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Post-Traumatic Stress Disorder is Associated With Poor Health Behaviors: Findings From the Heart and Soul Study

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Abstract

Objective—Posttraumatic stress disorder (PTSD) results in substantial disability, including increased risk of cardiovascular disease (CVD). Poor health behaviors are major risk factors for initial and recurrent CVD events. Therefore, this study investigated whether PTSD is associated with poor health behaviors in patients with CVD.

Method—Cross-sectional study of 1,022 men and women with CVD. PTSD was assessed with the Computerized Diagnostic Interview Schedule for *DSM–IV*. Physical activity, medication adherence and smoking history were determined by self-report questionnaires. Multivariate logistic and linear regression models were used to evaluate the association of PTSD with health behaviors.

Results—Of the 1,022 participants, 95 (9%) had PTSD. PTSD was associated with significantly higher rates of physical inactivity in terms of overall exercise (*OR* 1.6, 95% CI [1.0–2.6]; $p = .049$), light exercise (*OR* 1.7, 95% CI [1.0–2.9]; $p = .045$), and self-rated level of exercise compared to others of their age and sex (*OR* 1.8, 95% CI [1.0–3.0]; $p = .047$). Participants with PTSD were more likely to report medication nonadherence, including forgetting medications (*OR* 1.8, 95% CI [1.0–3.3]; $p = .04$) or skipping medications (*OR* 1.7, 95% CI [1.1–2.9]; $p = .03$). Participants with PTSD also reported a greater smoking history (β 6.4 pack years, 95% CI [1.8–10.9]; $p = .006$), which remained significant after adjustment for depression and income.

Conclusions—Among patients with heart disease, those with PTSD were more likely to report physical inactivity, medication nonadherence and smoking. The majority of these associations were explained by adjustment for comorbid depression and lower income.

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Keywords

posttraumatic stress disorder; health behaviors; smoking; physical activity; medication adherence

Though posttraumatic stress disorder (PTSD) is an illness commonly known for its impact on mental health, it is increasingly recognized as a disorder that is associated with poor physical health as well (Heppner et al., 2009; Hoge et al., 2004; Kessler, 2000; Kross, Gries, & Curtis, 2008). Veterans with PTSD have been found to have a higher lifetime prevalence of circulatory, digestive, musculoskeletal, nervous system, respiratory and infectious diseases (Boscarino, 1996; Andersen, Wade, Possemato, Ouimette, 2010). In particular, PTSD has been shown to be a major risk factor for cardiovascular disease (CVD), with studies finding that patients with PTSD are at increased risk of myocardial infarction and CVD death (Boscarino, 2006; Kang, Bullman, & Taylor, 2006; Kubzansky, Koenen, Jones, & Eaton, 2009; Kubzansky, Koenen, Spiro, Vokonas, & Sparrow, 2007).

PTSD can impact physical health through several potential pathways. Schnurr and Green (2004) have created a conceptual framework describing psychological, biological, behavioral, and attentional mechanisms by which PTSD might lead to adverse physical health outcomes. The psychological effects of PTSD include dissociation and the development of avoidant coping strategies, which may result in delayed seeking of health care. PTSD might also act via biological mechanisms, leading to physiological changes such as excess sympathetic activity and disruption of the hypothalamic-pituitary-adrenal axis that may directly damage the cardiovascular system and cause atherosclerosis (Kubzansky & Koenen, 2009; McEwen, 2003). This study focuses on the association between PTSD and health behaviors, which plays a particularly important role in the development and progression of CVD (Whooley et al., 2008). For example, lower physical activity is one of the strongest predictors of future CVD events and death in patients with existing heart disease (Lavie, Thomas, Squires, Allison, & Milani, 2009). Medication adherence is critical for control of CVD risk factors, such as diabetes, high blood pressure, and dyslipidemia, and nonadherence predicts cardiovascular events (Gehi, Ali, Na, & Whooley, 2007). Finally, smoking causes CVD events through atherosclerosis of the coronary arteries, dyslipidemia, and increased thrombosis.

Several studies have demonstrated that patients with PTSD have increased rates of tobacco and illicit substance use, but other health behaviors have received less attention (Feldner, Babson, & Zvolensky, 2007; Jacobsen, Southwick, & Kosten, 2001). Few studies have looked at exercise patterns in patients with PTSD. Those that have been published did not compare physical activity habits of patients with PTSD to a control sample without PTSD and/or had a sample size too small to draw conclusions about the association between PTSD and exercise (Buckley, Mozley, Bedard, Dewulf, & Greif, 2004; de Assis et al., 2008). Medication adherence may also be lower in PTSD, but this has only been studied in pediatric transplant patients and patients with recent myocardial infarction (Shemesh et al., 2001; Shemesh et al., 2004). In addition, the association of PTSD with these health behaviors has not been examined in patients with stable CVD, a population at highest risk for future CVD events.

In this study, data was collected from a diverse cohort of 1,022 patients with stable CVD to investigate the association of PTSD with physical activity, medication adherence, and smoking. The hypothesis was that PTSD would be associated with a higher incidence of poor health behaviors. Understanding the association of PTSD and health behaviors can lead to new avenues to reduce CVD morbidity and mortality and improve the long-term health of the growing number of individuals living with PTSD.

Method

The Heart and Soul Study is a prospective cohort study designed to examine the association between mental health disorders and cardiovascular events in adults with stable CVD. Detailed methods of the study have been described previously (Ruo et al., 2003) and are summarized briefly below.

Participants

Participants were 1,024 adults with CVD recruited from San Francisco area hospitals and clinics, including 838 men, 186 women; 615 white, 409 other ethnicities (please see Table 1 for additional sample demographics). Participants were eligible for the study if they had a history of myocardial infarction, angiographic evidence of stenosis of 50% or greater in one or more coronary vessels, evidence of prior exercise-induced ischemia by treadmill or nuclear testing, a history of coronary revascularization, or a diagnosis of coronary artery disease documented by an internist or cardiologist. Potential participants were excluded if they had a history of myocardial infarction in the past six months (treadmill test contraindicated), they were unable to walk one block (could not complete treadmill test), or they were planning to move out of the local area within three years. Recruitment was open to non-English speaking participants, and in-person oral translation of forms and interview questions was available for those who did not identify English as their primary language. All participants spoke English, but 16 participants identified a non-English language as their primary language (nine Spanish, six Russian, and one Man-darin).

Procedures

Outpatients with documented CVD were identified from hospital and clinic administrative databases. A total of 15,438 of these patients were mailed an invitation to participate in the study, and 2,495 responded that they would be interested. After attempting to contact the respondents by phone, 596 declined to participate and 505 could not be reached. An additional 370 met the exclusion criteria described above. The remaining 1,024 patients enrolled in the study and completed baseline examinations between September 2000 and December 2002 that included a structured psychiatric interview, a questionnaire packet, fasting blood draw, echocardiogram, and exercise treadmill test. All participants provided written informed consent after reviewing detailed consent forms and having the opportunity to ask questions of the study staff. The research protocol was approved by the institutional review boards at participating institutions. Out of the 1,024 participants who completed baseline examination, two did not complete PTSD assessments, leaving a total of 1,022 participants for this analysis.

Measures

PTSD—PTSD was evaluated with the Computerized Diagnostic Interview Schedule for *DSM–IV* (CDIS), a validated, computer-based interview administered by trained research personnel, (Robins, Slobodyan, Marcus, et al., 1999) which assesses PTSD based on criteria outlined in the Diagnostic and Statistical Manual IV (APA, 2000). Staff attended a 4-day CDIS training session that included observed interviews to standardize administration. The CDIS has been widely used in epidemiologic studies, has shown good sensitivity compared to gold standard clinical interviews for PTSD, and has shown good concordance among clinical and lay interviewers (Breslau, Peterson, Kessler, & Schultz, 1999; Kulka et al., 1988). In our study, the CDIS PTSD symptom questions showed good internal consistency (Cronbach's alpha = .84). Out of the 1,022 participants, 95 were classified as having current PTSD, as they had symptoms meeting PTSD criteria in the last year.

Physical activity—Physical activity was evaluated with five-items. To evaluate overall activity, participants were asked how often in the last month they performed 15–20 minutes of exercise. Participants chose from one of the following six categories: not at all active, a little active (1–2 times per month), fairly active (3–4 times per month), quite active (1–2 times per week), very active (3–4 times per week) and extremely active (5 or more times per week). Specific types of exercise were evaluated by asking how often in the last month participants engaged in 15–20 minutes of light, moderate, or heavy exercise, with examples provided for these categories. Participants chose from one of four responses: not at all, less than once per week, 1–2 times per week, and 3 or more times per week. Finally, participants were asked to rate their physical activity levels compared to others of their age and sex. Participants rated themselves as much less active, somewhat less active, about the same, somewhat more active, or much more active. These items demonstrated good internal reliability (Cronbach's alpha = .75).

As responses were not normally distributed and several categories had very few responses, the physical activity items were dichotomized. For the overall activity question, those who reported being not at all active or a little active were considered "inactive," while those who were fairly active, quite active or very active were "active." This dichotomous classification has been used in previous Heart and Soul studies and was found to be a strong, independent predictor of further CVD events (Whooley et al., 2008). In addition, those who participated not at all or less than once per week for a particular level of exercise were categorized as "inactive" for that level of activity, while all other participants were considered "active." Finally, participants who considered themselves much less active or somewhat less active compared to others were categorized as "inactive." To validate these classifications, we compared exercise treadmill scores in those classified as inactive versus active. We found that inactive participants had significantly lower treadmill scores, indicating worse performance ($p < .001$ for each of the five physical activity questions).

Medication adherence—Medication adherence was assessed with a standardized questionnaire. Participants were asked, "In the past month, how often did you forget to take one or more of your prescribed medications?" Possible responses were never, once in the last month, 2 to 3 times in the last month, about once per week, several times per week, or *nearly every day*. Based on prior analyses from this cohort, we defined nonadherence as forgetting to take medications once per week or more (Gehi et al., 2007). Participants were also asked "Overall, in the past month, how often did you take your medications as the doctor prescribed?" Possible responses were *less than half of the time, about half of the time* (50%), *most of the time* (75%), *nearly all of the time* (90%), and *all of the time*. As in prior analyses, nonadherence was defined as 75% of the time or less (Gehi, Haas, Pipkin, & Whooley, 2005; Gehi et al., 2007). Finally, they were asked how often they decided to skip one or more of their prescribed medications, with possible responses being never, once in the last month, 2 to 3 times in the last month, about once per week, several times per week, and *nearly every day*. Participants who reported skipping medications 2 to 3 times in the last month or more were classified as nonadherent. This differs from the classification of about once per week or greater as nonadherent in a prior analyses of depression and medication nonadherence as there were too few participants in the PTSD group meeting this criteria given the relatively smaller number of participants with PTSD (Gehi et al., 2005).

Smoking—To assess current smoking, participants were asked, "Do you currently smoke cigarettes?" with possible responses being *yes* or *no*. Duration of smoking was assessed by asking participants, "How many years have you or did you smoke cigarettes?" Possible responses were 0, 1-10, 11-20, 21-30, or greater than 30. Finally, participants were asked, "How many packs of cigarettes do you or did you usually smoke during those years?" Participants could choose: less than 1/2 pack per day, more than 1/2 pack per day but less

than 1 pack per day, more than 1 pack per day but less than 2 packs per day, or more than 2 packs per day. Participants were divided into three categories: *current smokers, former smokers, and never smokers*. Mean pack years for smoking was calculated by multiplying the mean for the number of years smoked by the mean for the number of packs smoked per day.

Covariates—A self-report questionnaire was administered to all participants to determine age, sex, ethnicity, medical history, education level, and income level. Annual income level was selected from one of six categories (less than $10,000, $10,000–19,999, $20,000–29,999, $30,000–39,999, $40,000–50,000, and greater than $50,000). As several categories had fewer than 10 responses in the PTSD group, this variable was dichotomized as annual income < $20,000 versus ≥ $20,000. This cutpoint is consistent with the U.S. Census Bureau Poverty Threshold in 2000-2002, the period during which baseline interviews were conducted (U.S. Census Bureau Poverty Thresholds, 2010). To measure alcohol use, the AUDIT-C, a validated screening questionnaire, was used (Bradley, Bush, McDonell, Malone, & Fihn, 1998; Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998), which had modest internal consistency in our study (Cronbach's alpha = .65). We measured height and weight and calculated body mass index by dividing the weight in kilograms by the square of the height in meters. Fasting total, high-density lipoprotein, and low-density lipoprotein cholesterol were measured from venous blood samples (Shlipak, Ix, Bibbins-Domingo, Lin, & Whooley, 2008). Participants brought their medications to the study visit and research assistants recorded all current medications. Medications were categorized using Epocrates Rx (San Mateo, California). The CDIS was used to measure current depression, defined as meeting *DSM-IV* criteria for a major depressive episode. The CDIS has been previously validated with clinical interviews (Robins et al., 1999; Robins et al., 1981) and had high internal reliability in our study (Cronbach's alpha = .95).

Statistical Analysis

Baseline differences were compared between participants with and without PTSD using *t* tests for continuous variables and chi-square tests for dichotomous variables. Multivariate logistic regression models were used to evaluate the association of PTSD with physical activity, medication adherence and current smoking. Adjustments were made for potentially confounding patient characteristics that were associated with PTSD at $p < .20$, (age and sex). Models of PTSD and physical activity were also adjusted for current smoking as this was considered a potential confounder of the association of PTSD and current physical activity. Models were not adjusted for alcohol use because there was no significant difference in alcohol use between participants with and without PTSD. All statistical tests were two-sided with $\alpha = .05$. Ordinal logistic regression models were used to calculate the association of PTSD and smoking status. Ordinal logistic regression yields a single odds ratio for the association of PTSD and each combination of higher versus lower risk outcome categories (current vs. former or never smoker and current or former vs. never smoker). To analyze the association between PTSD and the mean number of smoking pack years, multivariate linear regression models adjusted for age and sex were used. To evaluate the role of depression in the association between PTSD and health behaviors, sensitivity analyses were performed, excluding patients with depression and adjusting for depression. Finally, annual household income (defined as < $20,000 vs. ≥ $20,000) was added to the models, as this differed significantly by PTSD status and could be a mechanism leading to poor health behaviors in patients with PTSD. Based on the sample size of 1,022, a two-tailed α of 0.05, and the 9% prevalence of PTSD in the sample, the study had 80% power to detect odds ratios for the health behavior outcomes of at least 1.79–2.22 given expected outcome prevalences of 10–50%. The study had 80% power to detect a beta coefficient of at least 6.4 pack years of smoking. SAS version 9.2 (SAS Institute) was used to perform all analyses.

Results

Participant Characteristics

Of the 1,022 participants, 95 (9%) had PTSD. Those with PTSD were younger and more likely to have depression (see Table 1). Participants with PTSD were more likely to be inactive, to be nonadherent to their medications, to be current smokers, and to have a more extensive smoking history. In addition, participants with PTSD were more likely to have an income under $20,000. Of the 95 participants with PTSD, the distribution of Criterion A events associated with PTSD symptoms included: seeing someone seriously injured in combat or experiencing the unexpected sudden death of a close friend or relative (15 participants for each); sexual assault by a relative (seven participants); sexual assault by a nonrelative, being held captive, tortured, or kidnapped not in combat or seeing someone seriously injured or killed not in combat (five participants for each); being wounded in combat (four participants); being diagnosed with a life-threatening illness (three participants); being involved in a serious accident or being held captive or tortured in combat (two participants for each); being mugged or threatened with a weapon, being in a natural disaster, or unexpectedly discovering a dead body (one participant for each). Twenty-eight participants reported other types of events that met trauma criteria from the CDIS PTSD module.

PTSD and Physical Activity

Participants with PTSD were significantly more likely to rate themselves as being much less active (23% vs. 14%) or somewhat less active (32% vs. 20%) than others. Similarly, participants without PTSD were more likely to rate themselves as having about the same activity (24% vs. 19%), being somewhat more active (27% vs. 17%) or being much more active (14% vs. 9%) than others. After adjustment for potential confounders, participants with PTSD were more likely to be inactive in terms of overall exercise, light exercise, and level of exercise compared to others (see Table 2), although the statistical significance was marginal. Participants with PTSD were also more likely to be inactive in terms of moderate and heavy exercise, but these differences were not statistically significant.

PTSD and Medication Adherence

After adjusting for age and sex (see Table 2), participants with PTSD had an 80% higher odds of medication nonadherence ($p = .04$) and 70% higher odds of skipping medications ($p = .03$) but no difference in report of frequency of taking medications as prescribed.

PTSD and smoking—Participants with PTSD were significantly more likely to be current or former smokers and to have a more extensive smoking history, with 6.4 more pack-years of tobacco use (see Table 2).

Depression and income—After additional adjustment for depression, PTSD remained marginally significantly associated with greater pack years of smoking (see Table 2). After excluding the 223 participants with depression and adjusting for age and sex, PTSD remained significantly associated with overall physical in-activity, light exercise inactivity, and greater pack years of smoking (see Table 3). Following additional adjustment for income, only the associations of PTSD and greater pack years of smoking remained significant (Tables 2 and 3).

Discussion

The findings from this study suggest that PTSD may be associated with poor health behaviors that play a role in the relationship between PTSD and increased CVD risk, but

that this association may be due to other psychosocial factors. To the best knowledge of the authors, this is the only controlled study of PTSD and physical activity. A study of 826 male veterans seeking treatment at a PTSD clinic found that the majority (58%) exercised at levels below national guidelines (Buckley et al., 2004). In another uncontrolled study of 50 patients with PTSD, 52% reported being initially physically active, but only 22% remained active after developing PTSD (de Assis et al., 2008). In this study, activity levels in patients with PTSD were compared to a control sample without PTSD by examining a large, ethnically and socioeconomically diverse cohort of patients with CVD. This study showed that participants with PTSD had higher rates of inactivity, especially in terms of light exercise and that the majority of participants, with and without PTSD, exercised at rates below guidelines set forth by the American Heart Association and the American College of Sports Medicine (Haskell et al., 2007). The high rate of inactivity in these patients with a history of heart disease is concerning as studies show that exercise has substantial benefits in secondary prevention of CHD and in reducing CV morbidity and mortality (Lavie et al., 2009; O'Connor et al., 1989).

Several studies have found that patients with psychological stressors are less likely to adhere to treatment recommendations but few have examined the association of PTSD and medication adherence (Shemesh et al., 2000; Shemesh et al., 2001; Shemesh et al., 2004). In an examination of 56 patients six months after myocardial infarction, Shemesh and colleagues found those with PTSD were more likely to be nonadherent to aspirin and to be readmitted for cardiovascular problems (Shemesh et al., 2004). An earlier study in a similar group of postmyocardial infarction patients also found that those with PTSD were more likely to be nonadherent to captopril and that patients with nonadherence suffered more adverse outcomes. The association of PTSD and smoking has been more widely studied, and lifetime and current smoking rates have been found to be twice as high among patients with PTSD (Feldner et al., 2007). This study highlights the fact that even in a group of patients with existing CVD, who theoretically would have received extensive counseling about risk factor modification, PTSD was associated with medication nonadherence and greater tobacco use, behaviors that could substantially increase CVD risk (Gehi et al., 2005; Gehi et al., 2007).

The data from this study fits into Schnurr and Green's (2004) conceptual framework describing how PTSD leads to adverse physical outcomes. Focusing on the behavioral component, these results demonstrate that patients with PTSD had both greater adoption of high risk behaviors (smoking) and lower uptake of preventive behaviors (exercise). There are several possible explanations for why patients with PTSD may show alterations in these health behaviors.

The study by de Assis et al. (2008) found that 71% of patients with PTSD reported a lack of motivation to exercise. Following the development of PTSD, an increasing number also reported fear that exercise could cause health problems. In addition, avoidance symptoms seen in PTSD, such as a sense of foreshortened future might make patients feel it is unnecessary to engage in healthful preventive behaviors. This sense of foreshortened future may also increase participation in risky behaviors like smoking. The emotional distress and hyperarousal symptoms of PTSD can also cause patients to "self-medicate" with substances like nicotine to decrease their anxiety levels (Feldner et al., 2007; Jacobsen et al., 2001). These same hyperarousal symptoms may make quitting smoking more difficult by increasing withdrawal symptoms (Jacobsen et al., 2001). Finally, the psychosocial impact of PTSD could contribute to poor health behavior patterns. Many patients with PTSD have a lower socioeconomic status, as was reflected in our study by the fact that participants with PTSD were significantly more likely to have income levels under $20,000. Economic concerns could decrease medication adherence or prevent patients from joining a gym or

participating in organized sports (Kessler, 2000). Patients living in neighborhoods with lower socioeconomic status also have decreased access to safe areas for exercise (Rundle et al., 2008). In our models, income did appear to play an important role in the associations of PTSD and health behaviors. In addition to economic issues, patients with PTSD may have difficulties with interpersonal relationships that could reduce the social support that often motivates and facilitates healthy behaviors (Kessler, 2000).

The findings from this study should be interpreted in light of several limitations. First, this study sample consisted mostly of urban men with existing CVD. While this is an important group to study given their high risk for recurrent CVD events and mortality, these results may not generalize to other populations. Second, cross-sectional data was used for this study; therefore, it cannot be determined whether the association between PTSD and altered health behaviors is causal. Third, the CDIS is a validated measure of PTSD, but it does not include detailed information on the duration or severity of PTSD symptoms. Fourth, health behaviors were measured by self-report and no objective measures were available to confirm responses. Self-report of health behaviors may be inaccurate and participants may have been subject to many biases, including recall bias (Newell, Girgis, Sanson-Fisher, & Savolainen, 1999), social desirability, and demand characteristics. The findings from this study may represent differences in the perception or reporting of health behaviors, and differences in actual levels of smoking, adherence, or activity cannot be confirmed. It is possible, for example, that a patient with PTSD could report lower than actual activity levels because they view themselves as having functional limitations. In addition, measures such as physical activity levels compared to others are subjective, and a person's view of their peers' activity levels could be influenced by their PTSD status as well as their own exercise habits. It is somewhat reassuring that in prior studies using this cohort, self-report of medication nonadherence and physical activity were important predictors of future CVD events and mortality (Gehi et al., 2007; Whooley et al., 2008). In addition, prior studies have found that self-report is a reliable method of assessing physical activity (Ainsworth, Jacobs, & Leon, 1993; Bowles, FitzGerald, Morrow, Jackson, & Blair, 2004; Jackson, Morrow, Bowles, FitzGerald, & Blair, 2007) and medication adherence (Blumberg et al., 2005; Gehi et al., 2007). Finally, given the high rate of comorbidity between PTSD and depression, there was limited power to fully examine the independent effects of these psychiatric disorders on health behaviors.

The findings from this study support the hypothesis that poor health behaviors are associated with PTSD and may be involved in the high risk of adverse CVD events in patients with PTSD. This study highlights the importance of counseling patients with PTSD about making healthy lifestyle choices. Patients with PTSD may need targeted interventions for smoking cessation, adherence to their medication regimens, and formulation of an exercise plan. These goals are particularly important in patients with PTSD and a past history of CVD, as they are at high risk of having another adverse CVD event. Future studies should evaluate the prospective association of PTSD and health behaviors as well as further examine the potential causal mechanisms, such as depression and socioeconomic disparities, linking PTSD to poor health behaviors. In addition, studies should examine whether healthy lifestyle modifications can decrease the incidence of adverse cardiovascular events in patients with PTSD and whether they can perhaps help alleviate symptoms of PTSD itself.

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Table 1

Characteristics of Participants With PTSD vs. Participants Without PTSD

Characteristic	PTSD (*n* = 95)	No PTSD (*n* = 927)	*p*
Age, years	61 ± 11	67 ± 11	<.001
Male, *n* (%)	72 (76)	766 (83)	.10
White, *n* (%)	54 (57)	561 (61)	.48
High school education, *n* (%)	113 (90)	778 (87)	.92
Annual income under $20,000, *n* (%)	64 (67)	433 (47)	<.001
Regular alcohol use, *n* (%)	25 (26)	268 (29)	.56
Myocardial infarction, *n* (%)	55 (58)	492 (53)	.34
Depression, *n* (%)	58 (61)	165 (18)	<.001
Medication Use			
Beta blocker, *n* (%)	56 (59)	536 (58)	.83
Statin, *n* (%)	60 (63)	595 (64)	.84
Renin-angiotensin inhibitor, n (%)	46 (48)	477 (51)	.57
Aspirin, *n* (%)	76 (80)	715 (77)	.52
Cardiovascular risk factors			
Body mass index	29 ± 5	28 ±5	.82
Total cholesterol, mg/dL	174 ± 35	178 ± 43	.42
LDL cholesterol, mg/dL	102 ± 27	105 ± 34	.39
HDL cholesterol, mg/dL	47 ± 14	46 ± 14	.58
Systolic blood pressure, mmHg	134 ± 20	133 ± 21	.71
Diastolic blood pressure, mmHg	75 ± 12	75 ± 11	.49
Hemoglobin A1c	5.9 ± 1.5	6.0 ± 1.1	.48
Health behaviors			
Overall physical activity: inactive, *n* (%)	43 (45)	330 (35)	.06
Light exercise: inactive, *n* (%)	28 (29)	204 (22)	.09
Moderate exercise: inactive, *n* (%)	49 (52)	413 (44)	.18
Heavy exercise: inactive, *n* (%)	82 (85)	785 (83)	.69
Compared to others: inactive, *n* (%)	70 (74)	544 (59)	.004
Medication nonadherence- forgot, *n* (%)	17 (18)	93 (10)	.02

Characteristic	PTSD (*n* = 95)	No PTSD (*n* = 927)	*p*
Medication nonadherence- skipped, *n* (%)	25 (26)	139 (15)	.004
Medication nonadherence- as prescribed, *n* (%)	10 (11)	73 (8)	.37
Smoking status			
Current smoker, *n* (%)	32 (34)	169 (18)	<.001
Former smoker, *n* (%)	43 (45)	463 (50)	.38
Never smoker, *n* (%)	20 (21)	294 (32)	.03
Mean pack years smoking	27.3 ± 22	19.9 ± 21	<.001

Note. PTSD = Post-traumatic stress disorder; LDL = Low-density lipoprotein; HDL = High-density lipoprotein.

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Table 2

Adjusted Associations of PTSD With Poor Health Behaviors

	Model 1		Model 2		Model 3	
Health behavior	***OR***	**95% CI**	***OR***	**95% CI**	***OR***	**95% CI**
Physical activity						
Overall: inactive	1.6	[1.0–2.6]*	1.4	[0.83–2.3]	0.99	[0.63–1.6]
Light exercise: inactive	1.7	[1.0–2.9]*	1.6	[0.96–2.8]	0.87	[0.53–1.4]
Moderate exercise: inactive	1.4	[0.88–2.3]	1.4	[0.83–2.3]	0.99	[0.63–1.6]
Heavy exercise: inactive	1.3	[0.63–2.7]	1.3	[0.60–2.7]	1.2	[0.60–2.3]
Compared to others: inactive	1.8	[1.0–3.0]*	1.5	[0.83–2.6]	0.92	[0.55–1.5]
Medication nonadherence						
Forgot to take	1.8	[1.0–3.3]*	1.4	[0.79–2.7]	0.70	[0.38–1.3]
Skipped	1.7	[1.1–2.9]*	1.4	[0.82–2.4]	1.4	[0.80–2.3]
Overall not taking as prescribed	1.1	[0.56–2.3]	0.89	[0.42–1.9]	0.89	[0.42–1.9]
Smoking						
Smoking status[a]	1.7	[1.1–2.5]*	1.5	[0.99–2.3]	1.6	[0.90–2.9]
Mean pack years	β = 6.4[b]	[1.8–10.9]**	β = 6.7[b]	[2.0–11.5]**	β = 6.0[b]	[1.3–10.7]*

Note. OR = odds ratio; *CI* = confidence interval. Model 1: Odds ratios for physical activity were adjusted for age, sex, and current smoking. Odds ratios for medication nonadherence and smoking were adjusted for age and sex. Model 2: Includes additional adjustment for depression. Model 3: Includes additional adjustment for annual income <$20,000.

[a] Smoking status (current vs. former vs. never smoker) was entered into an ordinal logistic regression model.

[b] These values represent β values, not odds ratios.

* $p < .05$.

** $p < .01$.

Table 3

Adjusted Associations of PTSD With Poor Health Behaviors Excluding Participants With Depression

	Model 1		Model 2	
Health behavior	***OR***	**95% CI**	***OR***	**95% CI**
Physical activity				
Overall: inactive	3.0	[1.4–6.4]**	0.71	[0.38–1.3]
Light exercise: inactive	2.5	[1.2–5.4]*	0.68	[0.34–1.4]
Moderate exercise: inactive	2.0	[0.91–4.2]	0.87	[0.47–1.5]
Heavy exercise: inactive	1.1	[0.38–3.3]	1.1	[0.47–2.5]
Compared to others: inactive	1.5	[0.69–3.4]	1.2	[0.64–2.2]
Medication use				
Forgot to take	2.1	[0.82–5.2]	0.61	[0.25–1.5]
Skipped	1.4	[0.59–3.3]	1.4	[0.58–3.2]
Overall not taking as prescribed	1.5	[0.78–3.0]	1.5	[0.77–3.0]
Smoking				
Smoking status[a]	1.6	[0.88–2.8]	1.5	[0.71–3.3]
Mean smoking pack years	β = 8.9[b]	[1.9–15.9]**	β = 8.9b	[1.9–15.9]**

Note. OR = odds ratio; *CI* = confidence interval. Model 1: Odds ratios for physical activity were adjusted for age, sex, and current smoking. Odds ratios for medication nonadherence and smoking were adjusted for age and sex. Model 2: Includes additional adjustment for annual income < $20,000.

[a] Smoking status (current vs. former vs. never smoker) was entered into an ordinal logistic regression model.

[b] These values represent β values, not odds ratios.

* $p < .05$.

** $p < .01$.