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Research paper

Veterans Group Exercise: A randomized pilot trial of an Integrative Exercise program for veterans with posttraumatic stress

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ABSTRACT

Background: Posttraumatic stress disorder (PTSD) is prevalent among military veterans and is associated with significant negative health outcomes. However, stigma and other barriers to care prevent many veterans from pursuing traditional mental health treatment. We developed a group-based Integrative Exercise (IE) program combining aerobic and resistance exercise, which is familiar to veterans, with mindfulness-based practices suited to veterans with PTSD. This study aimed to evaluate the effects of IE on PTSD symptom severity and quality of life, as well as assess the feasibility and acceptability of IE.

Methods: Veterans ($N = 47$) were randomized to either IE or waitlist control (WL). Veterans in IE were asked to attend three 1-h group exercise sessions for 12 weeks.

Results: Compared with WL, veterans randomized to IE demonstrated a greater reduction in PTSD symptom severity ($d = -.90$), a greater improvement in psychological quality of life ($d = .53$) and a smaller relative improvement in physical quality of life ($d = .30$) Veterans' ratings of IE indicated high feasibility and acceptability.

Limitations: The sample was relatively small and recruited from one site. The comparison condition was an inactive control.

Conclusions: This initial study suggests that IE is an innovative approach to treating veterans with symptoms of PTSD that reduces symptoms of posttraumatic stress and improves psychological quality of life. This approach to recovery may expand the reach of PTSD treatment into non-traditional settings and to veterans who may prefer a familiar activity, such as exercise, over medication or psychotherapy.

1. Introduction

Posttraumatic stress disorder (PTSD) is prevalent among military veterans, with estimates ranging from 15% among Vietnam War veterans (Schlenger et al., 1992) to 5–20% among those deployed to Iraq and Afghanistan (Ramchand et al., 2010). Given the symptoms associated with PTSD, such as avoidance of activities, negative emotions, and poor sleep, veterans with PTSD face functional impairment and decreased quality of life in several domains (Erbes et al., 2007; Magruder et al., 2004; Pittman et al., 2012; Zatick et al., 1997). Patients with PTSD are also at increased risk of negative health outcomes, including cardiovascular disease, obesity, and even early mortality (Ahmadi et al., 2001; Bartoli et al., 2015; Boscarino, 2006; Jordan et al., 2013; Kubzansky et al., 2007, 2009; Turner et al., 2013; Vaccarino et al., 2013).

Unfortunately, many veterans do not pursue mental health care, and among those who do, there is substantial lag time from end of deployment to initiation of mental health care (Maguen et al., 2012). In fact, less than ten percent of veterans attend a minimally recommended number of mental health appointments within the first year since PTSD

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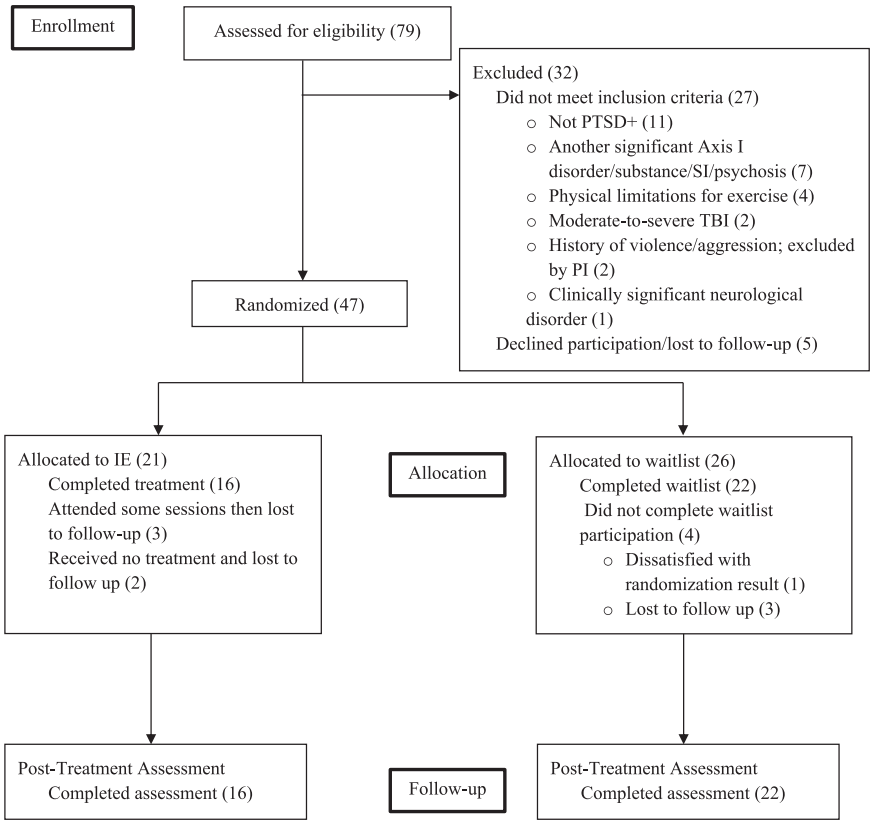

Fig. 1. IE, Integrative Exercise; WL, Waitlist Control.

diagnosis (Seal et al., 2010). Veterans who screen positive for mental health disorders endorse barriers to treatment and concerns about stigma at a far higher rate than those who screen negative, thus impeding care for those who need treatment the most (Hoge et al., 2004). Accordingly, the development of new acceptable treatments for PTSD may be necessary to overcome these substantial barriers to care.

Exercise is emerging as a potential intervention for the treatment of PTSD. Aerobic exercises are familiar to military veterans, as they are a part of daily life of all military personnel during their service, and lack the stigma often associated with more traditional mental health interventions. Individuals with PTSD report exercising at a lower rate than those without PTSD (Zen et al., 2012). Combined with the data suggesting that PTSD is associated with negative cardiac outcomes, exercise may be a particularly salient intervention for the veteran population.

There is preliminary evidence to support exercise as an effective intervention for PTSD in civilian adults (Manger and Motta, 2005; Kim et al., 2013; Fetzner and Amundson, 2015; Rosenbaum et al., 2015), but research in this area may not be generalizable to the typical outpatient, veteran population. Manger and Motta (2005) evaluated a 12-session aerobic exercise program among nine adults with PTSD, with no comparison group, finding a significant reduction in symptoms of PTSD. Kim et al. (2013) observed superior reduction in PTSD symptoms among 11 female nurses with PTSD who participated in a 16-session mindfulness-based stretching and deep breathing exercise program compared to 11 female nurses with PTSD participating in a control condition. The nature of the control condition was not specified. Fetzner and Amundson (2015) evaluated 33 participants (76% female) with PTSD who completed 6 sessions of stationary biking. The participants were divided into three groups with varying attentional focus (i.e., attention to somatic arousal, distraction from somatic arousal, and no attentional prompting). All groups demonstrated significant reduction in PTSD symptom severity. Rosenbaum et al. (2015) assessed change in PTSD symptom severity among 81 participants with PTSD attending an inpatient program. They found that participants randomized to usual care (individual and group psychotherapy, medication) plus 3 30-min resistance training sessions per week and a pedometer-based walking program had significantly reduced PTSD symptoms compared to participants randomized to usual care alone. Though exercise is ubiquitous in the military experience, only one study of exercise for veterans with PTSD was found in the literature: One study of Australian Vietnam veterans demonstrated high acceptance of exercise therapy (Otter and Currie, 2004), however, only five veterans were diagnosed with PTSD, and quantitative outcome data were not reported. This literature also lacks reporting of functional outcomes, which are particularly important in the case of PTSD.

In recent years, military settings have increasingly adopted mindfulness-based practices (Crawford et al., 2013). Trials of Mindfulness-Based Stress Reduction (MBSR) for veterans with PTSD have shown promise for this approach in reducing PTSD symptom severity, but the effect of treatment has varied (Kearney et al., 2012, 2013; Niles et al., 2012; Polusny et al., 2015). The investigators of one trial raised the question as to whether the MBSR should be modified or tailored for veterans with PTSD, particularly due to frequent manifestations of veterans' posttraumatic symptoms, such as intrusive thoughts, during mindfulness practice (Kearney et al., 2013). Another consideration is that mindfulness-based interventions include attitudinal principles that are well-suited for incorporation with other activities, allowing patients to benefit from these skills while engaging in their daily lives.

Given the promise of exercise- and mindfulness-based interventions for PTSD, we developed an Integrative Exercise (IE) program combining aerobic and resistance exercise, as well as yoga poses, movements, and breathing, within the context of mindfulness-based principles, such as nonjudgmental attitude and acceptance. The aim of the current study was to evaluate the efficacy, feasibility, and acceptability of the IE intervention compared with a waitlist control among military veterans with PTSD. Primary treatment outcomes were PTSD symptom severity and quality of life.

2. Methods

2.1. Participants

Study participants included veterans age 18–69-years-old who met Diagnostic and Statistical Manual of Mental Disorders (*DSM-IV*; American Psychiatric Association, 2000) criteria for current PTSD or partial PTSD. Exclusion criteria were: (1) lifetime history of any psychiatric disorder with psychotic features, bipolar disorder, or mania, (2) alcohol or substance dependence in past year, (3) prominent suicidal or homicidal ideation, (4) pregnancy, (5) clinically significant neurological disorder or systemic illness affecting CNS function, (6) history of seizure disorder, (7) asthma, (8) physical disabilities precluding use of exercise equipment, (9) myocardial infarction in past 6 months, and (10) moderate to severe traumatic brain injury. Participants could also be excluded if they were deemed otherwise unsuitable for the study by the principal investigator (TCN). See Fig. 1 for participant flow. Participants could be taking psychoactive medication as long they had started it two months or longer prior to randomization and had remained on a stable dose through the duration of the trial; this was also the case for participation in psychotherapy. All participants were screened by a nurse practitioner to receive medical clearance to participate in the study. This screening included a history and physical as well as participant completion of the Physical Activity Readiness Questionnaire (Canadian Society for Exercise Physiology, 2002) and nurse practitioner completion of the Physical Activity Readiness Medical Examination. Any further concerns about participants' physical readiness for participation were brought to the principal investigator for review.

2.2. Treatment conditions

2.2.1. Integrative Exercise (IE)

IE was offered at a local YMCA convenient to public transportation. Participants were asked to attend three 1-h group sessions each week for 12 weeks, for a total of 36 sessions (though participants could attend more sessions weekly by choice). Exercise sessions included aerobic exercise, strength training with weights and resistance bands, and yoga movements and poses presented within a framework of mindfulness principles, with one principle presented in each session as the focus of the week. Each principle was based on concepts from MBSR (Kabat-Zinn, 1990) and Mindful Breathing (Chesney et al., 2016; presentation at International Congress for Integrative Medicine and Health), similar to the themes discussed during the MBSR program as attitudinal foundations of mindfulness (Kabat-Zinn, 1990). In IE, these principles were called "passwords" and were presented in a language adapted to our study population after feedback from both veterans and recreational therapists with substantial experience working with veterans; the passwords included: Focus, Breathe, Respect, Patience, New Start, Just Be, Acknowledgement, Trust, and Let Go! Each session included the same sequence of principal elements, beginning with a greeting, body-mind centering (including mindful breathing coordinated with movement), and a brief verbal presentation of the password of the week. Following this, instructors led participants in a dynamic warm-up (e.g., jumping jacks, fast walking and running), a series of aerobic exercises (e.g., running, steps, lunges) and resistance training exercises with free weights and elastic bands. Yoga poses and movements were utilized as part of strength training, stretching, and promotion of mindfulness principles. Each class worked on all major muscle groups and included specific muscle stretches, but the time spent for each class element varied from class to class to prevent muscle soreness. Exercises were designed to be accessible and replicable without expensive equipment or expansive space requirements. The mindfulness password of the week was repeatedly presented during the class when appropriate (e.g., for "focus," participants were reminded to notice when their thoughts drifted and to redirect their attention back to their breath and body sensations). Each class ended with a cool-down including repetition of body-mind centering. Exercise instructors were certified physical trainers and/or yoga instructors and thoroughly trained in conventional physical fitness, yoga, and mindfulness principles. Fidelity of the intervention was promoted by one of the investigators (WEM) while training and supervising the exercise instructors and visiting the classes for observation. A second instructor was present in each class to provide assistance in tailoring the activities to the physical fitness levels and physical limitations of each participant. Participants were also provided with a 1-h audio file to guide home exercise sessions should they be unable to attend in person (e.g., transportation problems). In addition to attendance taken at in-person sessions, the number of sessions completed at home reported by participants was recorded for evaluation of adherence.

2.2.2. Waitlist (WL)

The monitor only waitlist control condition lasted for 12 weeks, with participants completing study interviews and questionnaires at the same intervals as those in the IE condition. Participants were offered IE after completion of the research protocol; 10 of 22 WL completers chose to engage in IE at that time.

2.3. Procedures

Participants were recruited starting March 2013, with the final participant completed by August 2015. Participants were randomized to either IE or WL, with randomization determined by blocked randomization lists from four strata defined by gender and age (18–50 or 51–69 years). Assessment points occurred at pre-treatment (interviews, self-report measures), week 4 (self-report measures), week 8 (self-report measures), and post-treatment at week 12 (interviews, self-report measures). Clinical interviewers were blind to treatment condition. Research was approved by the Committee on Human Research at the University of California, San Francisco and the San Francisco Veterans Affairs Medical Center, and all participants provided written informed consent. This pilot randomized controlled trial for military veterans with PTSD was registered in a public registry (ClinicalTrials.gov identifier NCT01674244).

2.4. Measures

Structured Clinical Interview for DSM-IV-TR Axis I Disorders (First et al., 1996). This semi-structured interview was administered at pre-treatment to determine diagnostic status for purposes of study eligibility and recording of comorbid Axis I psychiatric conditions. It has good reliability and validity (Lobbestael et al., 2011; Shear et al., 2000; Steiner et al., 1995).

Clinician-Administered PTSD Scale (CAPS) (Blake et al., 1995). Current and lifetime PTSD symptoms were assessed via CAPS interview based on the *DSM-IV* (American Psychiatric Association, 2000) administered pre- and post-treatment. This semi-structured interview measures the frequency and intensity of PTSD-related symptoms, thus providing both categorical diagnostic standing and symptom severity ratings. Diagnostic status was used to determine eligibility for inclusion in the study and could consist of either current PTSD (over past 3 months) or partial PTSD (defined as a criterion A trauma, criterion B symptoms and either criterion C or D symptoms or history of PTSD diagnosis but without current criterion B symptoms). Severity scores were used to evaluate response to treatment. CAPS total scores may range from 0 to 136, with higher scores indicating higher symptom severity. Criterion symptom clusters (re-experiencing, avoidance/numbing, hyperarousal) were also evaluated separately. The CAPS has good test-retest reliability and internal consistency (Blake et al., 1995).

World Health Organization Quality of Life (WHOQOL-BREF) (WHOQOL Group, 1998). This 26-item self-report assesses quality of life in several domains; physical health and psychological health were

included in this study. This measure was completed every 4 weeks. Domain scores range from 4 to 20, with higher scores indicating greater health in each domain. The WHOQOL-BREF has good reliability and validity (Skevington et al., 2004).

Feasibility and Acceptability Questionnaire. This self-report questionnaire was completed by IE condition completers at post-treatment. Fourteen items were grouped into three main categories: overall treatment impressions, content of intervention, and length of intervention. Participants responded to each statement on a 5-point Likert-type scale, with 1 indicating strong disagreement and 5 indicating strong agreement.

Godin Leisure-Time Exercise Questionnaire (Godin and Shephard, 1985). This self-report questionnaire was completed by participants in both the IE and WL conditions and has good reliability and validity, as established by comparisons with maximum oxygen consumption (VO_2max) and body fat in adults (Godin and Shephard, 1985). Leisure Score Index (LSI) scores were calculated to determine level of physical exercise activity completed over the past week. This measure served as a validity check that participants in the IE condition were more physically active than participants in the WL condition after treatment.

2.5. Data analysis

Primary outcomes were PTSD symptom severity (as determined by CAPS) and quality of life psychological and physical domains. These are presented as intent-to-treat analyses based on all available data. Mixed-effects models were used to evaluate change in primary outcome measures using all available data, with the group (IE vs. WL), time point, and group-by-time interaction entered as fixed effects and subjects entered as random effects. Data are presented as observed variables rather than marginal means. Cohen's *d* effect sizes were calculated as the group difference in model-adjusted post-treatment scores divided by the standard deviation of baseline scores. A power analysis yielded power of .80 at $\alpha = .05$ to detect an effect size of .90 for the CAPS total score.

Treatment attendance and treatment acceptability and feasibility were also evaluated. Differences in dropout by condition were evaluated using chi-square analyses. Among those in the IE group, correlations between attendance and change in PTSD symptom severity, and attendance and change in quality of life were calculated to evaluate whether there was a dose-response relationship for IE. For the feasibility and acceptability analyses, results were evaluated based on descriptive statistics, as there was no comparison group.

3. Results

Fig. 1 illustrates participant flow through the study. Participants included 47 veterans, with 42 veterans meeting *DSM-IV* diagnostic criteria for PTSD and 5 meeting criteria for partial PTSD. Twenty-one veterans were randomly assigned to IE and 26 to WL. Baseline demographic and diagnostic data are presented in Table 1. The sample was mostly male (81%) and racial or ethnic minority (60%). Age ranged from 24- to 69-years-old ($M = 46.80$, $SD = 14.93$). The mean CAPS score at baseline was 61 ($SD = 17.27$), with average duration of PTSD being 18 years ($SD = 14.49$). Nineteen participants (40%) were taking psychiatric medication at baseline. There were no significant differences between groups on any observed baseline variables.

3.1. Self report exercise activity

Based on LSI scores, baseline exercise level did not differ between participants randomized to IE ($M = 23.90$, $SD = 19.97$) or WL ($M = 26.00$, $SD = 26.32$), $t(42) = .29$, $p = .77$. At post-treatment, participants in IE ($M = 50.53$, $SD = 24.79$) reported engaging in significantly more exercise activity than participants in WL ($M = 26.50$, $SD = 20.21$), $t(35) = 3.24$, $p = 003$.

3.2. PTSD symptoms

Fig. 2 illustrates the distribution of change in CAPS scores for each group from baseline to post-treatment. Table 2 presents CAPS overall and subscale scores at baseline and post-treatment. On average, participants in the IE group demonstrated a 30.64 point reduction ($SD = 17.00$) in overall CAPS score from baseline to post-treatment, which was a significantly greater reduction in PTSD symptom severity compared with waitlist ($M = 14.77$, $SD = 24.56$; $d = -.90$ [95% CI: −1.72, −.08], $F(1,35.3) = 4.64$, $p = .038$). When evaluating CAPS subscales, there was differential improvement in symptoms of hyperarousal favoring the IE group, $d = -.80$ [95% CI −1.55, −.05]. $F(1,35.2) = 4.40$, $p = .044$). Though not statistically significant, there was a moderate effect of differential improvement in symptoms of re-experiencing ($d = -.67$ [95% CI −1.58, .24], $F(1,35.6) = 2.08$, $p = .159$) and avoidance/numbing ($d = -.55$ [95% CI −1.19, .10], $t(1,35.0) = 2.79$, $p = .104$).

3.3. Quality of life

Fig. 2 presents the distributions of change in WHOQOL-BREF physical and psychological domain scores for each group from baseline to post-treatment. Mixed model analyses using data from all assessment points showed greater improvement in the psychological domain among the IE group compared with waitlist ($d = .53$ [95% CI .16, −.90], $F(1100.3) = 8.43$, $p = .005$) but a smaller relative improvement in the physical domain ($d = .33$ [95% CI −.16, .82], $F(1101.4) = 1.80$, $p = .183$).

3.4. Treatment dropout and attendance

There was no significant difference in attrition between groups, with 5 participants (24%) discontinuing IE and 4 (15%) dropping from the waitlist condition, $\chi^2(1) = .53$, $p = .47$. Most attrition occurred immediately or shortly after randomization; of the 5 IE participants who dropped out, only 3 attended an exercise session, and of those, an average of 1.33 in-person sessions were attended prior to dropout. Treatment completers in the IE group ($n = 16$) attended 28 in-person sessions, on average ($SD = 11$, range 10–52). When at-home sessions are included, the average number of sessions for IE completers increased to 31 ($SD = 10$). In evaluating the data for a dose-response relationship, there were some small-to-moderate correlations between number of sessions completed and change scores, though none were statistically significant at the $p < .05$ level. All analyses utilized data representing in-person and home sessions. There was a moderate effect for a greater number of sessions completed to be associated with less reduction in PTSD symptom severity ($r = .34$, $p = .23$). However, greater number of sessions attended was associated with an improvement in physical quality of life ($r = .33$, $p = .25$) and psychological quality of life ($r = .25$, p = .39). Baseline levels of the outcome variables appeared to be moderately related to number of sessions ultimately attended, with higher baseline PTSD symptom severity associated with greater number of sessions attended ($r = .26$, $p = .35$), and lower baseline physical quality of life ($r = -.41$, $p = .13$) and psychological quality of life ($r = -.53$, $p = .04$) also associated with greater number of sessions attended.

3.5. Acceptability and feasibility

Overall, completers of IE ($n = 16$) reported high levels of satisfaction with the intervention. The most highly endorsed items regarded perceiving benefit from the treatment, learning new skills and techniques, receiving input from instructors regarding appropriate personal modifications, and experiencing the intervention to be engaging and

Table 1
Sample demographics.

	IE (n = 21)	WL (n = 26)	Test statistic	All participants
Age, mean (*SD*), years	47.42 (15.94)	46.31 (14.37)	$t(45) = .25$	46.80 (14.93)
Gender, no. (%)			$x^2(1) = .0003$	
Male	17 (80.95)	21 (80.77)		38 (80.85)
Female	4 (19.05)	5 (19.23)		9 (19.15)
Race, no. (%)			$x^2(6) = 5.23$	
Caucasian	12 (57.14)	13 (50.00)		25 (53.19)
Black/African American	4 (19.05)	8(30.77)		12 (25.53)
Asian	1 (4.76)	2 (7.69)		3 (6.38)
American Indian or Alaska Native	0 (.00)	1 (3.85)		1 (2.13)
Native Hawaiian or Other Pacific Islander	0 (.00)	1 (3.85)		1 (2.13)
More Than One Race	3 (14.29)	1 (3.85)		4 (8.51)
Other	1 (4.76)	0 (.00)		1 (2.13)
Hispanic	6 (28.57)	5 (20.00)	$x^2(1) = .46$	11 (23.91)
Education duration, mean (*SD*), years	16.10 (3.70)	15.35 (2.26)	$t(45) = .85$	15.68 (2.98)
Body Mass Index, mean (*SD*)	27.85 (5.45)	29.17 (7.48)	$t(43) = .66$	28.58 (.99)
Baseline CAPS, mean (*SD*)	64.25 (20.54)	58.50 (14.19)	$t(44) = 1.12$	61.00 (17.27)
PTSD duration, mean (*SD*), years	18.02 (14.36)	18.10 (14.88)	$t(44) = .02$	18.07 (14.49)
Current depression, no. (%)	7 (35.00)	9 (34.62)	$x^2(1) = .0007$	16 (34.78)
Other psychiatric comorbidity, no. (%)	13 (65.00)	14 (53.85)	$x^2(1) = .58$	27 (58.70)
Total number of comorbidities, mean (*SD*)	1.40 (1.14)	1.23 (1.11)	$t(44) = .51$	1.30 (1.11)
Taking psychiatric medication, no. (%)	8 (38.10)	11 (42.31)	$x^2(1) = .09$	19 (40.43)

Note: SD, standard deviation; CAPS, Clinician-Administered PTSD Scale; IE, Integrated Exercise; WL, Waitlist Control. All *ps* < .05. Certain items were missing for some participants: ethnicity (1 WL), Body Mass Index (1 IE, 1 WL), baseline CAPS (1 IE), PTSD duration (1 IE) current depression (1 IE), other psychiatric comorbidity (1 IE), total number of comorbidities (1 IE).

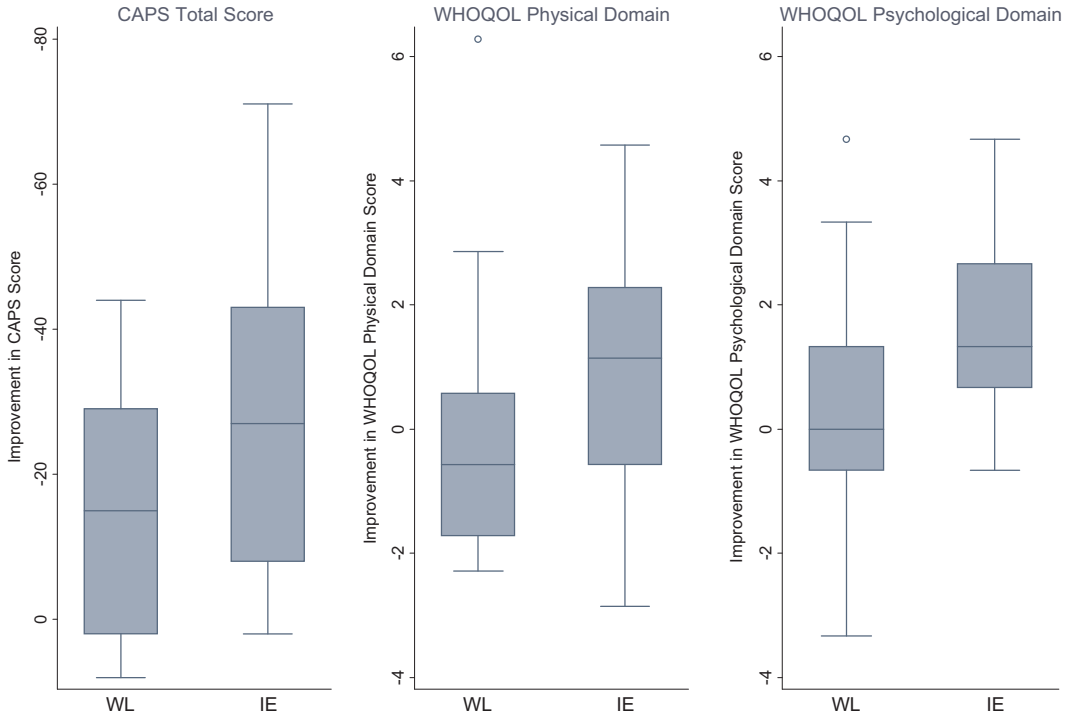

Fig. 2. CAPS, Clinician-Administered PTSD Scale; WHOQOL, World Health Organization Quality of Life, Brief Version; IE, Integrative Exercise; WL, Waitlist Control.

fun. In general, respondents agreed that the intervention was not burdensome, but there were mixed responses regarding the number of treatment sessions suggested (3 per week for 12 weeks), which is corroborated behaviorally by most participants attending fewer than the recommended 36 sessions. Table 3 provides descriptive statistics for each of the items on the Feasibility and Acceptability Questionnaire.

4. Discussion

This randomized pilot study evaluated the effect of IE on PTSD symptom severity and quality of life among veterans with PTSD. Participants in the IE group demonstrated greater improvement in PTSD symptom severity and psychological quality of life compared with participants randomized to WL. These results, combined with similar dropout to waitlist and high participant ratings of feasibility and acceptability, demonstrate promise for this intervention as a less stigmatizing and more familiar alternative to traditional PTSD treatments.

Patients treated with IE experienced an average reduction of 31 points on the CAPS – a clinically significant reduction in PTSD symptom severity. Though it is difficult to compare symptom reduction across trials with differing inclusion and exclusion criteria, this decrease in symptoms meets or exceeds the results of empirically supported

Table 2
PTSD symptom severity at intake and post-treatment.

	Intake		Post-treatment	
	IE	WL	IE	WL
CAPS Total	64.25 (20.54)	58.5 (14.19)	34.2 (19.62)	44.23 (23.62)
CAPS Re-experiencing	16.65 (7.75)	17.12 (6.41)	5.40 (6.14)	10.23 (9.26)
CAPS Avoidance/ Numbing	25.50 (9.97)	23.15 (8.92)	15.40 (11.30)	18.69 (11.21)
CAPS Hyperarousal	22.10 (7.50)	18.23 (6.80)	13.40 (8.42)	15.32 (8.23)

Note: CAPS, Clinician-Administered PTSD Scale; IE, Integrative Exercise; WL, Waitlist Control. Values are presented as mean (standard deviation). Statistics are reported based on intent-to-treat sample.

psychotherapies (i.e., Cognitive Processing Therapy (CPT), Prolonged Exposure Therapy) reported in other trials of veterans with PTSD (Forbes et al., 2012; Monson et al., 2006; Schnurr et al., 2007; Surís et al., 2013; Yehuda et al., 2014). In addition to total CAPS scores, we evaluated change in PTSD symptom clusters and found an advantage of IE over waitlist for symptoms of hyperarousal. In trials of empirically supported therapies for PTSD with veteran samples, report of response of individual symptom clusters has not been common. However, two studies of CPT did report symptom cluster results, and there was no advantage of CPT over waitlist (Monson et al., 2006) or present centered therapy (Surís et al., 2013) in change in hyperarousal in these trials. Thus, the improvement in hyperarousal symptoms among those in the current study's IE condition is particularly notable.

In addition to improvement in PTSD symptom severity, there was a moderate, statistically significant effect of IE on improvement of psychological quality of life, representing a broad effect on psychological well-being beyond the target symptoms of PTSD. However, though IE appears to be a predominantly a physical intervention, the advantage it had over WL on quality of life in the physical domain was relatively small and not statistically significant. It is possible that physical gains made by IE participants were not very large or did not map onto physical quality of life as defined by the WHOQOL-BREF, which includes items related to capacity for work, activities for daily living, and necessity for medical treatment to function, among others. It is also possible that other aspects of the intervention besides physical exercise were the mechanism for improved psychological quality of life. For example, based on the results of other studies of mindfulness-based protocols for PTSD (Kearney et al., 2012; Niles et al., 2012; Polusny et al., 2015), perhaps mindfulness principles were a particularly salient element of IE. Some other potential mechanisms for change include promotion of social interaction and behavioral activation. Additional investigations into these elements of the intervention should elucidate which aspects of the treatment promote change.

IE participants' responses on the Feasibility and Acceptability Questionnaire indicate the intervention was both practical and acceptable to veterans. All respondents agreed or strongly agreed that they felt they benefitted from this treatment, learned new skills and techniques, and would recommend the treatment to a friend. The instructors were also universally highly rated. However, responses on the questionnaire as well as attendance data raise questions as to the optimal "dose" of the intervention, both in terms of outcomes and what is logistically realistic for veterans. There was a wide range of attendance among IE completers: of the 36 sessions requested of participants, approximately one-third of completers attended at least that many sessions, while three participants attended fewer than 18 sessions. Further, some participants completed in-home sessions, which relied completely on self-report. Given the variability in attendance, we attempted to evaluate the data for evidence of a dose-response relationship. These analyses yielded results that were not statistically-significant but still merit consideration: as expected, greater number of sessions was associated with more improvement in quality of life; however, greater attendance was associated with less reduction in PTSD symptom severity. Given the small sample size, we are hesitant to make strong claims about the optimal "dose" of IE but hope to address this issue in subsequent trials. Additionally, veterans with the highest levels of symptoms at baseline were the most likely to attend sessions and the least likely to show a large therapeutic gain. It is possible that this group represents a treatment refractory subgroup of veterans that have been described in multiple treatment trials of combat veterans (Krystal et al., 2011). Logistical barriers to attendance, such as location and inherent travel demands, as well as days/times of classes offered, may have precluded greater attendance; some participants did indicate that these factors were not ideal for their schedule. As research of this and similar interventions continues, care should be taken to maximize participant engagement and evaluate the role of attendance in outcomes.

Limitations of the study include small sample size, use of inactive comparison condition, lack of assessment of cardio-metabolic outcomes, self-report of physical activity levels, and limits to generalizability. In spite of being an inactive control, there was a noteworthy average 15-point reduction in CAPS among participants in the waitlist

Table 3
Feasibility and Acceptability Questionnaire.

Item	Mean (SD)	Median (Min-Max)
Overall treatment impressions		
I feel like I benefitted from this treatment	4.81 (.40)	5 (4–5)
This treatment taught me new skills and techniques	4.75 (.45)	5 (4–5)
I would recommend this treatment to a friend who was dealing with similar issues	4.69 (.48)	5 (4–5)
I was able to tolerate this treatment well	4.44 (.89)	5 (2–5)
Content of intervention		
The instructors suggested modifications to match my fitness level/physical limitations to exercise	4.75 (.45)	5 (4–5)
The instructors were engaging and made class fun	4.75 (.45)	5 (4–5)
The breathing techniques covered in class were just right	4.25 (.58)	4 (3–5)
We spent the right amount of time on each exercise	4.31 (.70)	4 (3–5)
The exercises covered in class were just right	4.19 (.91)	4 (2–5)
I wish other exercises had been included	3.38 (1.15)	3 (1–5)
Length of intervention		
The 60 min workouts were too long[a]	4.13 (.62)	4 (3–5)
This treatment did not seem like too big of a burden	4.00 (.89)	4 (2–5)
I wish the treatment had been longer (i.e., more sessions)	3.44 (1.41)	3.5 (1–5)
The 36 session treatment (3 times per week for 12 weeks) was just the right length	3.31 (1.35)	3 (1–5)

Note: Response options ranged from 1 (strongly disagree) to 5 (strongly agree). Responses were collected from IE completers. [a]This item was reverse coded; i.e., the results indicate that most participants did not think the 60 min workouts were too long.

group. Nonetheless, the reduction of symptoms in the IE group was statistically significantly greater than the waitlist group. Still, it is not possible to rule out that an expectation of eventually being able to participate in IE may have driven an anticipatory reduction of symptoms among those randomized to WL. In future work, IE should be compared to gold-standard treatments for PTSD, such as empirically supported psychotherapies, not only in terms of efficacy, but also feasibility and acceptability. Another limitation of this study is the use of a self-report questionnaire to assess participation in exercise. Though the Godin Leisure-Time Exercise Questionnaire has been cited in hundreds of studies, more sophisticated tools exist to measure engagement in physical activity and may provide a more accurate measurement of participation in exercise. Furthermore, given the risk of several medical conditions associated with PTSD, the role of this intervention in improving both mental and physical health should be evaluated. Funding has been obtained (PI: Neylan) for a larger randomized clinical trial of IE vs. an attention control with psychoeducation classes. The larger sample size in this upcoming trial will facilitate greater statistical power to evaluate several remaining questions about this intervention, including potential mediators and moderators of treatment outcome. This trial will also include alternate measures of physical functioning, which may be a more accurate representation of participation in exercise compared with self-report.

Previous research has demonstrated that those with mental health diagnoses endorse the highest levels of stigma and barriers to treatment, and this is also the case for those with the highest level of PTSD symptom severity (Hoge et al., 2004; Ouimette et al., 2011). Thus, developing new, effective treatment options for these veterans is vital. IE is an innovative intervention for veterans with PTSD that may appeal to those averse to more traditional treatments for PTSD, and the data from this study initially support its efficacy in reducing symptoms of PTSD and improving psychological quality of life. This intervention may not only broaden access to those who do not pursue care due to perceived stigma but also may be an option for those who are unable to pursue traditional mental health care due to logistical barriers. Participant ratings of the intervention indicated high acceptability and feasibility, and attrition from IE was not significantly different from attrition in WL. Promoting engagement in any type of PTSD treatment can be difficult, and finding the right treatment for each person remains a challenge. Integrative exercise expands the options for PTSD care available to veterans in a way that is familiar to this population yet incorporates new skills that may promote recovery and wellness.

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Contributions

GJC, LST, MAC, and TCN obtained funding. WEM, TJM, BEC, DEB, LST, MAC, and TCN designed the study. LAG, WEM, TJM, AS, LST, JAH, MAC, and TCN collected and managed the data. LAG, WEM, TJM, BEC, DEB, SM, MAC, and TCN analyzed and interpreted the data. LAG, WEM, TJM, BEC, DEB, LST, SM, MAC, and TCN drafted and assisted with revisions of the manuscript. All authors approved the final manuscript.

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The funding sources did not have any role in the conduct of the research or the preparation of this article.

Conflicts of interest

None.

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