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# Combat Exposure, Posttraumatic Stress Disorder Symptoms, and Health Behaviors as Predictors of Self-Reported Physical Health in Older Veterans

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We used path analysis to model the effects of combat exposure, posttraumatic stress disorder (PTSD) symptoms, and health behaviors on physical health. Participants were 921 male military veterans from the Normative Aging Study. Their mean age at time of study was 65. Measures of combat exposure, PTSD symptoms, smoking, and alcohol problems were used to predict subsequent self-reported physical health status. Both combat exposure and PTSD were correlated with poorer health. In path analysis, combat exposure had only an indirect effect on health status, through PTSD, whereas PTSD had a direct effect. Smoking had a small effect on health status but did not mediate the effects of PTSD, and alcohol was unrelated to health status. We conclude that PTSD is an important predictor of physical health and encourage further investigation of health behaviors and other possible mediators of this relationship.
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Studies of trauma survivors consistently show that exposure to a traumatic event is associated with increased risk of negative psychological outcomes, especially posttraumatic stress disorder (PTSD; *e.g.*, Kessler et al., 1995; Kulka et al., 1990). Perhaps less widely recognized is the fact that trauma is associated with poor physical health as well. A qualitative literature review concluded that trauma is linked to poor self-reported health, and greater medical service utilization, morbidity, and mortality (Friedman and Schnurr, 1995). For example, among members of a large health maintenance organization, childhood trauma was associated with increased likelihood of a variety of disorders, including ischemic heart disease, stroke, cancer, and chronic bronchitis and emphysema (Felitti et al., 1998). A longitudinal study of male World War II (WWII) veterans found that combat was linked to physical decline or death during early to middle adulthood, although not during later life (Elder et al., 1997). Another longitudinal study of WWII veterans reported that heavy combat exposure was associated with increased likelihood of death or chronic illness before age 65 (Lee et al., 1995).

Discussing potential explanations for these relationships, Friedman and Schnurr (1995) noted that injury resulting directly from traumatic exposure accounts for only a small proportion of the observed relationship between trauma and physical health because most trauma survivors are not physically injured. They proposed that PTSD, as a *reaction* to a traumatic event, was likely to be an important mediator of trauma's effects on health and presented path analytic findings on female Vietnam veterans in support of their proposal. Additional evidence of PTSD as a mediator of the relationship between trauma and poor health comes from data collected in the National Vietnam Veterans Readjustment Study (Kulka et al., 1990). Using path analysis, Taft and colleagues (1999) replicated Friedman and Schnurr's findings in female veterans and extended them to male veterans.

Friedman and Schnurr (1995) reviewed biological, psychological, and behavioral correlates of PTSD that could explain the relationship between PTSD and health. They suggested that the best-documented biological abnormalities associated with PTSD—enhanced cardiovascular reactivity, autonomic hyperarousal, disturbed sleep physiology, adrenergic dysregulation, enhanced thyroid function, and altered HPA activity—would increase risk

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for a number of medical illnesses. Psychological factors included depression, hostility, and poor coping. Behavioral factors included health risk behaviors such as smoking and alcohol abuse. The link between PTSD and increased prevalence of alcohol abuse is well-known (*e.g.*, Kulka et al., 1990; Stewart, 1996), but PTSD also is associated with increased likelihood of smoking (Beckham et al., 1995; Falger et al., 1992; Shalev et al., 1990).

We are currently studying relationships among trauma, PTSD, and physical health outcomes in older military veterans by building upon our program of research on the role of military service in the lives of men who are participating in the Department of Veterans Affairs (VA) Normative Aging Study (NAS; Spiro et al., 1997). The NAS is a longitudinal project begun in 1963 to study aging in 2280 healthy men, 95% of whom are veterans. Participants are assessed every 3 to 5 years by interview and physical exam and periodically by questionnaire. Additionally, they are assessed at irregular intervals for various special projects. The NAS provides an opportunity to study PTSD in a community-residing sample of older male veterans, especially regarding issues of physical health and of military service. In a previous study of NAS participants, we found that 54% of the WWII veterans and 19% of the Korean conflict veterans had served in combat (Spiro et al., 1994). PTSD prevalence according to the Mississippi Scale for Combat-Related PTSD (Keane et al., 1988) was roughly 1% among combat veterans, which is extremely low in comparison with prevalence in younger cohorts (Kulka et al., 1990) but comparable to the 2% PTSD prevalence observed in another community-residing sample in which older men comprised virtually all of the combat group (Norris, 1992).

To our knowledge, only two studies have examined the relationship between PTSD and physical health in an older population. In one, which focused on men who had served in the Dutch resistance during WWII, PTSD was associated with a history of angina (Falger et al., 1992). In the other study, which focused on male military veterans who sought medical treatment from the VA, PTSD was associated with reports of chest pain and arthritis but not utilization (Hankin et al., 1996).

The current project examined the association between PTSD and physical health in older veterans by using path analysis to delineate the relative contributions of trauma, PTSD, and health behaviors to the health status of NAS participants. The hypothesized path model included: a) paths from combat exposure, PTSD, smoking, alcohol problems, and age (a covariate) to a measure of health status; b) a path from combat exposure to PTSD; and c) paths from PTSD to smoking and alcohol problems. Our primary objective was to test the hypothesis that PTSD predicts poor health. We also examined the extent to which PTSD accounts for the relationship between combat and poor health, and, in turn, the extent to which smoking and alcohol abuse account for the relationship between PTSD and poor health. Health behaviors such as smoking and alcohol abuse have traditionally been treated as variables to be controlled when examining relationships between psychiatric disease and health (*e.g.*, Hayward, 1995). Our focus on the role of health behaviors as potential mediators of the health effects of PTSD provides an alternate perspective.

Physical health status was measured with a self-report questionnaire, the SF-36 (Ware et al., 1993), which has excellent reliability and validity for measuring physical health (McHorney et al., 1993). Nevertheless, concerns have been raised about the influence of psychological factors on self-reported health. For example, Watson and Pennebaker (1989) concluded that negative affectivity (neuroticism) substantially accounts for observations of a relationship between everyday stress and health. Friedman and Schnurr (1995) noted that Watson and Pennebaker found that negative affectivity is related only to self-reported symptoms and not to morbidity, mortality, utilization, or disease risk factors—a pattern that stands in contrast to that observed for trauma and PTSD. Nevertheless, we controlled for the effects of psychological factors in our analyses by using the SF-36 in a manner that adjusts for mental health status (Ware et al., 1995).

## Methods

### *Participants*

Participants were drawn from the Boston VA Normative Aging Study. At study entry, NAS men were of slightly higher socioeconomic status than the US population (Bossé et al., 1984). However, their scores on measures of personality and mental health are comparable to population norms (Butcher et al., 1991; Spiro et al., 1994).

In February 1990, the 1778 active NAS members received a mailed questionnaire about their military service experiences. Over 80% responded. Respondents who served in either WWII or the Korean conflict were generally similar to nonrespondents on a number of factors, including combat exposure and the MMPI clinical and validity scales, as well as the MMPI PTSD Scale (Spiro et al., 1994). Of the 1210 men studied by Spiro et al., 1009 responded to a 1992 survey that included questions about physical health and health behaviors. Almost 20% of the 201 nonrespondents had died, but other reasons for nonresponse are unknown. The present sample consists of the 921 men who responded to both the 1990 and 1992 surveys and who had complete data on the measures described below. These 921 men, who represent 76.1% of Spiro et al.'s original sample, did not differ significantly from the 289 excluded men on measures of either demographic status or military service.

### *Measures and Procedure*

The 1990 mail survey included measures of PTSD and combat exposure that have been shown to have very good reliability and validity: for *PTSD symptoms*, the Mississippi Scale for Combat-Related PTSD (Keane et al., 1988), and for *combat exposure*, the Combat Exposure Scale (Keane et al., 1989). Each yields a continuous score, with higher scores reflecting higher PTSD symptom levels and greater degrees of combat exposure, respectively. The possible range of scores is 35 to 175 on the Mississippi and 0 to 41 on the Combat Exposure Scale. Although the Mississippi and the CES were developed on samples of Vietnam veterans, these scales perform well in older veterans (Engdahl et al., 1996; Hyer et al., 1996; Spiro et al., 1994).

Data on health behaviors and health status were collected in a 1992 mail survey. Health behaviors were *current smoking*, measured dichotomously (0 = no, 1 = yes), and *alcohol problems*, measured by the CAGE (Ewing, 1984). CAGE scores range from 0 to 4, with scores of 2 or higher typically used to indicate a likely alcohol disorder (Buchsbaum et al., 1992).

The SF-36 (Ware et al., 1993) was administered in the 1992 mail survey. The SF-36 is a 36-item questionnaire that consists of four scales that primarily reflect physical health (physical functioning, role limitations due to physical problems, pain, and general health perceptions) and four scales that primarily reflect mental health (vitality, social functioning, role limitations due to emotional problems, and mental health). Scores on each scale range from 0 to 100, with higher scores indicating better health. We assessed *physical health* with the Physical Component summary score (Ware et al., 1995), which was developed to aggregate the information in the eight scales into a single index that is orthogonal to a Mental Component summary score that also may be computed from the scales. An important feature of the Physical Component is that it is adjusted for the influence of mental health status. Specifically, before summation, raw scores are converted to $z$-scores using normative data and coefficients are applied as follows: physical functioning (.42402), role limitations due to physical problems (.35119), pain (.31754), general health perceptions (.24954), vitality (.02877), social functioning (−.00753), role limitations due to emotional problems (−.19206), and mental health (−.22069). Thus computed, the physical component is a highly valid indicator of physical health status (Ware et al., 1995).

### *Data Analysis*

We performed path analysis using LISREL 8.14 to analyze a covariance matrix for the measures described above. Path coefficients were estimated using maximum likelihood and are presented in standardized form to facilitate comparisons among paths. Assessment of model adequacy and subsequent model modification were performed as suggested by Bollen (1989) and Jöreskog (1993). We controlled for the effect of age by including it in path analysis as a predictor of health status.

## Results

Most of the 921 men were white (99%; $N$ = 875), married (93%; $N$ = 845), and had graduated high school (90%; $N$ = 818). Their mean age at the time of the military survey in 1990 was 65.35 years (SD = 6.32; range = 50 to 85 years). Slightly more than half (55%; $N$ = 489) had been employed in a blue-collar job at study entry. In 1990, 50% were retired ($N$ = 447), 49% were working full or part-time ($N$ = 443), and < 1% ($N$ = 8) were unemployed. Sixty-seven percent ($N$ = 620) served in WWII and 33% ($N$ = 301) served in the Korean conflict. (The sample size was slightly less than 921 for some of the demographic variables.)

Table 1 illustrates how the five predictors (combat exposure, PTSD, current smoking, and alcohol problems, plus the covariate, age) were related to the SF-36 scales that comprise the physical component. Combat exposure was weakly related to only one of the eight scales, pain. Smoking and alcohol problems were related to several scales, but the correlations were small. In contrast, PTSD was related to all scales, with higher PTSD scores correlated with poorer physical and mental health. Note that mean SF-36 scores were roughly .5 SD or higher (healthier) than normative scores for men age 65 to 69 (Ware et al., 1993).

Table 2 presents the correlation matrix and means and standard deviations for all variables included in path analysis. The average amount of combat exposure in the sample was low. Among the 394

TABLE 1
*Bivariate Correlations among Predictors and SF-36 scales* (N = 921)

| SF-36 Scale | Mean (SD) | Age in 1990 | Combat exposure[a] | PTSD symptoms[b] | Current smoking[c] | Alcohol problems[d] |
|---|---|---|---|---|---|---|
| Physical functioning | 82.79 (19.88) | −.25*** | −.04 | −.24*** | −.06 | −.03 |
| Role—physical | 69.66 (37.39) | −.25*** | −.04 | −.25*** | −.03 | −.07* |
| Pain | 79.21 (21.12) | −.05 | −.07* | −.27*** | −.08* | −.05 |
| General health perceptions | 69.27 (18.22) | −.06 | −.06 | −.34*** | −.12*** | −.09** |
| Vitality | 67.85 (18.32) | −.13*** | −.01 | −.29*** | −.07* | −.07* |
| Social functioning | 91.97 (16.97) | −.15*** | −.06 | −.22*** | −.05 | −.02 |
| Role—emotional | 89.78 (24.09) | −.05 | −.01 | −.19*** | −.06 | −.05 |
| Mental health | 85.14 (12.81) | .03 | .02 | −.35*** | −.07* | −.12*** |

[a]Keane Combat Exposure Scale.
[b]Mississippi Scale for Combat-Related PTSD.
[c]Yes = 1, no = 0.
[d]CAGE scale.
*$p < .05$; **$p < .01$; ***$p < .001$.

combat veterans (43% of the sample), the average amount of combat exposure was moderate (14.39, SD = 10.09), however, and 17% ($N$ = 67) had experienced heavy combat. Few of the participants (9%; $N$ = 80) were current smokers, and the average number of alcohol problems was .58; 16% ($N$ = 150) had a score indicating a history of problem drinking (2 or higher on the CAGE).

Only 5 men (< 1%) had a PTSD score higher than the cut point of 89, which appears to have good sensitivity and specificity for a PTSD diagnosis in community samples (Kulka et al., 1990). It is therefore important to remember that the following analyses examine how health status relates to PTSD symptoms, and not the disorder.

The fit of the initial model, reflecting the hypothesized relationships described above, was inadequate, $\chi^2(6) = 42.83$, $p < .001$, adjusted goodness of fit index (AGFI) = .95, nonnormed fit index (NNFI) = .66. We improved the fit first by setting to zero two nonsignificant ($p > .05$) paths leading from combat and from alcohol problems to physical health. Neither of these changes significantly worsened the fit of the model. We also examined modification indices for fixed paths. Three were quite large (> 6.0): from combat to smoking, from age to smoking, and from age to alcohol problems. Because these were plausible associations, we freed the three paths in the final model, which resulted in a significant improvement in model fit at each step. (Further information about the intermediate models is available from the first author.)

The final path model is depicted in Figure 1. The fit of this model ($\chi^2[5] = 8.59$, $p = .13$, AGFI = .99, NNFI = .96) was significantly better than the fit of the initial model, $\Delta\chi^2(1) = 34.27$, $p < .001$. Combat exposure was positively related to current smoking and to PTSD symptoms, as shown in Figure 1. The total effect of combat on physical health status was −.06 ($p < .05$), indicating that greater combat exposure was related to poorer health. Of this total effect, 90% was accounted for through PTSD and 10% through smoking and from PTSD through smoking. As noted above, the direct path of combat to physical health was not statistically significant and was removed from the model to improve fit.

Figure 1 shows that there was a direct effect of PTSD symptoms on physical health. Higher PTSD scores were associated with poorer heath status. As expected, higher PTSD scores predicted both increased likelihood of current smoking and number of alcohol problems, but these health behaviors did not account for the relationship between PTSD and physical health. There was a small but statistically significant path from smoking to physical health, with smoking predicting poorer health status, but the path from alcohol problems to health was not significant and was removed from the final model to improve fit. Contrary to expectation, the indirect effect of PTSD on health through smoking did not account for meaningful amount of variance. Of the total effect of PTSD on health (−.26, $p < .001$), less than 2% was indirect through smoking.

As expected, older age was related to poorer health status. Older age also was related to decreased likelihood of smoking and fewer alcohol problems.

## Discussion

We found that combat exposure and PTSD symptoms longitudinally predicted self-reports of poor health status among older male veterans. We also found that PTSD symptoms were associated with increased likelihood of smoking and number of alcohol problems, and that smoking was associated

TABLE 2
*Means, Standard Deviations, and Correlation Matrix for Variables in a Path Model to Predict Self-Reported Physical Health (N = 921)*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1) Age in 1990 | 1.000 | | | | | |
| 2) Combat exposure[a] | .242*** | 1.000 | | | | |
| 3) PTSD symptoms[b] | .060 | .222*** | 1.000 | | | |
| 4) Smoking[c] | −.105** | .075* | .087** | 1.000 | | |
| 5) Alcohol problems[d] | −.144*** | −.050 | .112*** | .060 | 1.000 | |
| 6) Physical health[e] | −.225*** | −.067* | −.273*** | −.066* | −.055 | 1.000 |
| Mean | 65.346 | 6.156 | 57.294 | .087 | .580 | 46.927 |
| SD | 6.314 | 9.706 | 9.617 | .282 | 1.002 | 9.572 |

[a]Keane Combat Exposure Scale.
[b]Mississippi Scale for Combat-Related PTSD.
[c]Yes = 1, no = 0.
[d]CAGE scale.
[e]SF-36 physical component.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

with poor health. Path analysis revealed that the effect of combat exposure on health status was indirect, mostly because of the positive association between combat and PTSD, whereas the effect of PTSD on health status was direct. Smoking did not account for a significant amount of the relationship between PTSD symptoms and health.

The finding that PTSD symptoms were associated with self-reports of poor health status is consistent with a growing body of literature on the health consequences of PTSD. Although most studies have focused on self-reported health status and physical symptoms (*e.g.*, Kulka et al., 1990), there is some evidence that PTSD is associated with increased cardiovascular morbidity (Falger et al., 1992; Shalev et al., 1990). There are no published data on the comorbidity of PTSD and other medical conditions, as diagnosed by exam or laboratory tests. However, Boscarino (1997) recently reported a study of Vietnam veterans in which PTSD was related to increased likelihood of a variety of self-reported chronic conditions, including circulatory, digestive, musculoskeletal, nervous system, and respiratory categories.

The bivariate correlation between combat exposure and physical health status was statistically significant but small. Although other investigators have reported more substantial correlations between

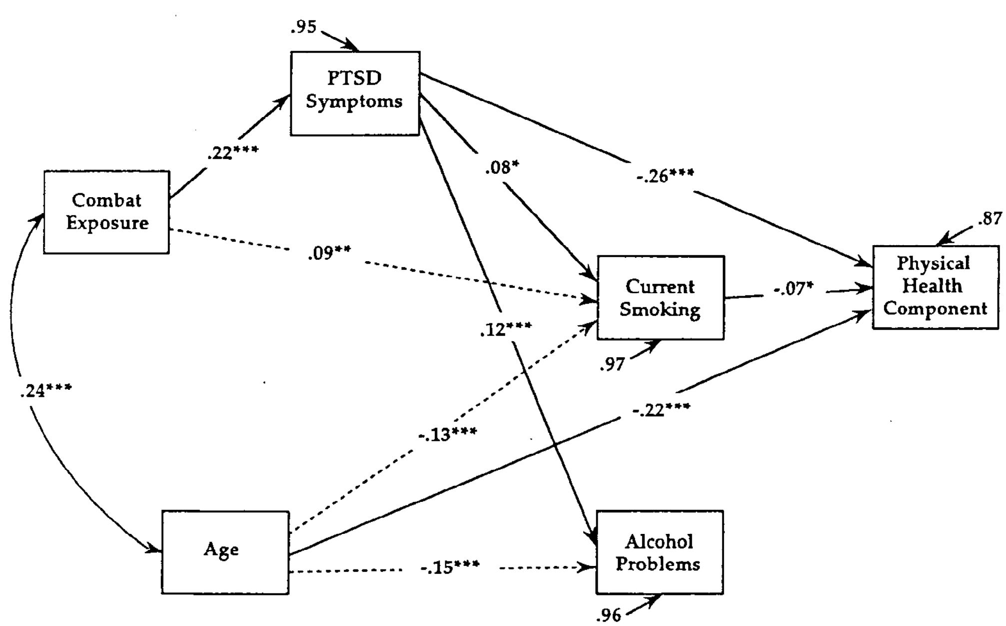


FIG. 1. Final path model to predict physical health as a function of combat exposure, PTSD symptoms, and health behaviors. Solid lines indicate hypothesized paths, and dashed lines indicate paths added to improve model fit. Path coefficients are reported in standardized format. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

trauma and adverse physical health outcomes (see Friedman and Schnurr, 1995), our findings are not surprising in light of data from a different sample of older veterans. Elder and colleagues (1997) reported that WWII combat was associated with increased morbidity and mortality only from 1945 to 1960, and not thereafter—which is when the present study began. We may have failed to find substantial effects of combat in our sample because the majority of participants were WWII veterans assessed long after the period of greatest risk.

Our path analytic finding showing that combat exposure was associated only indirectly with poor health status, primarily through PTSD symptoms, is compatible with the view that the effects of stressors on health are mediated by distress reactions (Cohen and Williamson, 1991). In other words, reactions to stressors, *e.g.*, posttraumatic symptoms in response to combat exposure, are in a sense the "active ingredients" leading to poor health after exposure.

The effect of PTSD symptoms on health that was accounted for by smoking was small compared with the substantial direct effect of PTSD. Our use of a dichotomous smoking measure, and of other measures, was constrained by their availability in the NAS archive. Had we been able to measure smoking as a continuous variable, *e.g.*, as pack-years, we might have detected a greater mediating role because amount of smoking is correlated with PTSD severity (Beckham et al., 1995). Nevertheless, investigators have observed strong relationships between PTSD and poor health outcomes when controlling for pack-years (Beckham et al., 1998; Boscarino, 1997), so it is unlikely that our dichotomous measure significantly biased our results.

Like Elder et al. (1997) in their study of a select group of WWII veterans, we failed to find an association between alcohol abuse and physical health. We did not anticipate this failure because alcohol abuse is a known risk factor for many serious health problems (*e.g.*, National Institute on Alcohol Abuse and Alcoholism, 1981). One possible explanation is the measure we used. The CAGE (Ewing, 1984) is widely employed for screening and has good sensitivity and specificity for alcohol disorders in the elderly (Buchsbaum et al., 1992), but it does not perform as well as longer instruments (Magruder-Habib et al., 1992). Also, the CAGE is a measure of lifetime problems; a measure of current or recent problems, or number of drinks per day, may be more strongly related to health status in a relatively brief time frame such as the 2 years in this study.

In addition to the aforementioned limitations, another methodological issue is our reliance on self-reports. Even though we used a measure that addresses the problem of mental health status affecting reports of physical health (Ware et al., 1995), we acknowledge that self-reports are not the same as physical exams or laboratory tests. A further methodological issue is the relatively healthy nature of the sample. The relatively low level of PTSD symptoms and the small number of men with PTSD in this sample might have attenuated the observed correlations. With respect to physical health, potential participants with preexisting physical illnesses were excluded from the NAS at study entry in the 1960s because the NAS was intended to be a naturalistic study of aging in initially healthy men. A related issue is the fact that we are studying men who were healthy enough to survive long enough to be included in the present investigation. Both of these factors may have attenuated our ability to detect all of the expected relationships. Another issue is that we examined the effects of combat exposure only, and not of other trauma. Our rationale was that the PTSD measure we used, the Mississippi Scale for Combat-Related PTSD (Keane et al., 1988), is specific to military trauma. It would be useful for future research to employ measures of trauma and of PTSD that are sensitive to both military and non-military trauma.

The most significant methodological limitation of the study is the nonexperimental nature of the data. Neither this, nor any existing study, provides concrete evidence that PTSD causes poor health. All we have demonstrated is that PTSD symptoms at one point in time were associated with subsequent health status 2 years later. Our findings on PTSD are not unique in this regard; all data on the physical health correlates of psychiatric disorder (*e.g.*, Hayward, 1995) are only suggestive of a causal relationship.

## Conclusions

PTSD may be distinctive among psychiatric disorders in terms of its effects on health. Friedman and Schnurr (1995) discuss three domains associated with PTSD that might lead to adverse health effects: *biological* (autonomic hyperarousal, altered HPA activity, cardiovascular reactivity, disturbed sleep physiology, adrenergic dysregulation, and enhanced thyroid function), *psychological* (depression, coping, and hostility), and *behavioral* (smoking, alcohol abuse, and other health behaviors). The potential distinctiveness of PTSD is not that any of these correlates is specific to PTSD (except the pattern of altered HPA activity; Yehuda et al., 1995) but that their combined effects could lead to increased risk of poor health.

We recommend that future research address the question of the mediational role of health behaviors in the relationship between PTSD and physical health. Although we did not find evidence that health behaviors mediate the relationship between PTSD symptoms and physical health, caution is warranted in making generalizations from our data. The poor health behaviors associated with PTSD may play a role in health outcomes in a less select (*i.e.*, healthy) population. It is likely that some combination of biological, psychological, and behavioral factors accounts for the observed health effects of PTSD.

This study increases knowledge about the multifactorial sequelae of posttraumatic reactions that occur among aging men. An important next step is to further extend this knowledge through longitudinal study of health trajectories (*e.g.*, Elder et al., 1997) and by examining cohort differences in reactions to traumatic events.

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