Post-traumatic stress disorder (PTSD), a prevalent and costly psychiatric disorder, is associated with high rates of obesity and cardiometabolic diseases. Many studies have examined PTSD and risky behaviors (e.g., smoking, alcohol/substance abuse); far fewer have examined the relationship between PTSD and health-promoting behaviors. Physical activity and eating behaviors are 2 lifestyle factors that impact cardiometabolic risk and long-term health. This comprehensive review of the literature (1980–2014) examined studies that reported physical activity and eating behaviors in adults with PTSD or PTSD symptoms. A systematic search of electronic databases identified 15 articles on PTSD–physical activity and 10 articles on PTSD–eating behaviors in adults. These studies suggest that there may be a negative association among PTSD, physical activity, and eating behaviors. Preliminary evidence from 3 pilot intervention studies suggests that changes in physical activity or diet may have beneficial effects on PTSD symptoms. There was considerable heterogeneity in the study designs and sample populations, and many of the studies had methodological and reporting limitations. More evidence in representative samples, using multivariable analytical techniques, is needed to identify a definitive relationship between PTSD and these health behaviors. Intervention studies for PTSD that examine secondary effects on physical activity/eating behaviors, as well as interventions to change physical activity/eating behaviors that examine change in PTSD, are also of interest.

Abbreviations: CBT, cognitive behavioral therapy; PTSD, post-traumatic stress disorder.

INTRODUCTION

Post-traumatic stress disorder (PTSD) is a psychological condition triggered by a traumatic event. Although not everyone who experiences trauma develops PTSD, a significant minority of individuals go on to experience chronic PTSD symptoms that can last years and even decades after the traumatic event (1). PTSD is prevalent among military veterans and civilians alike. A recent study by the Department of Veterans Affairs reports that nearly 30% of Iraq and Afghanistan veterans seen at its facilities have PTSD (2), and PTSD rates among Vietnam-era military veterans are estimated at well over the half-million mark (3, 4). Among civilian populations, the prevalence of PTSD is lower but still significant, affecting approximately 8% of the US adult population (5). There is substantial evidence suggesting that chronic PTSD is associated with cardiovascular and metabolic risk factors, with studies reporting higher rates of obesity, dyslipidemia, hypertension, diabetes, and cardiovascular disease (6–8). PTSD is also associated with significant impairments in physical functioning and comorbid psychological conditions such as depression (9–12).

Physical inactivity and poor eating behaviors (particularly binge eating and binge eating disorder) are important established predictors of morbidity and mortality, including diabetes, cardiovascular disease, hypertension and hyperlipidemia, and obesity (13–15). Physical activity and diet have demonstrated efficacy as secondary prevention strategies, promoting weight loss/maintenance and glucose control, attenuating functional decline, and improving mood and anxiety symptoms (16–18). Individuals with PTSD may be less likely to exercise and more likely to have poor dietary habits because of fear of bodily arousal symptoms (e.g., increased heart rate, shortness of breath) or comorbid depression, which is common in PTSD and undermines motivation to exercise and eat healthily (11). People with PTSD also engage in other unhealthy behaviors, such as smoking and alcohol use, which may make it more difficult for someone with PTSD to start an exercise program or to consume a well-balanced diet (19, 20). Recent evidence suggests that hyperarousal symptoms of...
PTSD are most strongly associated with inactivity and that a heightened concern for safety, which is common in PTSD, may interfere with exercise (21). Use of food to cope with negative affect and stress may also explain why PTSD is associated with unhealthy diet and overweight/obesity (22). Finally, sleep disturbance, a prominent PTSD symptom, is a barrier to physical activity (23, 24) and healthy diet (25). In addition to these behavioral indices, research has shown that poor social support (26) and low self-efficacy (27)—psychosocial factors that are critical facilitators of physical activity and healthy diet (28–33)—are common in PTSD.

A comprehensive review of the literature examining PTSD and health-promoting behaviors is needed, given the central role of physical activity and diet in the prevention of overweight/obesity and related cardiometabolic sequelae and the high prevalence of these health conditions among individuals with PTSD. Previous reviews of the link between PTSD and health that include health behaviors have focused largely on adverse health behaviors such as tobacco use, alcohol/substance abuse, or eating disorders such as anorexia nervosa and bulimia nervosa, and few have included or focused on military veterans. The aim of this paper is to provide a narrative review of the existing published data regarding PTSD, physical activity, and eating behaviors. This review will discuss the gaps in the existing literature and identify areas for future research.

METHODS

We conducted a search of the published literature (including PubMed, PsycINFO, and Cochrane) for original research articles published in English between January 1980 and July 2014 using a text search. A text search identifies studies that have any part of the word or string of words in the search fields, casting a relatively wide net. The search terms used for this search included the following: posttraumatic stress disorder, post-traumatic stress disorder, or PTSD with physical activity, exercise, sedentary, inactivity, or sitting; and diet, nutrition, eating disorder, disordered eating, or binge eating. We also utilized references of empirical and review articles to identify additional studies. This literature search was initially restricted to studies conducted in military service members and veterans; however, this yielded a very small number of studies. We subsequently conducted another literature search inclusive of all adult samples (regardless of military/veteran status) that yielded sufficient results for this review. We consulted a medical librarian regarding our search procedures and confirmed that we had obtained an accurate and comprehensive list of articles that meet our study objectives using these search approaches.

Studies that provided information on the associations between PTSD and physical activity or eating behaviors in adults were included. Given our interest in health behaviors related to obesity and cardiometabolic health, we did not consider studies that did not separate binge eating from other eating disorders (e.g., anorexia nervosa or bulimia nervosa). Finally, studies that did not directly assess PTSD status or symptoms (e.g., only assessed trauma exposure) were not considered. Methodological rigor was considered during the inclusion and exclusion process, such that articles that had a sample size of less than 25 were excluded, as were studies that did not statistically examine between-group differences. Data collected from each study included the study design, number of individuals who had a diagnosis of or symptoms consistent with PTSD, study location, primary outcome of the study, the measure utilized to assess PTSD, physical activity and/or eating behaviors, and statistical associations of PTSD with physical activity and eating behavior. All papers were reviewed independently by 2 researchers (K. S. H, K. D. H.). Any disagreements between reviewers were discussed until consensus was reached.

RESULTS

A meta-analysis approach was not feasible given the large heterogeneity of the study designs and methodologies. Also, the outcome of PTSD was not measured consistently across studies, because different instruments were used and the way in which the outcome was examined (dichotomous vs. continuous) varied greatly. The same is true of the physical activity and dietary outcomes. Therefore, a comprehensive and descriptive review of the literature was conducted.

Search results

Figures 1 and 2 show the article selection process for the PTSD–physical activity and PTSD–eating behavior literature searches. Although a large number of articles on PTSD and health have been published in the last decade, few focused on the association between PTSD and health-promoting behaviors such as physical activity and eating behaviors. Fifteen studies of PTSD and physical activity were identified. Ten studies of PTSD and eating behaviors were identified.

Studies were commonly conducted among community samples of adults, with a few studies examining these associations in military or veteran samples (n = 6). Studies in the literature utilized survey instruments (n = 11), medical record codes (n = 2), and/or clinical interviews (n = 12) for diagnosing PTSD and binge eating disorder. Few studies (n = 4) reported using previously validated measures of physical activity or eating behaviors.

The identified studies were categorized by behavior (e.g., physical activity or eating behavior), sample population, and study design. Details of these studies are summarized in Tables 1 and 2.

PTSD and physical activity

PTSD as a correlate or predictor of physical activity. There were 10 published observational studies that reported the associations between PTSD and physical activity (21, 34–43), all of which were conducted between 2010 and 2014. Six of the 10 studies examined the associations between PTSD status (yes/no) and physical activity (34, 36, 38, 39, 41, 43). These studies can be further divided by those that examined physical activity versus inactivity as the primary outcome. Among those studies that examined physical activity, 2 reported that adults with PTSD were significantly less likely to engage in regular physical activity compared with
those without PTSD (36, 38), and 2 reported no differences in physical activity by PTSD status (39, 43). The results for inactivity by PTSD status are also mixed, with 1 reporting no differences in inactivity by PTSD status (41) and 2 reporting that individuals with PTSD are significantly more likely to be inactive (34, 43). One of these studies reported that, compared with veterans with other psychiatric diagnoses, veterans with PTSD had the highest odds of no regular exercise (odds ratio = 1.09, 95% confidence interval: 1.06, 1.12) (34).

The other 5 observational studies identified in this review examined the associations between PTSD symptoms and physical activity (21, 35, 37, 40, 42). Two studies, both conducted in young adult samples (mean age, <25 years), reported that, as PTSD symptoms increased, physical activity levels decreased (21, 42). One of these studies reported that only hyperarousal symptoms were significantly and negatively associated with exercise (42). The remaining 3 studies reported no significant associations between PTSD symptoms and physical activity (35, 37, 40).

Preventive effects of exercise on developing PTSD. There were 2 published prospective cohort studies that examined the relationships between exercise and risk of PTSD (44, 45). The first study examined the relationship between changes in exercise over time (increase in exercise, no change in exercise, decrease in exercise) and probable PTSD among trauma-exposed firefighters (45). This study reported that a decrease in exercise over time is related to delayed onset of PTSD (present at follow-up but not enrollment) and is associated with a lower likelihood of recovery from PTSD. The other prospective cohort study examined the associations between physical activity (measured at follow-up) and prospectively assessed PTSD symptoms (measured at baseline and follow-up) among 38,883 US service members enrolled in
The most consistent results were reported for vigorous physical activity, such that those who reported increased engagement in vigorous physical activity were at significantly reduced odds of having new-onset symptoms and/or persistent PTSD symptoms. Those individuals who reported "cannot physically do" strength training or vigorous physical activity had significantly higher odds of new-onset PTSD symptoms. No significant effects for any of the other activity intensities were observed.

**Exercise as an intervention for PTSD symptoms.** Two intervention studies utilized physical activity as a treatment for PTSD symptoms, and both reported beneficial effects (46, 47). The first study from 2005 was a small, single-arm, community-based study of physical activity for PTSD symptoms (47). Nine adults with PTSD completed the 10-week exercise regimen and demonstrated significant before and after reductions in PTSD symptoms.

The second intervention study from 2014 examined the effects of a 2-week aerobic exercise program on PTSD symptoms (46). Thirty-three participants with PTSD were randomly assigned to 3 exercise conditions: Group 1 (prompted attention to somatic arousal during exercise); Group 2 (distraction from somatic arousal during exercise); and Group 3 (exercise with no distractions or interoceptive prompts). Results of this study showed that exercise, with and without distraction, significantly reduced PTSD symptoms. Interestingly, when specific PTSD symptoms were examined, significant group × time interactions were observed.

**Figure 2.** Scheme for eating behaviors article selection process, January 1980–July 2014. BED, binge eating disorder; EB, eating behavior; PTSD, post-traumatic stress disorder.
interactions were found, such that those randomized to Group 1 experienced significantly less reduction in hyperarousal symptoms than did the other 2 groups.

PTSD and eating behaviors

PTSD as a correlate or predictor of eating behaviors. There were 9 published observational studies that reported the associations between PTSD and eating behaviors (36, 48–55), all of which were conducted between 1997 and 2014. These studies can be further divided into 2 categories based on primary outcome: disordered eating behaviors (n = 7) and dietary content (n = 2).

Six of the 9 studies examined the associations between PTSD and binge eating disorder and reported conflicting results (48–50, 52–55). Three of these studies reported no significant differences in the prevalence of PTSD between patients with and without binge eating disorder (49, 50, 55), while 2 studies reported significant associations between PTSD and binge eating disorder (52, 56). Only 1 study explored the association between PTSD symptoms and binge eating behaviors (48). This study was completed in a sample of treatment-seeking women with substance use disorder and PTSD. Women who engaged in binge eating had significantly more PTSD symptoms than did those who do not binge eat. These between-group differences were not observed for the Clinician-Administered PTSD Scale (CAPS) (57) clinical interview.

One study took a slightly different approach to examining the associations between PTSD and disordered eating, focusing instead on the subclinical indicator of “emotional eating” as assessed by self-report (54). Participants with PTSD exhibited significantly more emotional eating than did participants without PTSD. PTSD symptom severity was also significantly associated with increased emotional eating, explaining a significant proportion of the variance in adjusted models.

Two studies examined the association between PTSD and dietary quality (36, 51). One study of young women reported that PTSD symptoms were associated with an increased frequency of fast food and soda consumption (51). Another study reported that participants with PTSD eat significantly fewer servings of fruit per day compared with persons without PTSD (36). No differences in consumption of vegetables, soda, caffeine, or fast food by PTSD status were observed.

Preventive effects of eating behaviors on PTSD. No prospective studies of PTSD and dietary behaviors were identified in this review.

Eating behavior interventions for PTSD symptoms. Only 1 dietary intervention study for PTSD was identified (58). This study examined the efficacy of 12-week fish oil supplementation in trauma-exposed Japanese Disaster Medical Assistance team workers. This single-blind, randomized parallel-group trial reported no significant effects for fish oil supplementation on PTSD symptoms. However, there was a significant gender effect, such that women in the fish oil group reported significantly greater improvements in PTSD symptoms compared with women in the psychoeducation only group, whereas no differences were noted in men.

Summary of results

In summary, 15 studies of PTSD and physical activity and 10 studies of PTSD and eating behaviors in adults from 24 unique study populations were included in this review. Regarding the PTSD and physical activity literature, physical activity was identified as a primary outcome in only 6 of these studies. The methods of assessing PTSD and physical activity, study design, and sample characteristics varied widely across these 15 studies. Results from the observational studies are split, with half of the studies reporting a significant negative association between PTSD and physical activity and the other half reporting no significant associations between PTSD and physical activity. Studies that examined specific PTSD symptoms reported significant associations for PTSD-hyperarousal only. Results of the 2 pilot intervention studies, however, suggest a positive effect of physical activity intervention on PTSD symptoms.

Regarding the PTSD and eating behaviors literature, binge eating disorder was the primary outcome in 5 of these studies. Four studies examined dietary quality and subclinical eating behaviors. Results from the observational studies were split, with 3 studies reporting no association between PTSD and binge eating disorder and 4 studies reporting high rates of binge eating disorder among adults with PTSD. The studies examining dietary content are also inconclusive, though suggestive of an association between PTSD and eating fewer servings of fruit and consuming more fast food. Only 1 intervention study was identified and reported significant effects of fish oil supplementation on PTSD symptoms only among women.

DISCUSSION

Studies have consistently shown that habitual physical activity and a healthy diet are associated with better physical and mental health (59–62). As the evidence continues to grow showing increased risk of cardiometabolic diseases among individuals with PTSD, so too does the recognition among the clinical community that PTSD is more than “just” a mental illness. However, as Levine et al. cogently note, “Current management of PTSD focuses on the psychiatric parameters of this condition with little emphasis on addressing the comorbid cardiometabolic risk factors that impair overall long-term health outcomes” (8, p. 1). Even less attention is paid to health-promoting behaviors in this at-risk population; instead, the focus of clinical research has been on adverse health behaviors such as tobacco use, alcohol/substance abuse, and eating disorders such as anorexia nervosa and bulimia nervosa.

While these adverse behaviors clearly play a critical role in disease risk, it is important to recognize that optimal health is achieved by minimizing adverse health behaviors and promoting healthy behaviors. Years of research on PTSD and tobacco use in veterans have resulted in numerous evidence-based smoking cessation interventions for veterans with PTSD (63–65). It appears that the time is ripe to establish a similar scientific basis to inform health promotion interventions targeting physical activity and diet in adults with PTSD.

An important and necessary first step in guiding research in this area is to evaluate existing models of PTSD and health
Table 1. Summary of Published Studies on Physical Activity and PTSD, 1980–2014

<table>
<thead>
<tr>
<th>First Author, Year</th>
<th>Study Design</th>
<th>Population</th>
<th>Sample Size</th>
<th>Setting</th>
<th>Primary Outcome</th>
<th>Analytical Methods</th>
<th>Results</th>
<th>PA Measure</th>
<th>PTSD Measure</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Godfrey, 2013 (36)</td>
<td>Cross-sectional</td>
<td>Nonveteran (88%) and veteran adults</td>
<td>39.9</td>
<td>80*</td>
<td>25</td>
<td>San Diego VA and university health-care facilities</td>
<td>Diet and exercise</td>
<td>Multivariate ANOVA (not adjusted)</td>
<td>Participants with PTSD reported significantly less vigorous PA. No other differences across PA were observed.</td>
<td>Short form of the IPAQ</td>
</tr>
<tr>
<td>Kozatic-Kovacic, 2009 (38)</td>
<td>Cross-sectional</td>
<td>Male Croatian veterans</td>
<td>30-61y</td>
<td>478</td>
<td>269</td>
<td>University hospital</td>
<td>BMI and PTSD</td>
<td>χ² test</td>
<td>Significantly fewer veterans with PTSD engaged in weekly PA compared with veterans without PTSD.</td>
<td>Weekly PA (yes/no), item wording not provided</td>
</tr>
<tr>
<td>Kukihara, 2014 (39)</td>
<td>Cross-sectional</td>
<td>Earthquake, tsunami, and nuclear disaster survivors in Japan</td>
<td>58.0</td>
<td>241</td>
<td>Government survey</td>
<td>Trauma, depression, and resilience</td>
<td>t tests</td>
<td>No significant differences in exercise habits were reported for respondents with vs. without PTSD.</td>
<td>Measure not reported</td>
<td>IES-R (yes/no)</td>
</tr>
<tr>
<td>Zen, 2012 (43)</td>
<td>Cross-sectional</td>
<td>Outpatients with documented cardiovascular disease</td>
<td>64</td>
<td>1,022</td>
<td>95</td>
<td>Clinical</td>
<td>Association between PTSD and health behaviors in patients with CVD</td>
<td>Multivariate logistic regression models (adjusted)</td>
<td>Patients with PTSD were more likely to be inactive vs. those with no PTSD.</td>
<td>Questionnaire developed by authors (dichotomized as inactive vs. active)</td>
</tr>
<tr>
<td>Chwastiak, 2011 (34)</td>
<td>Epidemiologic</td>
<td>Veterans</td>
<td>64</td>
<td>501,161</td>
<td>31,072</td>
<td>1999 Large Health Survey of Veteran Enrollees</td>
<td>Obesity and health behaviors</td>
<td>Multivariate logistic regression</td>
<td>67.5% of patients with PTSD reported no weekly exercise. Veterans with PTSD have the highest odds of no regular exercise (adjusted model) vs. those with other psychiatric diagnoses.</td>
<td>Single item: “How often do you engage in regular activities (e.g., brisk walking, jogging, bicycling) long enough to work up a sweat?” (“any regular exercise” vs. “none”)</td>
</tr>
<tr>
<td>Rutter, 2013 (21)</td>
<td>Cross-sectional</td>
<td>Undergraduate psychology students</td>
<td>18</td>
<td>200</td>
<td>University</td>
<td>PTSD, depression, and health status</td>
<td>Bivariate correlations and linear regression</td>
<td>Significant, negative association reported between PTSD symptom severity and exercise, PTSD-hyperarousal was the only significant predictor of exercise in regression analyses.</td>
<td>Single item from the Health Risk Appraisal questionnaire</td>
<td>PCL-C</td>
</tr>
<tr>
<td>Spitzer, 2010 (41)</td>
<td>Cross-sectional</td>
<td>Community-dwelling adults</td>
<td>54.2</td>
<td>3,049</td>
<td>55</td>
<td>Government</td>
<td>PTSD and low-grade inflammation</td>
<td>χ² test</td>
<td>No significant differences in physical inactivity (%) were reported between those with vs. those without PTSD.</td>
<td>Inactivity defined as performing sports for less than 1 hour per week</td>
</tr>
<tr>
<td>Vujanovic, 2013 (42)</td>
<td>Cross-sectional</td>
<td>Community sample of trauma-exposed adults</td>
<td>24.3</td>
<td>86*</td>
<td>University</td>
<td>Smoking status, exercise on PTSD and PTSD symptoms</td>
<td>Hierarchical multiple regression analyses</td>
<td>Significant main effect of PDS-hyperarousal symptoms only</td>
<td>Exercise Habits Questionnaire-Revised (METs)</td>
<td>SCID, PDS</td>
</tr>
<tr>
<td>Davidson, 2013 (35)</td>
<td>Cross-sectional</td>
<td>Inpatient veterans with PTSD</td>
<td>45</td>
<td>346</td>
<td>VA 90-day residential rehabilitation program for PTSD</td>
<td>Suicide risk</td>
<td>Zero-order correlations</td>
<td>On average, reported very littlevigorous PA. PTSD symptoms not significantly associated with exercise</td>
<td>Single item at intake: &quot;Over the past month, how often have you engaged in regular activities long enough to work up a sweat?&quot;</td>
<td>PCL-M</td>
</tr>
</tbody>
</table>

Table continues
<table>
<thead>
<tr>
<th>First Author, Year (Reference No.)</th>
<th>Study Design</th>
<th>Sample</th>
<th>Setting</th>
<th>Primary Outcome</th>
<th>Analytical Methods</th>
<th>Results</th>
<th>PA Measure</th>
<th>PTSD Measure</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoerster, 2012 (37)</td>
<td>Cross-sectional</td>
<td>Iraq and Afghanistan veterans</td>
<td>Veterans assessed at intake to VAMC postdeployment health clinic</td>
<td>PA correlates between PTSD symptoms and likelihood of meeting/not meeting PA recommendation (150 minutes/week of moderate-intensity activity).</td>
<td>No significant association between PTSD symptoms and likelihood of meeting/not meeting PA recommendation (150 minutes/week of moderate-intensity activity).</td>
<td>Short Form of the IPAQ. Categorized as meeting PA recommendations (≥150 vs. &lt;150 minutes/week of moderate-vigorous PA).</td>
<td>PCL-M</td>
<td>PTSD prevalence not reported</td>
<td></td>
</tr>
<tr>
<td>Medina, 2011 (40)</td>
<td>Cross-sectional</td>
<td>Participants with trauma exposure and reported alcohol consumption</td>
<td>University</td>
<td>Alcohol use for coping with trauma</td>
<td>Zero-order correlations</td>
<td>No significant association between PTSD symptom severity and exercise.</td>
<td>Exercise Habits Questionnaire-Revised</td>
<td>SCID, PDS</td>
<td>Does not include multivariable results</td>
</tr>
<tr>
<td>LeardMann, 2011 (44)</td>
<td>Prospective cohort</td>
<td>US service members</td>
<td>Millennium Cohort Study</td>
<td>PA and prospectively assessed PTSD</td>
<td>Multivariable logistic regression (adjusted)</td>
<td>Vigorous PA is associated with decreased odds of both new-onset and persistent PTSD symptoms. Those with PTSD symptoms at follow-up were proportionately less active than those without symptoms at follow-up.</td>
<td>Self-reported minutes/week were measured across 3 categories of activity: strength training, vigorous PA, and light/moderate PA. Then they were classified into 1 of 5 categories for each type of activity (from &quot;cannot do&quot; to &quot;very active&quot;).</td>
<td>PCL-C</td>
<td>PA measure of unknown validity, PA categorization scheme not readily interpretable, and age of sample not reported</td>
</tr>
<tr>
<td>Soo, 2011 (45)</td>
<td>Prospective cohort</td>
<td>Firefighters exposed to World Trade Center disaster</td>
<td>Clinical</td>
<td>Trends in probable PTSD</td>
<td>Cox regression models</td>
<td>Reporting a decrease in exercise associated with lower likelihood of recovery from probable PTSD. Reporting a decrease in exercise associated with delayed onset of probable PTSD.</td>
<td>Change in exercise since last questionnaire (measure not reported)</td>
<td>PCL-C</td>
<td>PA measure of unknown validity and does not include results adjusted for depression</td>
</tr>
<tr>
<td>Manger, 2005 (47)</td>
<td>Single-arm, 10-week exercise trial</td>
<td>Adults with PTSD from the community</td>
<td>Community/YMCA</td>
<td>PTSD symptoms</td>
<td>Paired-sample t-tests</td>
<td>Significant reductions in PTSD symptoms</td>
<td>Adherence to intervention</td>
<td>PDS, CAPS</td>
<td>No comparison group, small sample, and demographic characteristics not reported</td>
</tr>
<tr>
<td>Fetzner, 2014 (46)</td>
<td>RCT (2-week exercise with or without distraction)</td>
<td>Adults with PTSD</td>
<td>University</td>
<td>PTSD symptoms</td>
<td>Hierarchical linear model</td>
<td>Exercise, with and without distraction, demonstrated decreases in PTSD symptoms.</td>
<td>6 sessions of aerobic exercise (Group 1: PA plus cognitive distraction; Group 2: PA plus interoceptive prompts; Group 3: PA alone)</td>
<td>PCL-C</td>
<td>Lacking &quot;no-exercise&quot; control group and small sample</td>
</tr>
</tbody>
</table>

Abbreviations: ANOVA, analysis of variance; BMI, body mass index; CAPS, Clinician Administered Post-Traumatic Stress Disorder Scale; CDIS, Computerized Diagnostic Interview Schedule; CIDI, Composite International Diagnostic Interview; CVD, cardiovascular disease; ICD-9, International Classification of Diseases, Ninth Revision; ICD-10, International Classification of Diseases, Tenth Revision; IES-R, Impact of Event Scale-Revised; IPAQ, International Physical Activity Questionnaire; MET, metabolic equivalent; PA, physical activity; PCL-C, Post-Traumatic Stress Disorder Checklist-Civilian Version; PCL-M, Post-Traumatic Stress Disorder Checklist-Military Version; PDS, Posttraumatic Diagnostic Scale; PTSD, post-traumatic stress disorder; RCT, randomized controlled trial; SCID, Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders; VA, Veterans Affairs; VAMC, Veterans Affairs Medical Center; YMCA, Young Men’s Christian Association.

a For Godfrey et al. (36), 45% female; for Vujanovic et al. (42), 58.1% female; for LeardMann et al. (44), 22.3% female; for Fetzner and Asmundson (46), 78% women.
b Range of years.
<table>
<thead>
<tr>
<th>First Author, Year (Reference No.)</th>
<th>Study Design</th>
<th>Sample</th>
<th>Setting</th>
<th>Primary Outcome</th>
<th>Analytical Methods</th>
<th>Results</th>
<th>Eating Behavior Measure</th>
<th>PTSD Measure</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dansky, 1997 (49)</td>
<td>Cross-sectional</td>
<td>Participants in the National Women’s Study</td>
<td>46.1</td>
<td>3,006</td>
<td>376</td>
<td>Telephone interviews</td>
<td>Relationship between eating disorders and PTSD</td>
<td>$\chi^2$ test</td>
<td>No differences in PTSD among those with vs. those without binge eating disorder</td>
</tr>
<tr>
<td>Grilo, 2012 (50)</td>
<td>Cross-sectional</td>
<td>Obese patients with binge eating disorder</td>
<td>42.7</td>
<td>105</td>
<td>25</td>
<td>Clinical</td>
<td>Associations between binge eating disorder and PTSD</td>
<td>ANOVA/ANCOVA</td>
<td>Patients with binge eating disorder plus PTSD did not have a greater frequency of binge eating compared with binge eating disorder without PTSD</td>
</tr>
<tr>
<td>von Lojewski, 2012 (55)</td>
<td>Cross-sectional</td>
<td>Patients receiving treatment for eating disorders</td>
<td>20.9</td>
<td>226</td>
<td>Clinical, inpatient and outpatient</td>
<td>Psychiatric comorbidity in eating disorders</td>
<td>$t$ test</td>
<td>Prevalence of PTSD did not differ by binge eating disorder status</td>
<td>CIDI, ICD-10 (yes/no)</td>
</tr>
<tr>
<td>Litwack, 2014 (52)</td>
<td>Cross-sectional</td>
<td>US military veterans</td>
<td>51.9</td>
<td>499</td>
<td>Clinical</td>
<td>Symptom severity of bulimia nervosa, binge eating disorder, and comorbidities in veterans</td>
<td>General linear models (adjusted)</td>
<td>PTSD symptom severity significantly associated with lifetime but not current binge eating disorder severity</td>
<td>SCID</td>
</tr>
<tr>
<td>Pagoto, 2012 (56)</td>
<td>Cross-sectional/epidemiologic</td>
<td>US adults</td>
<td>44.9</td>
<td>20,013</td>
<td>1,341</td>
<td>CPES</td>
<td>PTSD and obesity</td>
<td>Multivariate logistic regression</td>
<td>Significant association of past year PTSD with past year binge eating disorder</td>
</tr>
<tr>
<td>Cohen, 2010 (48)</td>
<td>Cross-sectional (secondary analysis of baseline data)</td>
<td>Women with substance use disorder and PTSD</td>
<td>38</td>
<td>122</td>
<td>Community substance treatment program</td>
<td>Eating disorder symptoms</td>
<td>$t$ tests</td>
<td>PTSD symptoms significantly higher among those with vs. those without binge eating</td>
<td>The Eating Disorder Examination Questionnaire</td>
</tr>
<tr>
<td>Talbot, 2013 (54)</td>
<td>Cross-sectional</td>
<td>Community-dwelling adults and veterans</td>
<td>30.2</td>
<td>93</td>
<td>44</td>
<td>University</td>
<td>Emotional eating</td>
<td>Univariate ANCOVA and linear regression (adjusted)</td>
<td>PTSD participants exhibited significantly more emotional eating than participants without PTSD. More severe PTSD is associated with increased emotional eating. PTSD severity explained a significant proportion of variance in eating behavior.</td>
</tr>
<tr>
<td>Hirth, 2011 (51)</td>
<td>Cross-sectional</td>
<td>Women who visited select reproductive clinics in Texas</td>
<td>20.8</td>
<td>3,154</td>
<td>1,203</td>
<td>Clinical</td>
<td>Association between PTSD and dietary behaviors</td>
<td>Ordinal and binary logistic regression models</td>
<td>PTSD symptoms positively associated with frequency of fast food consumption and frequency of soda consumption</td>
</tr>
</tbody>
</table>

Table continues
Table 2. Continued

<table>
<thead>
<tr>
<th>Study Design</th>
<th>Sample Characteristics</th>
<th>Sample Size</th>
<th>Setting</th>
<th>Primary Outcome</th>
<th>Analytical Methods</th>
<th>PTSD Measure</th>
<th>Eating Behavior Measure</th>
<th>Impact of Event Scale-Revised</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCT (fish oil plus psychoeducation vs. psychoeducation)</td>
<td>Japanese Disaster Medical Assistance Team workers deployed to disaster areas</td>
<td>172</td>
<td>Clinical</td>
<td>PTSD symptoms</td>
<td>ANCOVA with ITT analysis</td>
<td>CIDI (yes/no)</td>
<td>Unvalidated eating characteristics measure created for this study</td>
<td>No significant differences in PTSD changes between the 2 groups.</td>
<td>Single-blind study and demographic characteristics not reported.</td>
</tr>
</tbody>
</table>

Abbreviations: ANCOVA, analysis of covariance; CAPS, Clinician Administered Post-Traumatic Stress Disorder Scale; CIDI, Composite International Diagnostic Interview; CPES, Collaborative Psychiatric Epidemiology Surveys; ICD-10, International Classification of Diseases, Tenth Revision; ITT, intention to treat; PDSQ, Psychiatric Diagnostic Screening Questionnaire; PTSD, post-traumatic stress disorder; RCT, randomized controlled trial; SCID, Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders; VA, Veterans Affairs.

provided in the literature. Current theoretical models relating PTSD to physical health outcomes emphasize risky behaviors (6, 66, 67). The evidence synthesized in this review suggests that health-promoting behaviors such as physical activity and healthy eating behavior should be included as mediating variables along the PTSD–health pathway. There is also reason to consider including sedentary behavior and binge eating alongside tobacco use and substance abuse as risky behaviors in these models. Sedentary behavior has been shown to be a distinct risk factor, independent of amounts of physical activity, for poor health outcomes including cardiometabolic and inflammatory biomarkers, obesity, functional decline, and depression (68–71). Binge eating and binge eating disorder demonstrate many of these same associations (72–75).

In an effort to inform future research in this area, limitations in the existing literature and considerations for future work are discussed here. Specifically, issues related to sample characteristics, study design, methodology, and study outcomes are presented.

Sample characteristics

The studies included various samples ranging from treatment-seeking to non–treatment-seeking clinical populations, community- and population-based samples, and military service members and veterans. Although a strength in terms of generalizability, the heterogeneous sample characteristics make it difficult to summarize these results in a meaningful way. Many of these studies are limited by under-representation of ethnic minorities and women (the latter in studies of military service members and veterans). Elevated rates of chronic PTSD have been reported among black and Hispanic military veterans compared with white veterans, attributed in part to their greater rates of combat exposure (76). Women, both civilian and military, have high rates of exposure to trauma (77). Female veterans are a growing (~10% of US military veterans are female) (78) and understudied group. A greater effort must be made to include representative samples of ethnic minorities and females in studies of PTSD and these health behaviors. Finally, a notable limitation of many of these studies is a focus on young and middle-aged adults, with very little representation of older adults (>65 years of age). Both the civilian and the veteran populations are experiencing a graying effect, with nearly 40% of male veterans being over the age of 65 (78).

Study design

The literature to date is limited largely to observational studies, with only 2 longitudinal and 3 intervention studies of PTSD and physical activity or eating behavior identified. The lack of longitudinal and intervention studies points to future research in this area. Both cross-sectional studies in larger and more diverse populations and longitudinal studies are needed to 1) elucidate the effects of changes in PTSD symptom severity and changes in health behaviors, 2) examine the impact of aging with chronic PTSD on health and physical function, and 3) explore barriers and facilitators to an active lifestyle and healthy eating behaviors in adults.
with PTSD. It is recommended that future studies also measure and evaluate mediating and moderating factors, which may provide a more nuanced understanding of the relationships between PTSD and physical activity and eating behaviors. Such factors may include functional status, psychosocial factors, socioeconomic status, environmental characteristics, and somatic symptoms. Perhaps the most notable of these factors is depression. PTSD and depression are highly comorbid in national surveys and in military samples. Depression has also been linked to physical inactivity and poor eating behaviors (79, 80). Although some of the studies included in this review examined these associations with multivariable models including depression, others did not adjust for depression and/or examined only univariate associations (Tables 1 and 2). Unfortunately, many of these studies were underpowered to examine the mediating or moderating effects of depression; however, this is an important question for future studies in larger samples. The only study that examined the independent effects of PTSD and depression in a stepwise fashion reported that the association between PTSD and physical inactivity was explained, in part, by depression (43).

Feasibility studies of physical activity and eating behavior change are also needed in veterans with PTSD, which will inform subsequent larger efficacy trials. As persons with PTSD engage in multiple unhealthy lifestyle behaviors, future studies designed to promote multiple health behavior change (e.g., increased exercise, decreased tobacco use, healthier diet) would be particularly informative. The scientific foundation generated by these future research efforts will be instrumental in informing more integrated clinical care models that integrate preventive therapies (e.g., exercise, diet, pharmacological modalities) with psychiatric intervention to treat PTSD and associated cardiometabolic disease risk factors.

Measurement

Another important consideration among these studies is the validity of PTSD, physical activity, and eating behavior assessments. The studies approached the construct of PTSD in 3 ways: 1) coding PTSD status as yes/no using diagnostic codes, 2) coding PTSD yes/no using clinical interview, or 3) assessing PTSD symptoms based on self-report. Of those studies that did assess PTSD via interview, different clinical instruments, with different measurement properties and sensitivities, were used. Consistency in assessing and reporting PTSD status and symptoms would greatly strengthen this body of work. The Clinician Administered PTSD Scale is widely considered the “gold standard” of PTSD assessment, and it provides both a categorical diagnosis and a scale of symptom severity. However, the Clinician-Administered PTSD Scale requires a great deal of time and trained personnel to administer the interview. When possible, clinical interviews or validated self-report assessments of PTSD are preferred over the use of diagnostic codes, as the latter do not indicate current symptomology. Of note, only 2 of these studies measured or explored specific PTSD symptoms (i.e., hyperarousal, reexperiencing, avoidance) and their associations with physical activity or eating behavior, highlighting another area for further research efforts.

The studies also varied widely in their approach to assessing physical activity and eating behavior. A critical limitation of the current literature is the utilization of self-report tools of unknown reliability and validity to assess physical activity. Several of the studies provided no information on how physical activity was assessed or used a single-item measure of unknown validity. Only 4 studies used a validated physical activity questionnaire. Studies of eating behaviors used clinical interview or diagnostic codes to determine binge eating disorder, but the assessment validity of subclinical eating behaviors and dietary habits was unclear.

Future studies building on the data reported here should use validated, multiitem physical activity and dietary assessment instruments. Other assessment methods such as activity monitors, food diaries, and ecological momentary assessment technology to capture “real-time” physical activity and eating behaviors are needed so that we can better understand why it is that PTSD is associated with activity and eating behavior. Finally, population-based studies that examine physical activity and sedentary behavior in adults with PTSD are now feasible with the availability of objective activity monitors (e.g., pedometers, accelerometers).

In closing, there is a paucity of research examining the associations among PTSD, physical activity, and eating behaviors in civilian and military populations. Although preliminary, the results of these studies suggest that PTSD may be negatively associated with physical activity and unhealthy eating behaviors. However, the results of these studies are mixed, pointing to the need for future research in representative samples of adults including veterans, which utilize validated outcome measures, appropriate comparison groups, and multivariable analytical techniques. Such studies are needed to inform future intervention studies. Intervention studies for PTSD that examine secondary effects on physical activity and eating behaviors, as well as interventions to change physical activity and eating behaviors that test change in PTSD symptoms, are potential areas for future research.

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REFERENCES


50. Hall et al.


