service in affecting post-war mortality risk, we examined the effects of childhood and young adult personality characteristics on selection into different aspects of military service. These traits have been shown to affect mortality risk in studies by Howard Friedman and his collaborators. However, none of the traits was associated with active duty service or with combat experience. Nevertheless, two traits were predictive of service in the Pacific Theater. Men characterized by conscientiousness in childhood were less likely to be sent to the Pacific theater (Hazard Ratio = 0.98, $p < .05$, $n = 176$). Conversely, more neurotic young adults (measured in 1940) were at increased risk of being sent to the same theater (Hazard Ratio = 1.09, $p < .10$, $n = 176$). However, when a veteran served in the South Pacific theater, neither conscientiousness nor neuroticism remained associated with his mortality risk.

Table 2 shows the results of nine Cox proportional hazards models, with each model regressing characteristics of wartime experiences and post-war control measures on the risk of post-wartime, all-cause mortality. The table is constructed in nested fashion from left to right, as shown in Figure 1. Specifically, model 1 examines the role of active duty on risk of death; model 2 examines the role of age at entry on risk of death among active duty personnel; and model 3 compares risk of death associated with serving overseas versus domestic duty among active military personnel. Similarly, models 4 and 5 respectively assess the roles of duty in the Pacific theater and combat exposure on risk of death among military personnel serving overseas. Models 7, 8, and 9 mirror models 3, 4, and 5 with the addition of post-wartime indicators for education level, mental health status, and heavy alcohol use.

Results show that having been on active duty at any time during World War II did not alter the all-cause mortality risk when compared to civilians during the war. Similarly, among those on active duty, the age at which they entered the military did not make a difference in this mortality risk. Simply stated, active duty military personnel, regardless of age at entry into service, do not have substantially different post-war mortality risks than their civilian counterparts.

However, closer examination of subgroups of military personnel does indicate that certain military experiences increased their mortality risk. Comparing men on overseas duty with veterans who only served on the homefront, the former are 1.54 times as likely to have died by the year 2000. Furthermore, among men stationed overseas, those who served in the Pacific are 1.5 times more likely to have died by 2000 than overseas personnel in other theaters.[2]

Similarly, compared to men on overseas duty who did not experience combat situations, WWII combatants are almost 1.3 times as likely to have died by the year 2000. While at first glance this effect appears to be rather modest for such a substantial stressor, we should not forget that this particular effect is for overseas personnel who, as noted above, are already at a substantially greater mortality risk than servicemen on the homefront. To examine the combined effect of identified risk factors, an additional equation which included all three of the significant predictors was also calculated. This model (#6) shows that duty overseas, duty in the Pacific, and exposure to combat all pose risks, and none of these risks is solely explained by another (that is, risk associated with serving in the Pacific is not explained away by combat exposure, and so on). Although the hazards are diminished in two cases, they remain statistically significant in this comprehensive model.

In order to better understand the process by which these particular subgroups of servicemen come to have a greater mortality risk, we examined the role of three potential post-war mediating factors: education, mental health, and heavy alcohol use in 1950[3]. Model 7 shows the role of these intervening factors in relation to the effects of overseas duty. Mental health has no relation to later mortality among active duty veterans, though both education and alcohol use are significant mediators of all-cause mortality. As expected, higher levels of educational achievement are related to a modestly lower risk of mortality whereas heavy alcohol use is strongly associated with an increased mortality risk. However, despite the inclusion of these mediating factors, WWII veterans with overseas duty remain about 1.4 times as likely to die by the year 2000 as their homefront peers. The same pattern is found in Model 8 when comparing the mortality risk of the Pacific theater to other theaters.

More striking results are apparent, however, when these mediating factors are included in the combat exposure model (#9). The effects of the mediators remain fairly consistent. Mental health continues to be non-significant, education lowers the mortality risk, while heavy drinking significantly increases this risk. On the other hand, the effect of combat exposure is reduced to non-significance, although the hazard ratio remains positive. Thus, the increased mortality risk associated with combat appears to operate through the mediating mechanisms examined.

More detailed examination of the data, however, does not show a clear conclusion regarding alcohol as a mediator of wartime stress. This may reflect, in part, the diverse meanings of self-reported use of alcohol. Some heavy drinkers deny their habit or avoid answering the question

[2]These results are suggestive of the possibility that the hazard ratio for the overseas duty indicator in model 3 might be driven entirely by the effect of the Pacific theater service. However, examination of the effect of overseas duty excluding those with Pacific theater service from the sample showed that only about 25% of the increased risk of death from overseas duty was due to the Pacific theater (excluding those serving in the Pacific, HR = 1.37)

[3]Additional measures from 1960 were tested, but substantive results did not differ. We also attempted to examine the possible role of smoking behaviors, but unfortunately these analyses were inconclusive due to excessive missing data.

altogether. Assuming that heavy drinkers have a greater likelihood of non-response than other veterans (due to social stigma, higher attrition rates, etc.), and that combatants are more likely to be heavy drinkers, we would expect combatants to have more missing data (non-response) on alcohol use than those not exposed to combat. This would support the possibility of a mediational relationship between combat exposure and heavy drinking. Examination of the data tends to verify this expectation – more combatants have missing data on alcohol use than noncombatants (a ratio of about 8 to1).

The effect of heavy alcohol use might simply express the continuation of problem drinking, with its long-term implications for a shorter life-span; or an accentuation of drinking under intense war stress and its persistent health costs in the postwar era. It may also be a self-medication response to the PTSD effects of heavy combat without a prior record of alcohol use (Fontana and Rosenheck 1993).

Case histories on file provide examples of each of these accounts. For example, in reflecting upon his combat experiences, a veteran observed that he drank before the war, but that he really started drinking during stints on the battlefront and had lengthy periods of problem drinking in the postwar years. His wife wrote Terman that her husband became a problem drinker after the war. Another combat veteran, who practiced law in the postwar era, was discharged for medical disability involving psychoneurosis. His daughter reported that her father had periods of very heavy drinking during the war and afterwards when his pain killers were not effective. Heavy drinking is correlated with smoking, but the evidence at hand on smoking shows no effect on mortality among veterans in the sample.

The analysis up to this point has focused on all-cause mortality in view of our small sample. Nevertheless, we compared each cause of death on the dimensions of war stress. We expected cardiovascular disease to be distinguished from the other causes by a concentration of war stressors. However, the results of our analysis showed no reliable link between CVD or cancer and the war stressors.

## CONCLUSIONS AND DISCUSSION

Stressful experiences in early life may have behavioral consequences that persist across the life course. Such influences from the past represent one of the more compelling reasons why wartime experiences deserve investigation in the lives of aging veterans. With the development of longitudinal samples after WW II, some could be used to investigate the psychosocial and mortality risks of combat exposure among returning Vietnam veterans. However, few such samples were launched before World War II. Consequently, longitudinal studies of American veterans who served during this war are virtually nonexistent, especially in relation to health and mortality.

This research investigates the multifaceted nature of wartime experience and its mortality risks (based on death certificates) in a sample of veterans of World War II, with their diversity of military service. Stressful military experience most commonly refers only to exposure to combat, but war mobilization in World War II drew men into active military duty across a wide age range, from 18 to the late 30s or even later. We hypothesized that late entrants experienced more life disruption than early entrants and thus had a greater mortality risk in the long term. Service only on the homefront minimized this risk, whereas overseas duty increased it, most especially in the Pacific theater, and when it involved combat. To investigate these expectations, we turned to the Lewis Terman sample of California males who were born between 1900 and the 1920s.

The study members were recruited, along with females, for an investigation of talented young people. Launched in 1922, the sample extends across 13 waves of data collection, from 1922

to 1992. Approximately 38 percent of the men served in the armed forces of World War II. However, the archival data were not designed to investigate wartime experiences and their lifelong effects. To develop appropriate measures of wartime experiences, an extensive recoding of the life course and wartime data was carried out at the University of North Carolina, Chapel Hill, beginning in the mid-1980s. Of special relevance to this project are five measures of wartime experience that follow a nested design – the age at which men entered the military, service only on the home front, overseas military duty, the Pacific theater of service, and exposure to combat. Death dates and cause of death information, as well as personality variables and recodings of psychosocial data, were provided by Howard Friedman's research team at the University of California, Riverside.

This study, like all those based on long-term data archives, creates tension between ideal research models and reality. Options for design, measurement and sample size have been constrained by decisions made in different intellectual worlds. Nevertheless, these limitations are balanced by the true prospective design of the data, by careful measurement at each time point, and by relatively little attrition. Sample size restricted our measure of mortality to all causes, though we explored CVD and cancer as causes of death. The small sample size may also suggest only a tendency in a relationship. However, we have given priority to the patterning of the relationships and caution about their generalizability. The high-IQ sample and privileged background of the sample underscores this caution.

Three questions receive primary attention in the study, guided by a pathogenic model of the potential mortality risks stemming from wartime conditions. The first concerns the relative mortality risks of five wartime experiences. Do experiences other than combat exposure matter for a veteran's longevity? The second question concerns the effect of individual differences in the mortality risks for veterans. The veterans brought different life experiences to World War II which are known to affect longevity, and yet wartime conditions may have reduced their effect. Our third question concerns potential explanatory factors. In this category, we include level of education, mental health, and heavy alcohol use.

Consistent with our expectations, we find that a multi-faceted approach to war stressors adds significantly to our information on mortality risks – well beyond what we see in an assessment of combat exposure and its effects. The bigger picture focuses on military duty overseas, with emphasis on combat exposure and service in the Pacific. All three conditions have significant relative risks for mortality, with duty in the Pacific showing negative effects that exceed those of merely serving outside the U.S. Overseas duty in the high-risk region of the Pacific adds significantly to the risk of military service on the homefront. In addition, combat exposure increased the mortality risk of veterans in all overseas theaters.

Service on the homefront entailed only modest separations from family and job when compared to overseas duty. The former could visit family and friends, whereas overseas duty was typically for the war's duration. However, recruitment late in life (after age 30) also has no effect on a veteran's longevity, though we know it matters in terms of social strains (family separation, job dislocation) and has consequences for postwar health. Clearly, more study of the path from late mobilization to middle and later life is needed. Under what conditions do life disruptions, including divorce and re-employment problems, generate a sequence of negative events and chronic disease that has long-term consequences?

In addition to this research agenda, more information on the onset of impaired health would be helpful along with more precise descriptions of the type of impairment. The measure of physical health impairment used in the research is a trajectory that extends over several decades. It provides no clear time of onset, whether shortly after World War II or in later life (Elder, Shanahan and Clipp 1997). And it does not refer to a specific type of chronic impairment such

as diabetes or heart disease. This specificity would enable greater understanding of the mortality risk. Combat exposure entails a documented risk for post-traumatic stress disorder, life-threatening chronic disease, and physical disabilities.

We recognize that each measure of wartime experience represents a category of unspecified experiences. Homefront duty included a wide range of potential experiences, from geographic location of basic training to types of skill training. The full meaning of age at entry depended on the particular type of military regime. Overseas duty may have crossed the boundaries of diverse cultures and languages, each one marked by different military roles and health/mortality risks. Clearly, service in the Pacific theater posed far greater health and mortality risks than military duty in the European theater, and life circumstances within these theaters also varied widely. Lastly, exposure to combat may have varied widely in number and type of episodes and the cumulative amount of time on the battlefield. Knowledge of individual service histories and their exposure to the above risks would tell us much about lived experience on active duty and its consequences for longevity. Obviously, this is clearly only a preliminary step toward assessing war stresses and their mortality risks. The linking processes are largely unknown.

Veterans in the sample also brought diverse life experiences and attributes to their military service which had potential consequences for their well-being and longevity. We chose to focus on three factors that had consequences for the longevity of men who survived the war: a stable, intact family of origin; childhood conscientiousness (e.g. dependable); and adult neurosis. The number of broken families proved to be too small to investigate in the lives of veterans, and the other factors made no difference in the longevity of men who served in the Pacific. In terms of these factors, selection does not appear to account for our findings.

One of the major challenges of life course study is to identify factors which account for the persistent effect of early life experiences, such as war stress. This study focused on three: education of the men; their mental health or well-being in mid-life; and heavy drinking after World War II. Consistent with prior studies, level of education enhanced the longevity of veterans while heavy drinking shortened their life span. Mental health at mid-life made no significant difference either way. Only alcohol abuse helped to explain at least some of the effect of war stress on mortality risk. With heavy drinking in the model, the mortality risk of combat faded to insignificance. But as noted earlier, we don't know whether heavy drinking after the war was accentuated by battlefront experiences or whether it represents a pattern of behavioral continuity.

A thorough study of war-related stress in the lives and longevity of World War II veterans calls for more evidence on the events, social roles, and psychological patterns which connect wartime conditions to subsequent life situations and health trajectories, a life span that may extend across five or more decades. The suggestive effects of war stress on mortality warrant more research on the complex process through which they persist and impair longevity. A life course study of this process is overdue.

## Acknowledgments

This project links contributions from two research programs that have been working with and adding to the longitudinal data archive of the Terman Study, begun in the 1920s by Lewis Terman at Stanford University; the Carolina Life Course Program directed by Glen Elder since the mid-1980s; and the antecedents of mortality research directed by Howard Friedman, beginning in the early 1990s. With the assistance of multiple research grants (including NIMH Grant MH 41327), Elder's research group recoded portions of the Terman data to enable studies across the life course, but with emphasis on the impact of WW II experiences and on life patterns of health and illness. Friedman's research program has been supported by multiple research grants as well, beginning with Grant # AG08825 from the National Institute on Aging. Friedman's group has focused on creating reliable and valid measures of personality, collecting

and professionally coding the death certificates for Terman participants from counties around the country, and identifying how these and other psychosocial variables are related to health outcomes across the lifespan.

## Biographies

**Glen H. Elder, Jr.** is a University Research Professor of Sociology and Psychology at The University of North Carolina at Chapel Hill where he manages a research program on life course studies and directs an NIA training program on aging and the life course. His books (authored, co-authored, edited) include *Children of the Great Depression, Children in Time and Place, Methods of Life Course Research, and Children of the Land.* He is currently engaged in studies of pathways to higher education, military service, and work in young adulthood.

**Elizabeth C. Clipp** joined this project as a key collaborator at its beginning, but we lost her to cancer before the manuscript was revised in final form. Her collaboration with Elder dates back to the 1980s on studies of military experiences and health. As the Bessie Baker Professor of Nursing at Duke University, Clipp investigated the impact of early life events on health in later life, informal care giving in chronic illness, and care at the end of life.

**J. Scott Brown** is an Assistant Professor in the Department of Sociology and Gerontology and Research Fellow with Scripps Gerontology Center at Miami University. His research interests are focused on wealth and health inequalities across the life course with particular emphasis on gender and race differences in physical and mental health. His current projects include examinations of stratification in mortality and disability across socioeconomic status, race, and gender.

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**Howard S. Friedman** is Distinguished Professor of Psychology at the University of California, Riverside. Dr. Friedman is the recipient of the James McKeen Cattell Fellow Award from the Association for Psychological Science for outstanding career contributions. His research is focused on an archival prospective study of predictors and mediators of health and longevity. Friedman's recently edited book, *Foundations of Health Psychology* (Oxford University Press, 2007), was named a *CHOICE Magazine* Outstanding Academic Title for 2007.

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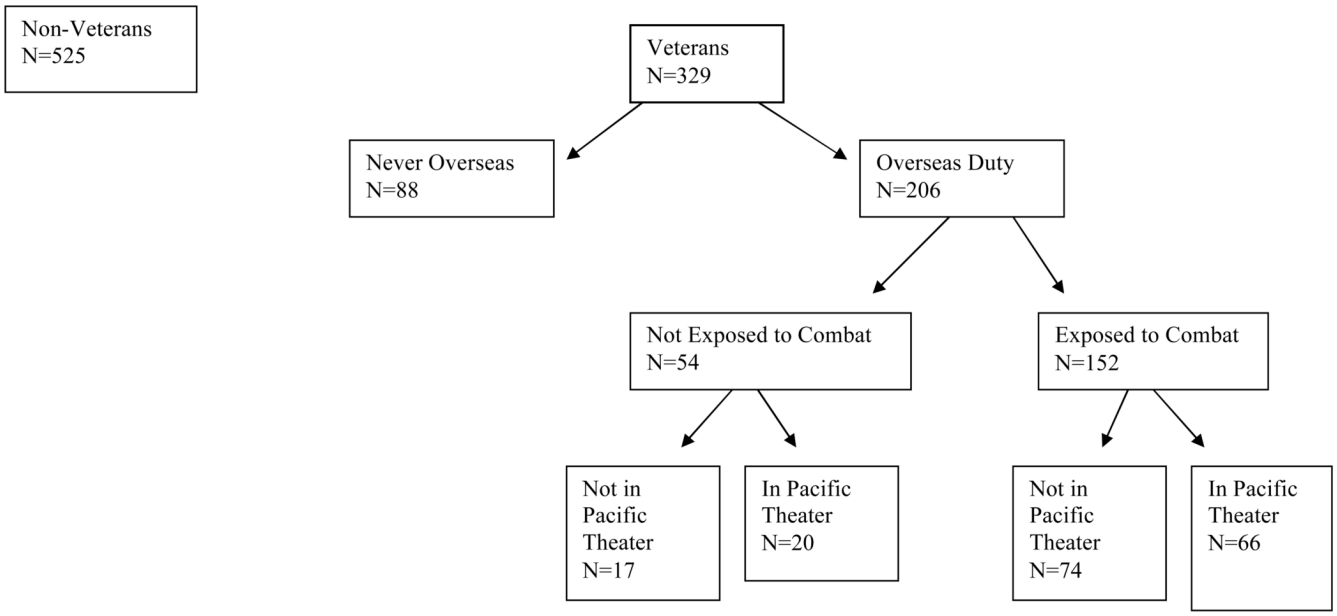


**Figure 1. Verified Subsamples of American Men At-Risk in World-War II[1]**

[1]These numbers represent the total who are *known* to be in each category; missing data in one category do not necessarily correspond with missing data in another category.

**Table 1**

Description of Measures

| Variable | N | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Active vs. non-active duty (329 vets; 525 non-vets) | 854 | .38 | .49 | 0 | 1 |
| Age at entry, months | 329 | 370.51 | 47.95 | 217 | 494 |
| Overseas duty (206 yes; 88 no) | 294 | .70 | .46 | 0 | 1 |
| Pacific theater duty (86 yes; 91 no) | 177 | .49 | .48 | 0 | 1 |
| Combat exposure (152 yes; 54 no) | 206 | .74 | .45 | 0 | 1 |
| Childhood conscientiousness | 665 | 20.60 | 2.84 | 30.82 | 12.71 |
| Adulthood neuroticism | 680 | 18.55 | 3.28 | 26.17 | 12.63 |
| Education level | 854 | 16.25 | 2.10 | 12 | 21 |
| Mental health status | 622 | .18 | .44 | 0 | 1 |
| Alcohol use | 647 | 1.83 | .61 | 1 | 3 |

**Table 2**

Cox Proportional Hazards Ratios of Risk of Death by Military Service Conditions[a]

| Military Service | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Active Duty | 1.03 | | | | | | | | |
| Age at Entry | | 1.00 | | | | | | | |
| Overseas Duty | | | 1.54* | | | 1.39* | 1.41* | | |
| Pacific Theater Duty | | | | 1.50* | | 1.48* | | 1.38+ | |
| Combat Exposure | | | | | 1.28+ | 1.29+ | | | 1.15 |
| *1950 Controls*[b] | | | | | | | | | |
| Education Level | | | | | | | 0.92+ | 0.90+ | 0.90+ |
| Mental Health Status | | | | | | | 1.00 | 0.99 | 1.03 |
| Heavy Alcohol Use | | | | | | | 1.59*** | 1.59** | 1.52** |
| Likelihood Ratio | 0.08 | 0.74 | 6.97** | 5.47* | 2.78+ | 18.74*** | 19.94*** | 19.02*** | 16.04** |
| Wald | 0.09 | 0.75 | 6.60* | 5.75* | 2.78+ | 18.22*** | 19.64*** | 19.25*** | 16.00** |
| N | 854 | 329 | 294 | 177 | 206 | 177 | 231 | 138 | 150 |

+ $p<.10$,

* $p<.05$,

** $p<.01$,

*** $p<.001$

[a] Samples for Models 2, 3, and 7 are sub-samples from Model 1. Samples from Models 4, 5, 8, and 9 are sub-samples from Model 3. For example, 329 of the 854 total respondents indicated active military service, and of these 294 have information on overseas status (206 overseas, 88 not overseas, 35 missing). Interpretations of the hazards ratios from each model should be adjusted accordingly.

[b] Because it is possible that some of the change in risk shown in Models 7, 8, and 9 is due to the reduced sample size (vs. the inclusion of the controls), each war experience predictor was also tested alone in the reduced subsample; in each case the risk associated with the war experience predictor was nearly identical.