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Exercise behavior and gender-related differences in posttraumatic stress disorder symptoms

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ABSTRACT

Objectives: Exercise has been proposed as a potential treatment for posttraumatic stress disorder (PTSD). However, the relationship between exercise, gender, and PTSD symptoms is unknown.
Design: This study examined the cross-sectional relationship among these variables in a national sample of 165 men and women who screened positive for PTSD.
Method: Participants completed an online survey consisting of the Godin Leisure-Time Exercise Questionnaire and the PTSD Checklist-Civilian.
Results: Active participants had significantly lower PTSD symptoms than insufficiently active participants. Significant interactions between gender and exercise for PTSD symptoms were found, such that active men had significantly lower PTSD symptoms than active women, and insufficiently active men and women. Additionally, strenuously active men reported significantly lower hyperarousal symptoms than strenuously active women, and insufficiently active men and women.
Conclusion: Findings suggest that the relationship between PTSD and exercise may differ for specific subpopulations of individuals with PTSD, such as men and women.

1. Introduction

Posttraumatic stress disorder (PTSD) is a mental disorder that affects about 5% of men and 10% women in the United States (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Its disabling symptoms include re-experiencing (e.g., flashbacks), avoidance behaviors, hyperarousal, and mood symptoms, such as negative affect (American Psychiatric Association, 2013). There are several effective treatments for PTSD, including psychotherapy and medication (Watts et al., 2013), however, the rates of use are low. For example, only about a third of individuals with PTSD seek treatment from a healthcare professional (Kessler et al., 2005; Madsen, Andersen, & Karstoft, 2016), often because of barriers to treatment such as stigma, the fear of negative social consequences, cost, and/or access to care (Kantor, Knefel, & Lueger-Schuster, 2017).

In addition, although PTSD has been shown to contribute to physical inactivity (Winning et al., 2017), exercise has recently been proposed as a possible treatment or treatment adjunct for PTSD (Whitworth & Ciccolo, 2016) given its well-known beneficial effects on negative mental health states (Ekkekakis, 2015; Herring, O'Connor, & Dishman, 2010). This is supported by several large cross-sectional studies that have repeatedly shown exercise to be inversely correlated to PTSD and its co-occurring conditions. More specifically, exercise has consistently been found to be inversely correlated with a PTSD diagnosis (Chwastiak, Rosenheck, & Kazis, 2011) and its symptoms, such as poor sleep quality (Talbot, Neylan, Metzler, & Cohen, 2014) and co-occurring depressive symptoms (Rutter, Weatherill, Krill, Orazem, & Taft, 2013). There is also emerging evidence supporting an inverse relationship between exercise participation and the severity of PTSD symptoms. For instance, regular participation in strenuous intensity exercise has been shown to be longitudinally associated with reductions in PTSD severity over time (Whitworth, Craft, Dunsiger, & Ciccolo, 2017). Additionally, exercise participation has been shown to be inversely associated with hyperarousal and avoidance symptoms in individuals who have experienced a traumatic event (Harte, Vujanovic, & Potter, 2013; Vujanovic, Farris, Harte, Smits, & Zvolensky, 2013).

The proposed beneficial relationship between exercise participation and PTSD symptoms is also theoretically supported by the

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Cross-Stressor Adaptation Hypothesis (Sothmann et al., 1996). Specifically, repeated exposure to a stressor, such as exercise for a sufficient intensity and duration can lead to adaptations in the stress response system. Further, these adaptations may lead a reduction in negative cognitive appraisals in response to a stressor (e.g., a reduction in PTSD symptoms).

Despite the growing amount of observational research in the field of PTSD and exercise, several important areas need further research. For instance, given the increased risk of PTSD for military personnel (American Psychiatric Association, 2013), a majority of the current studies have specifically targeted treatment seeking veterans, and by proxy, men (Chwastiak et al., 2011; LeardMann, Kelton, Smith, Littman, & Boyko, 2011). Additionally, other studies have purposefully excluded individuals with a current or past diagnosis of axis-1 psychological disorders in order to better understand the relationship between exercise and PTSD. However, these studies lack generalizability to other at-risk populations, such as women, non-treatment seeking individuals, or those who have a history of mental illness. This is an important shortcoming of the current research because it is not likely to be representative of the typical adult with PTSD, who is most likely to be female with co-occurring conditions (e.g., depression) (Sareen, 2014), and is less likely to engage in treatment (Kantor et al., 2017).

The above issues are further compounded by a lack of scientific rigor applied to the measurement of exercise. For instance, most studies have not used a validated measure of exercise. In fact, the most common practice has been to use an unvalidated single-item questionnaire that only assesses exercise frequency (Whitworth & Ciccolo, 2016), leaving out other important components of exercise dose, such as intensity and total exercise volume. Importantly, the intensity of exercise is known to have a meaningful psychological impact (e.g., changes to affective valence) even after a single session of exercise (Ekkekakis, Parfitt, & Petruzzello, 2011). As such, the lack of studies measuring exercise dose variables beyond frequency has therefore created a major gap in the current literature.

Overall, more work is needed in this area, as the limitations of the current research reduce the generalizability of the reported findings and prevent a rigorous examination of the relationship between PTSD symptom severity and exercise participation. This is particularly problematic for determining any relationship that might exist or differ among certain sub-populations, such as men and women or those with a history of psychiatric illness. Therefore, the purpose of this study was to overcome limitations of previous research on exercise and PTSD by examining the relationship between PTSD symptoms (i.e., re-experiencing, avoidance/numbing, and hyperarousal), gender, and exercise dose (i.e., frequency, intensity, and total volume) in a national sample of adults who screened positive for PTSD.

2. Methods

2.1. Procedures

This study used a cross-sectional design. Potentially interested individuals were recruited through online-classified listings (e.g., Craigslist) and social media, such as Facebook and Twitter from each of the major US regions (i.e., Northeast, South, West, and Midwest). The listings sought to recruit individuals who were currently bothered by a previous traumatic life event. However, PTSD or other psychological disorders were not specifically mentioned in the recruitment materials in order to encourage those without a formal diagnosis to participate. Each listing provided a link to the study's informed consent, where the consenting participants were redirected to an online survey. All participants completing the survey were entered into a raffle to win a $50 gift card. The odds of winning were 1 in 25. The study was approved by the University's Institutional Review Board. All data were collected between May and August 2015.

2.2. Participants

To be eligible, participants needed to be living in the United States with access to the Internet. All had to be at least 18 years old, read English, report experiencing a traumatic life event (e.g., sexual assault, violent crime, natural disaster, military combat), and screen positive for PTSD (see PTSD screening and symptoms below for details).

2.3. Measures

Demographic questionnaire. This questionnaire assessed participant age, gender, race/ethnicity, education, income, military veteran status, physical disability status, and history of psychiatric illness.

Self-reported exercise. The Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985) was used to measure the amount of self-reported leisure-time exercise done in a typical week. Respondents were asked to indicate how many times in a typical week they participated in 15 min or more of minimal effort (e.g., easy walking), moderate (e.g., resistance training), and strenuous (e.g., vigorous running or cycling) exercise. For scoring, the frequency of minimal effort, moderate, and strenuous exercise was multiplied by 3, 5, and 9 metabolic equivalents, respectively. After scoring the individual intensities, moderate and strenuous intensity exercise were also summed to represent total leisure-time exercise (Godin, 2011). Higher scores on the GLTEQ represent greater exercise participation, and for interpretation, a cut-off score of 24 was used to determine if an individual was likely to be meeting the national physical activity guidelines of $\geq$150 min of moderate-to-vigorous weekly physical activity (Amireault & Godin, 2015; Garber et al., 2011). Specifically, participants scoring a 24 or more on moderate or strenuous intensity exercise independently, or through a combination of moderate and strenuous intensity exercise (i.e., total leisure-time exercise) were likely to be meeting the guidelines and considered to be “active”. Thus, those scoring less than a 24 were not likely to be meeting the recommendations and considered “insufficiently active”. The GLTEQ has been shown to be a reliable and valid measure of total leisure-time exercise, and exercise done at strenuous, moderate, and minimal intensities (Amireault & Godin, 2015; Godin & Shephard, 1985).

PTSD screening and symptoms. The PTSD Checklist-Civilian corresponding to the DSM-IV (PCL-C) was used to screen for PTSD, and to measure the severity of PTSD symptoms in the past month (Weathers, Litz, Herman, Huska, & Keane, 1993). The PCL-C is a 17-item, 5-point self-report scale that asks individuals to rate their PTSD symptoms from “Not at all” to “Extremely”. Total scores range from 17 to 85, with higher scores indicating worse PTSD symptoms. Additionally, each of the items on the PCL-C corresponds with specific PTSD symptoms (i.e., re-experiencing, avoidance/numbing, and hyperarousal). Specific scores for the re-experiencing, avoidance/numbing, and hyperarousal symptom clusters range from 5 to 25, 7 to 35, and 5 to 25 respectively. The PCL-C is a reliable and valid measure of PTSD and strongly correlates with the gold standard measure of PTSD (i.e., Clinician Administered PTSD Scale; Blanchard, Jones-Alexander, Buckley, & Forneris, 1996). Importantly, the PCL-C has been shown to be reliable when administered via computer (Campbell et al., 1999). Given that participants were recruited from the general population, a recommended cut-point total score of 30 was used to indicate a positive screening for PTSD (Walker, Newman, Dobie, Ciechanowski, & Katon, 2002).

3. Data analysis

Descriptive statistics are presented as mean ± standard deviation for continuous variables, and percentages for categorical variables. Potential differences in PTSD symptoms were examined by gender and activity status using two-way analysis of covariance. PTSD symptoms were defined as the dependent variable, while gender and activity status were defined as independent variables. Exercise engagement was examined as a bivariate variable (i.e., active or insufficiently active) for total leisure-time exercise, strenuous, moderate, and minimal intensity exercise. In all analyses, age, race/ethnicity, income, education, physical disability status, and history of psychiatric illness were controlled for as potential confounds. All analyses were conducted using IBM SPSS 21, and statistical significance was set *a priori* at $p < 0.05$.

4. Results

A total of 234 individuals expressed interest in the study. Of these, 39 declined to participate, and an additional 30 participants screened negative for PTSD, leaving a final sample of 165. These 165 participants consisted of 44 men and 121 women ages 19–59. Additionally, a majority of the participants reported living in the Northeast (66.1%) or the South (21.1%), with fewer participants from the West (8.5%), and Midwest (4.2%). Demographic data for the entire sample is reported in Table 1. The mean total leisure-time exercise score for the aggregate sample was 23.0 ± 25.8. The scores for strenuous, moderate, and minimal intensity exercise were 13.4 ± 19.6, 9.6 ± 11.6, and 9.4 ± 9.0 respectively. Additionally, 42.5% of women were classified as being active according to their total leisure-time exercise score (i.e., ≥24 on the GLTEQ), while 25.0%, 15.8%, and 5.8% were classified as being active from strenuous, moderate, and minimal intensity exercise scores respectively. For men, 45.2% were classified as active from their total leisure-time exercise score, 38.1% from strenuous intensity, and 11.9% and 9.3% were considered active from their moderate and minimal intensity exercise scores respectively. The mean total PTSD symptom score was 57.5 ± 14.5. Mean scores for individual symptoms were 16.8 ± 5.0 for re-experiencing, 23.5 ± 6.6 for avoidance/numbing, and 17.2 ± 5.0 for hyperarousal.

Table 1
Demographic characteristics of men and women screening positive for PTSD (n = 165).

Characteristic	
Age (stdev)	33.7 (11.3)
Body Mass Index (stdev)	26.2 (6.3)
	n (%)
Gender	
Men	44 (26.7)
Women	121 (73.3)
Race	
American Indian/Alaskan Native	7 (4.2)
Asian	12 (7.3)
Black/African American	14 (8.5)
White	118 (71.5)
Other	14 (8.5)
Ethnicity	
Hispanic	17 (10.3)
Non-Hispanic	148 (89.7)
Education	
High school or less	18 (10.9)
Vocational school or some college	57 (34.5)
College graduate	90 (54.5)
Annual household income	
≤$15,000	47 (28.5)
$15,001-$40,000	41 (24.8)
$41,001-$80,000	39 (23.6)
≥$80,001	26 (15.8)
Unsure	12 (7.3)
Military Veteran	25 (15.2)
Active Military/Law Enforcement	13 (7.9)
Other first responder/Fire/EMT	4 (2.4)
Physical Disability	26 (15.8)
History of psychiatric disorder	
PTSD	93 (56.4)
Depression	98 (59.4)
Anxiety	88 (53.3)
Alcohol use disorder	15 (9.1)
Substance use disorder	8 (4.8)
Bipolar Disorder	21 (12.7)
Schizophrenia	8 (4.8)
Other	14 (8.4)

4.1. Total leisure-time exercise by PTSD symptoms

When comparing total PTSD symptoms of the sample by total leisure-time exercise and gender, active men and women had significantly lower mean total PTSD symptoms relative to insufficiently active men and women (55.0 ± 14.4 vs. 60.4 ± 14.1; $F = 5.77$, $p = 0.018$, $\eta^2 = 0.04$). In addition, there was a significant interaction between gender and total leisure-time exercise for total PTSD symptoms ($F = 5.01$, $p = 0.027$, $\eta^2 = 0.04$; see Fig. 1), such that active men had significantly lower total PTSD symptoms than insufficiently active men (49.0 ± 13.3 vs. 65.2 ± 12.5; $F = 7.12$, $p = 0.009$, $\eta^2 = 0.05$) and active women (49.0 ± 13.3 vs. 57.4 ± 14.3; $F = 4.73$, $p = 0.031$, $\eta^2 = 0.03$). Insufficiently active men and women did not significantly differ ($F = 0.95$, $p = 0.332$). The model $R^2 = 0.275$, with covariates contributing to about 23% of the variance.

Additionally, active men and women had significantly less avoidance/numbing (22.6 ± 6.5 vs. 24.9 ± 6.3; $F = 4.84$, $p = 0.029$, $\eta^2 = 0.03$) and hyperarousal (16.3 ± 4.7 vs. 18.1 ± 4.9; $F = 5.77$, $p = 0.018$, $\eta^2 = 0.04$) symptoms than insufficiently active men and women. Importantly, there were no gender differences in avoidance/numbing ($F = 0.11$, $p = 0.743$) and hyperarousal symptoms

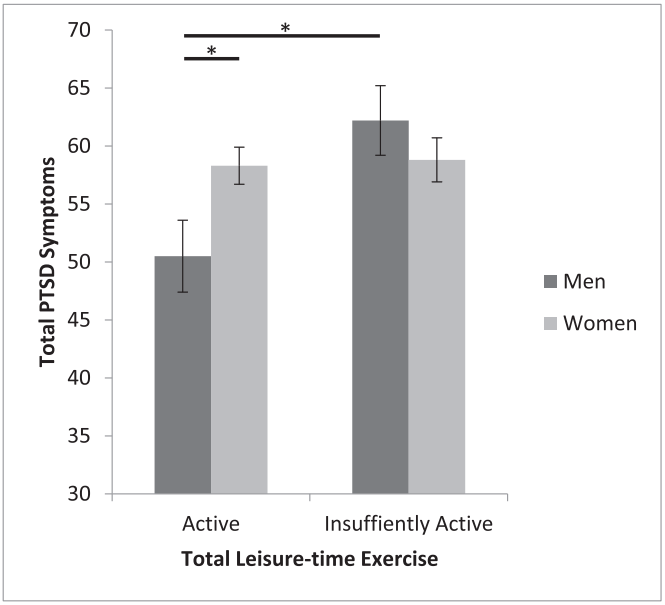

Fig. 1. Differences between men and women by activity status using total leisure-time exercise for PTSD symptoms. PTSD scores are reported as adjusted means with error bars representing standard error. Active men reported significantly lower total PTSD symptoms than active women, and insufficiently active men and women. $n = 165$, $^*p < 0.05$.

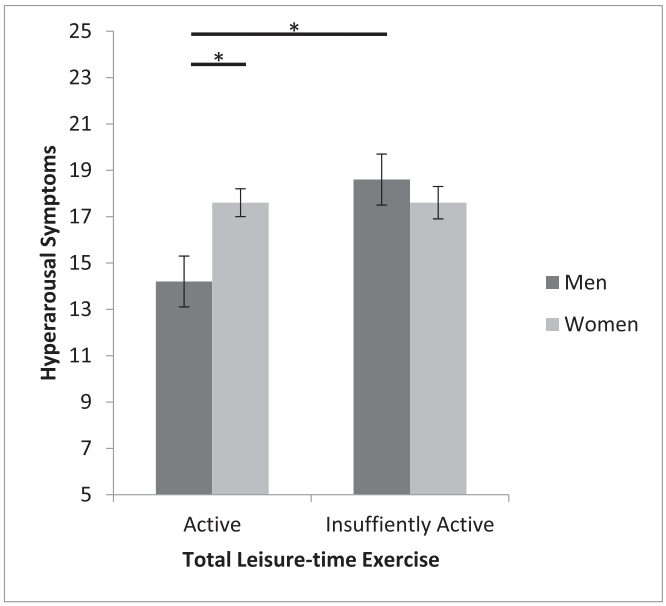

Fig. 2. Differences between men and women by activity status using total leisure-time exercise for hyperarousal symptoms. PTSD scores are reported as adjusted means with error bars representing standard error. Active men reported significantly less hyperarousal symptoms than active women, and insufficiently active men and women. $n = 165$, $^{*}p < 0.05$.

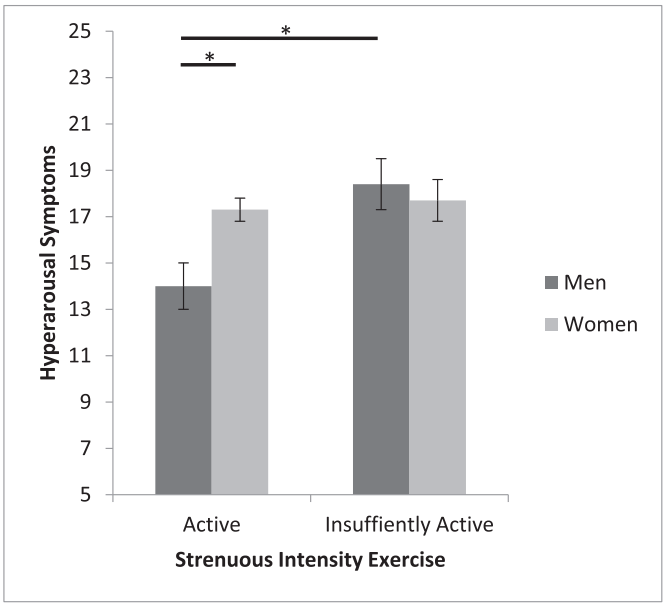

Fig. 3. Differences between men and women by activity status using strenuous intensity exercise for PTSD hyperarousal symptoms. PTSD scores are reported as adjusted means with error bars representing standard error. Active men reported significantly lower hyperarousal symptoms than active women, and insufficiently active men and women. $n = 165$, $^{*}p < 0.05$.

($F = 1.74$, $p = 0.190$). However, there was a significant interaction between gender and total leisure-time exercise for hyperarousal symptoms ($F = 6.37$, $p = 0.013$, $\eta^2 = 0.04$; see Fig. 2). Pairwise comparisons revealed that insufficiently active men and women did not differ significantly for hyperarousal symptoms ($F = 0.753$, $p = 0.387$), but active men had significantly lower hyperarousal symptoms than both insufficiently active men (13.7 ± 4.3 vs. 19.6 ± 4.0; $F = 8.00$, $p = 0.005$, $\eta^2 = 0.06$) and active women (13.7 ± 4.3 vs. 17.3 ± 4.5; $F = 7.15$, $p = 0.008$, $\eta^2 = 0.05$). The avoidance/numbing model $R^2 = 0.256$, with 23% of the shared variance accounted for by the covariates. Additionally, the hyperarousal model $R^2 = 0.207$, with covariates accounting for 15% of the variance. There were no significant differences in re-experiencing symptoms ($F = 2.36$, $p = 0.127$) or interactions between gender and total leisure-time exercise ($F = 2.58$, $p = 0.110$).

4.2. Strenuous intensity exercise by PTSD symptoms

When comparing total PTSD symptoms of the sample by total strenuous intensity and gender, there were significant differences in total PTSD symptoms and hyperarousal symptoms. Specifically, strenuously active men and women had significantly less total PTSD symptoms (53.6 ± 14.5 vs. 59.9 ± 14.1; $F = 4.61$, $p = 0.034$, $\eta^2 = 0.03$) and hyperarousal symptoms (15.6 ± 4.8 vs. 18.0 ± 4.8; $F = 6.22$, $p = 0.014$, $\eta^2 = 0.04$) than insufficiently active men and women. Also, there was a significant interaction between gender and strenuous exercise for hyperarousal symptoms ($F = 4.65$, $p = 0.033$, $\eta^2 = 0.03$; see Fig. 3). Similar to the above, insufficiently active men and women did not differ significantly by hyperarousal symptoms ($F = 0.35$, $p = 0.553$), but active men had significantly lower hyperarousal symptoms than both insufficiently active men (13.9 ± 4.5 vs. 18.9 ± 4.5; $F = 7.82$, $p = 0.006$, $\eta^2 = 0.05$) and active women (13.9 ± 4.5 vs. 16.6 ± 4.7; $F = 5.20$, $p = 0.024$, $\eta^2 = 0.04$). The model $R^2 = 0.207$ with 15% of the variance explained by covariates. There were no significant differences in re-experiencing symptoms ($F = 2.36$, $p = 0.127$) or interactions between gender and strenuous intensity exercise ($F = 0.11$, $p = 0.743$). Similarly, there were no significant differences in avoidance/numbing symptoms ($F = 2.50$, $p = 0.116$) or interactions ($F = 2.74$, $p = 0.100$).

4.3. Moderate intensity exercise by PTSD symptoms

No significant differences were found in total PTSD symptoms for moderate intensity exercise ($F = 0.10$, $p = 0.757$), nor were there any significant interactions between moderate intensity exercise and gender for total PTSD symptoms ($F = 0.06$, $p = 0.801$).

4.4. Minimal intensity exercise by PTSD symptoms

There were no significant differences found in total PTSD symptoms for minimal intensity exercise ($F = 0.02$, $p = 0.882$). Additionally, there was no significant interaction between gender and minimal intensity exercise for total PTSD symptoms ($F = 0.10$, $p = 0.755$).

5. Discussion

This is the first study to examine the relationships between gender, PTSD symptoms, and components of exercise dose (i.e., frequency, intensity, total volume) in a national sample of men and women who screened positive for PTSD. As expected, active individuals reported significantly less PTSD symptoms than insufficiently active individuals. However, the key findings of this study suggest several gender-related differences in PTSD symptoms based on exercise participation. Specifically, there was a significant interaction between gender and total leisure-time exercise (i.e., the summation of strenuous and moderate exercise) demonstrating that active men had significantly lower total PTSD symptoms than active women, and insufficiently active men and women. Importantly, this interaction only remained significant for hyperarousal symptoms when total PTSD symptoms were subdivided into the individual symptom clusters.

Additionally, when exercise was examined by intensity, there was a significant interaction between gender and strenuous intensity exercise for hyperarousal symptoms, such that active men had significantly lower symptoms than active women, and insufficiently active men and women. Importantly, there were no additional significant differences or interactions found for moderate or minimal intensity exercise. As such, these data suggest that the relationship between specific PTSD symptoms (i.e., hyperarousal symptoms), and exercise intensity differs among subpopulations, such as men and women.

These results were initially unexpected. However, gender differences in the prevalence (Pietrzak, Goldstein, Southwick, & Grant, 2011) and severity of PTSD (Hourani, Williams, Bray, & Kandel, 2015) have been reported. Research has also shown that there may be meaningful differences between men and women for treatment responses and recovery (Voelkel, Pukay-Martin, Walter, & Chard, 2015). To our knowledge, this is the first study to provide evidence supporting gender differences in the relationship between PTSD and exercise. One possible explanation for these differences is exercise preferences. Specifically, recent investigations of exercise interest and preferences of individuals with depression (Busch et al., 2015) and substance use disorders (Abrantes et al., 2011) have shown that more men prefer strenuous intensity exercise than women. Moreover, a large cohort study of military veterans and personnel (i.e., 78% male) reported a significant inverse correlation between regular strenuous intensity exercise and PTSD symptoms (LeardMann et al., 2011).

In addition to the novel findings reported above, this study moves the field forward in two meaningful ways. First, this study sought to increase external validity by avoiding convenience samples commonly used in prior observational studies (e.g., treatment-seeking veterans). Instead, these data represent nationally recruited men and women who screened positive for PTSD. Recruitment was accomplished outside of the hospital setting, allowing both treatment and non-treatment seeking individuals to participate. This is critical given that the underuse of mental health services is a well-known issue in the treatment of PTSD (Kantor et al., 2017). As such, the results of this study are more generalizable than much of the prior observational work in this field. Second, exercise was measured using the GLTEQ, a reliable and validated self-report instrument of total exercise volume, and exercise intensity (Godin & Shephard, 1985). The use of validated measures of exercise is necessary for reliably establishing the relationship between PTSD symptoms and components of exercise dose, as well as allowing for more meaningful between study comparisons.

Despite these strengths, this study is not without its limitations. For instance, all data were collected online by self-report. This limits the assessment of PTSD status to a positive/negative screening vs. a clinical interview to determine an actual diagnosis. However, the screening tool used in this study (i.e., the PCL-C) has strong psychometric properties and can be reliably administered electronically (Blanchard et al., 1996; Campbell et al., 1999). Regarding exercise, there are known limitations when measuring exercise by self-report (Sallis & Saelens, 2000); however, given that participants were recruited nationally, objective measurement of exercise behaviors was not feasible for this study. Additionally, online data collection limited participation to individuals who had access to the internet, and increased the chances of duplicate responses from a single participant. To minimize duplicate responses, we blocked multiple responses from the same IP address and required participants to provide a valid email address.

Finally, this study used a cross-sectional design, which prevents any directional interpretations of these results. Thus, it is possible that individuals with worse PTSD symptoms are more likely to avoid participating in exercise than those with less severe symptoms. Specifically, the overlap between the physical sensations of strenuous exercise and hyperarousal symptoms (e.g., increased breathing, heart rate, sweating) may cause individuals with higher hyperarousal symptoms to avoid strenuous exercise. Alternatively, it is also possible that regular strenuous intensity exercise may have a therapeutic effect on PTSD. For instance, as posited by the Cross-Stressor Adaptation Hypothesis, regular exposure to the physical stressors of exercise, may lead to adaptations in the stress response system, allowing for an improved response to other non-exercise stressors, such as PTSD symptom triggering stimuli (Sothmann et al., 1996).

Importantly, recent longitudinal studies of PTSD symptoms and exercise behavior have found evidence supporting both directions. For example, a study by Winning et al. (2017) found that worsening PTSD symptoms longitudinally predicted decreases in physical activity. In contrast, Whitworth et al. (2017) found that individuals who regularly engaged in exercise experienced less PTSD symptoms over time. As such, it is important to consider the possibility of a bidirectional relationship between PTSD and exercise. One where exercise engagement may both beneficially affect PTSD symptoms, and be inhibited by the disabling effects of the disorder. Further examination of the mechanisms of these relationships is clearly needed.

6. Conclusion

The results of this study suggest that the relationship between PTSD symptoms and exercise is more complex than previously reported. Specifically, this study demonstrates that the relationship between exercise and PTSD symptoms may be different for men and women. As such, it is recommended that future observational research continue to explore potential differences in the relationship between exercise dose and PTSD symptoms by gender and in specific sub-populations (e.g., military veterans/non-veterans, and treatment seeking/non-treatment seeking individuals). This research will be essential in the development of targeted exercise interventions for future experimental trials.

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