Effects Of Trauma-Informed Aquatic Therapy On Post-Traumatic Stress Disorder Symptoms Among Veterans

Running title: Aquatic Therapy For PTSD Symptoms

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Statements and Declarations

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Abstract

This study evaluated the effects of a non-exposure-based trauma-informed aquatic therapy treatment for post-traumatic stress (PTSD) symptoms among active-duty and military veterans. Participants engaged in up to eight treatment sessions over 8-10 weeks. Each individual treatment session was practitioner-led, lasted approximately 50-minutes, and performed at a private treatment facility. This single-arm trial enrolled 111 participants during calendar year 2023 for treatment. All participants had a prior medical diagnosis of PTSD as verified by medical/military records or a physician letter. The primary study outcome was changes in PTSD symptoms at baseline (pre-treatment) and after 4,6, and 8 treatment sessions using the PTSD Checklist Military Version (PCL-M). A total of 86/111

enrolled participants (77.5%) completed at least four sessions of treatment for post-testing. PCL-M scores averaged 56.2 (16.2) among all enrollees at baseline and 39.3(12.9) for those completing 4+sessions of treatment. The mean PCL-M reduction for the 86 participants with four+ treatments was 14.4 (14.2) points, $t(85)=9.4$, $p<.001$. Sixty-four percent of the latter achieved a PCL-M score reduction ≥10 points and 36% achieved a reduction ≥20 points. The results of this trial provide preliminary support for trauma-informed aquatic therapy as a potential non-exposure-based treatment for reducing PTSD symptoms among military populations.

Key words: Posttraumatic Stress; Aquatic Therapy; Veterans; WATSU; Clinical Trial

Posttraumatic stress disorder (PTSD) remains one of the most common and most disabling mental health conditions affecting U.S. active-duty and military veteran populations (Reisman, 2016; Wisco et al., 2022). With PTSD prevalence estimates as high, for example, as 15-20% among veterans of recent military conflicts in Iraq and Afghanistan – particularly among those with combat experience or multiple deployments – this translates to millions of affected service members (Armenta et al., 2018). Although generally defined as a psychiatric condition, research suggests that PTSD confers both adverse physical and psychological health effects. For instance, research indicates that PTSD is associated with many leading medical and psychiatric causes of death among veterans, including cardiovascular disease, cancer, diabetes, dementia, and suicide (Edmonson, et al., 2016; Fox, et al, 2021; Günak et al., 2020). Effective PTSD screening and treatment, therefore, may arguably be considered a practice for enhancing the overall healthcare of active-duty and military veterans, rather than solely addressing mental health symptoms.

PTSD providers can now offer multiple evidence-based treatments to patients. As indicated in the latest version of the Veteran Affairs/Department of Defense treatment guidelines for PTSD (Schnurr et al., 2024), these treatment options include PTSD psychotherapies, psychotropic agents, and eye movement reprocessing therapy.

Many of these treatments have also been recently validated in video therapy formats, increasing their accessibility. However, even with these numerous options, research shows that many people with PTSD fail to achieve a therapeutic response, whereas others prematurely terminate treatment due to adverse symptoms or side effects (Sloan et al., 2023; Watkins, Sprang, & Rothbaum, 2018). Such findings suggest a need for additional treatments. The recently resurgent interest in psychedelic substances such as MDMA and psilocybin, for example, may partly be a result of the continued absence of interventions for patients not responding to conventional evidence-based PTSD treatments (Krediet et al., 2020; Mitchell et al., 2023). Clinical trials examining non-exposure based behavioral treatments for PTSD, such as mindfulness meditation (Boyd, Lanius, & MacKinnon, 2018) and transcendental meditation (Nidich et al., 2018) are other recent examples of efforts to broaden the range of effective PTSD treatments.

The optimal future PTSD treatment landscape could offer every person with PTSD a form of treatment that is personally effective for their symptoms and without serious adverse side effects. This contrasts to the current standard of treatment efficacy, which is defined by averaged group outcomes rather than individual efficacy. Creating such a landscape will likely require multiple treatment options – some varying perhaps substantially in format and contents from traditional treatments – while remaining methodologically rigorous enough for scientific validation.

Towards this latter goal, the objective of the current paper is to describe treatment results using a novel non-exposure-based PTSD behavioral therapy called trauma-informed aquatic therapy (Corcoran et al., 2014; Schitter et al., 2020). Although conventional aquatic treatments (e.g., aquatic exercise) may reduce mood and anxiety symptoms (Tang et al., 2022), the trauma-informed aquatic therapy trialed in this study involved passive hydrotherapy and weekly treatment sessions with a licensed practitioner trained to guide participants through gentle poses and movements in a heated pool. The objective of this aquatic therapy experience was to enhance feelings of calm and trust and diminish PTSD symptoms while building physical and emotional pathways toward positive growth.

In a 2020 meta-analysis of passive hydrotherapy treatments such as those examined in this trial, medium to large effect size improvements were observed across domains including pain, physical function, and mental issues (Schitter et al., 2020). However, despite these promising findings, studies testing these passive hydrotherapy treatments among participants with established mental health conditions remain rare yet are essential for substantiating their clinical value.

This report describes results applying trauma-informed aquatic therapy across a full calendar year in an active-duty and military veteran population with diagnosed PTSD. The primary hypothesis for this study was that participation in the trauma-informed therapy would result in statistically and clinically significant reductions in PTSD symptoms as measured by a validated PTSD symptom measure prior to and post-treatment.

Methods

Participants

Study participants were veteran and active-duty adults with a diagnosis of PTSD receiving the trauma-informed aquatic therapy through Healing Wave Aquatics (https://healingwaveaquatics.org/) during calendar year 2023. PTSD diagnoses were established by each participant's medical records or by a letter from their physician or mental health provider affirming the diagnosis (i.e., a diagnostic interview was not performed). Prior to treatment, participants completed an intake form self-reporting information about demographic factors, medical conditions, traumatic brain injury history, military sexual trauma, gender preference for their treatment provider (participants were gender matched with a practitioner based on their stated preference), and suicide history. The study was approved by the university IRB as a retrospective study of anonymous pre-existing data.

Study design

The study consisted of a single-arm repeated measures design comparing participant's pre-treatment (baseline) PTSD symptoms to their symptoms after designated treatment sessions (no randomization was involved; all participants received the same treatment in the same sequence). Although the trauma-informed aquatic therapy treatment consisted of 8-sessions by design, participants' PTSD symptoms were also assessed after treatment sessions 4 and 6 – in addition to following session 8 – to maximize the capture of relevant treatment changes among those terminating treatment early.

Measurement of PTSD symptoms

The primary outcome of the study was changes in PTSD symptoms as measured by the PTSD Checklist Military Version (PCL-M [Weathers et al., 1993]) at baseline and after designated treatment sessions (pre-treatment, and post-sessions 4,6, and 8). The PCL-M is a validated, 17-item questionnaire for assessing PTSD symptoms. Responses options range from 1 "Not at all" to 5 "Extremely." Total PCL-M scores range from 17-85. Scores ≥36 are recommended as a clinical indicator of PTSD (https://www.ptsd.va.gov/professional/assessment/documents/PCL_handoutDSM4.pdf) . It was originally designed to evaluate symptoms in accordance with a diagnosis of PTSD as described in the Diagnostic and Statistical Manual of Mental Disorders (DSM–IV). The PCL-M was replaced in 2013 by the PCL-5 (Weathers et al., 2013) with the publication of the DSM-5. However, Healing Wave Aquatics

was still using the PCL-M at the time of this study (the PCL-5 was implemented at their facility in 2024). In practice, the results of the PCL-M and PCL-5 correlate highly (Blevins et al., 2015). A decrease of 10 points or more on the PCL-M was established as a minimum standard for clinically significant improvement on PTSD symptoms (Monson et al., 2008).

Participant satisfaction ratings

Following each trauma-informed aquatic therapy treatment session, participants rated their treatment satisfaction on the following question: "How comfortable did you feel with today's session?". The question was scored in a Likert-scale format, ranging from 1 (Not at all comfortable) to 5 (Very comfortable). For each participant, we averaged their individual session ratings to create an overall treatment satisfaction rating.

Trauma-informed aquatic therapy intervention

The trauma-informed aquatic therapy treatment in this study consisted of up to eight weekly individual 60-minute sessions with licensed practitioners who had completed additional training in providing treatment for participants with PTSD. All the treatment sessions were conducted in a temperature-controlled pool at the Healing Wave Aquatics facility.

Trauma-informed aquatic therapy is an adaptation of water-based bodywork exercises developed in the 1980's. The treatment is grounded in the Japanese healing art known as shiatsu and adapted to an aquatic environment. For this reason, these treatments are sometimes abbreviated as WATSU ("water shiatsu") with a history of application to a range of physical and mental health symptoms (Schitter et al., 2020).

The trauma-informed aquatic therapy sessions were designed to provide a safe, trustworthy environment in which participants could experience novel postural and movement experiences geared towards improving joint mechanics, tissue elasticity, and improving the functioning of the respiratory apparatus. The practitioner manually guided the participant through comfortable, safe, and supported movements based on the cues provided by the participant before, during, and over the course of multiple sessions. Figure 1 illustrates several sample trauma-informed aquatic therapy sequences. The aquatic therapy content of the eight treatment sessions was non-standardized to provide flexibility to meet individual participant's pace, comfort, and preferences. This means that the session design for each participant was specific to the unique requirements and constraints of the participant's emotional and structural needs. The pace and number of positions used for each trauma-informed aquatic therapy session was intended to vary from one participant to another and vary across sessions with the same participant. The practitioner sequenced the sessions using verbal, auditory, visual, and tactile cues from the participants during the session.

Insert Figure 1 about here

Despite the non-standardized content of each trauma-informed aquatic therapy session, each session contained a treatment arc. The beginning of each session drew participants attention towards their somatic cues in the buoyant aquatic environment. Breath, sink or buoyancy, movement resistance or ease, are just a few factors that can elicit this response. The participant was then positioned supine in the water with float straps or noodles on their legs and separate head/neck supports, creating a comfortable and safe supine position in the water. During the body of the session, the practitioner chose positions and movement sequences to aid the sense of relaxation for the participant. Providing spinal movement in the case of spinal stiffness and rotation to stiff hips are examples of this type of assessment. These movements emphasized the freedom and ease of movement for the participant using water pressure, drag and buoyancy. The end of the session reintroduced the body to the weight of gravity and the contact of the body on a solid surface. The participant was frequently docked on the wall of the pool in a sitting position to assist them in transitioning back into being responsible for supporting their own body again. Participants and their practitioner were permitted to communicate both verbally and nonverbally during sessions, but nonverbal signals were emphasized to minimize distractions to improve participants' focus on their body and breath.

Statistical analyses

We initially performed descriptive and frequency statistics on demographic factors collected pre-treatment. The latter factors included age, gender (binary male-female), race (including categories of white, black, and "other" to create groups with sample sizes large enough for comparison), military branch of service (air force, army, navy, marines, coast guard, and multiple branches), era served, veteran versus active-duty status (binary), marital status (single, married, divorced, separated, and partnered), and parent status using SPSS (version 29).

Primary analyses consisted of repeated measures analysis of variance comparing pre-treatment to post-treatment PCL-M scores. We calculated effect sizes in Hedge's g values (calculated as a sample size-corrected ratio of mean treatment differences divided by the pooled standard deviation. For moderate to large sample sizes, Hedge's g values are equivalent to Cohen's d effect size values). Hedge's g values $\geq .80$ are conventionally interpreted as large effect sizes (Lakens, 2013). As a secondary analysis to quantify clinical significance, we further categorized the percentage of participants achieving clinically significant change standards of ≥ 10 point and ≥ 20 points on the PCL-M. In exploratory analyses, we performed independent t-tests (for binary variables) and analysis of variance (for variables with>2 groups) to examine differences in PCL-M changes across demographic factors.

To evaluate the adequacy of our statistical power for detecting changes, we performed a power calculation estimating a medium effect size (Hedge's g=.50), an α level of .05 and a 2-sided test. In this calculation, the minimum number of sample pairs for achieving a power level ≥80% was 34 (Dhand & Khatkar, 2014). This result indicated that the current study sample had sufficient power to detect PTSD symptom reductions of a moderate or greater effect size.

Results

Table 1 provide a descriptive summary of the study sample. The baseline sample (N=111) was primarily middle-aged, male, and comprised of military veterans rather than active-duty personnel. More than 40% of the baseline sample described their race as non-white, >75% reported education levels above the high school level, and the majority indicated their military service in the Army, Marines, or Navy. Just over 20% of the sample reported being homeless or in transitional living circumstances. The baseline PCL-M scores (mean=56.2 [16.2]) were consistent with clinically elevated PTSD symptoms.

Treatment participation was very high overall, with modal number of trauma-informed aquatic therapy sessions being 8/8. Participant satisfaction levels were also rated highly, with a mean average rating of 4.9/5 (SD=.16) and a modal rating of 5/5 (92.2% of all individual sessions were rated at 5/5 satisfaction by participants, based on a total of 780 sessions during 2023 from which satisfaction data were collected). However, 25 participants discontinued treatment before session 4 (when the first treatment PCL-M was administered). When comparing the 25 participants who discontinued treatment early to the 86 participants completing 4 or more treatment sessions on demographic factors, we found no significant differences in age, employment or education status, pre-treatment PCL-M scores, years of military service, or active-duty versus veteran status. However, women were significantly more likely to discontinue treatment early (10/25 women) relative to men (19/86 men), p=.02.

Insert Table 1 about here

PTSD symptom changes across treatment.

Table 2 summarizes changes in PCL-M measured PTSD symptoms among the 86 participants with pre-and-post-treatment data. The mean change in PCL-M score was 14.4 points (p<.001), corresponding to a Hedge's g effect size value of .99 (95% CI=.74-1.25). Table 2 also displays treatment outcomes by the size of PCL-M changes in 10-unit metrics. Based on this result, 64% of the sample (55/86 participants) showed a PCL-M reduction of 10 or more points. Thirty-six percent (31/86 participants) reported a minimum reduction ≥20 points on the PCL-M.

Insert Table 2 about here

Factors associated with PCL-M treatment changes.

Table 3 describes the results of statistical tests comparing PCL-M changes across demographic factors. We observed no statistically significant differences in treatment response based on gender, active-duty versus veteran status, race, parenting status, housing status, or branch of military service.

Discussion

This report describes what we believe are the first clinical trial results statistically evaluating the efficacy of trauma-informed aquatic therapy for the treatment of PTSD symptoms in a military population with an established PTSD diagnosis. Paralleling other recently trial-tested potential treatments for PTSD such as psychedelics (Krediet et al., 2020; Mitchell et al., 2023) and meditation (Boyd et al, 2018; Nidich et al., 2018), trauma-informed aquatic therapy is a non-exposure-based treatment modality. Another similarity to meditation treatments for PTSD is that trauma-informed aquatic therapy represents a minimal risk, non-medication approach that avoids potential side effects from medicines as well as the adverse emotional reactions sometimes reported to trauma-focused psychotherapies. However, unlike psychedelics – involving the clinically supervised use of a psychedelic substance in a hospital – or learning a meditation practice in a class or meditation program, trauma-informed aquatic therapy requires a therapeutic pool setting, a series of weekly visits, and the hands-on guidance of licensed practitioners trained in the therapy. Trauma-informed aquatic therapy is believed to help reduce PTSD symptoms through progressive increases in safety, trust, and relaxation resulting from the session content (Corcoran et al., 2014). Because military populations are particularly vulnerable to trauma and PTSD (Armenta et al., 2018; Reisman, 2016; Wisco et al., 2022) they were the focus of this treatment trial.

Although preliminary, the results from the initial trial are promising in their support of trauma-informed aquatic therapy for treating PTSD. Even in this military population presenting with PTSD symptom levels well above conventional standards for defining clinically significant symptoms, the average treatment response was consistent with a large effect size (Hedge's g=.99, equivalent to approximately a one standard deviation reduction in symptoms). Sixty-four percent of participants attending at least four treatment sessions achieved a clinically significant response (≥10 points) and more than one-third showed symptom decreases exceeding 20 points on the PCL-M. The magnitude of these PTSD symptom reductions for trauma-informed aquatic therapy compares favorably with effect sizes reported for established evidence-based treatments summarized in recent PTSD treatment

guidelines (Schnurr et al., 2024). The effect sizes we observed for PTSD symptoms in this study are also consistent with or higher than those reported in a 2020 meta-analytic review summarizing the effects of passive hydrotherapy treatments such as trauma-informed aquatic therapy across 27 independent studies on related health conditions (Schitter et al., 2020).

Arguably the primary strength of the current trial results is the high level of external validity. Specifically, the program enrolled a broad sample of active-duty and military veterans who were referred by a community provider or self-seeking treatment. The treatment was further evaluated in a population with an established diagnosis of PTSD and clinically elevated symptoms as measured by a validated measure in the PCL-M. This methodology contrasts to conventional clinical trials that usually recruit using more extensive inclusion and exclusion criteria to enroll a more homogenous sample. The current study sample, in contrast, was heterogeneous, including substantial diversity in demographic factors and the design employing minimal exclusion criteria for participating. The "naturalistic" design of the current results, therefore, may increase the generalizability of the results to the overall population of active-duty and military veterans with PTSD. Notably, this same strength also implies that an important unknown from the current findings is whether the results apply equally to non-military populations with PTSD.

The high external validity from the current study design, however, necessarily came at the expense of lower internal validity. For example, the retrospective nature of this initial trial design prevented inclusion of a placebo control condition (e.g., conventional exercise-based aquatic therapy could serve as a rigorous placebo condition in a future randomized clinical trial design to evaluate the specific benefits of trauma-informed aquatic therapy) or wait-list control group. To establish the PTSD symptom reduction benefits specific to the treatment, it will be critical in subsequent research to include design features that control for the non-specific factors of the trauma-informed aquatic therapy, such as warm water, therapeutic environments, and physical touch. Similarly, it will be necessary to modernize the assessment of PTSD symptoms with trauma-informed aquatic therapy using the newer PCL-5 reflecting the most current diagnostic symptoms for PTSD (Weathers et al., 2013) in future research (this step has already initiated at the treatment location for this study) and specifically assess changes in theoretically proposed PTSD treatment mechanisms such as safety, trust, relaxation, and other positive emotions through validated self-report measures, clinical interviews, or imaging techniques such as fMRI. In the context of evaluating the data for this paper, the program is also now integrating measures of depression (Kroenke, Spitzer, & Williams, 2001) and positive emotions (Watson, Clark, & Tellegen, 1988) to capture treatment-related changes in these important dimensions.

Summary.

The current report provides the first quantitative assessment of a novel, non-exposure-based behavioral treatment called trauma-informed aquatic therapy in a military population with established PTSD. In this clinical sample of active-duty and military veterans participating in up to eight weekly sessions of treatment, we observed statistically and clinically significant reductions in PTSD symptoms as determined comparing pre-to-post-treatment symptom changes on the PCL-M. Treatment satisfaction was also rated very highly by participants and no adverse events were observed.

These preliminary efficacy and safety data are supportive of the potential benefits of trauma-informed aquatic therapy and the need for future research including design features to control for nonspecific treatment factors, evaluate the durability of treatment effects, and potentially compare directly to more established PTSD treatments.

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Figure captions.

Figure 1. Illustration of common instructor-led treatment poses during trauma-informed aquatic therapy (all participants and practitioners provided consent for these images).

Table 1. A description of the participating sample at baseline (N=111).

Variable	Baseline status
Age (mean in years [SD])	41.1(11.9)
Race (% white/black/other)	56.8/19.8/23.4
Gender (% female)	26.1
Marital status (single/married/divorced/other)	30.6/28.8/29.7/10.8
Active-duty/military veteran (%)	9.0/91.0
Years of military service (mean [SD])	8.7(6.4)
Education level (%) • High school/GED • Trade school or college • Master's degree or greater	 9.9 76.5 13.5
Employed (%)	42.3
Have children (%)	52.2
Currently enrolled in college/trade school (%)	21.6
Military branch (Air Force/Army/Coast Guard/Marines/ Navy/multiple; %)	4.5/27.9/4.5/18.0/43.2/1.8
Homeless or in transitional living (%)	21.6
Number of treatment sessions attended (mean[SD]/mode [out of a maximum 8 sessions])	6.2(2.5)/8
Treatment satisfaction rating (mean[SD])	4.9/5.0 (.16)
PTSD symptoms at baseline*	56.2 (16.2)

* Assessed using the PTSD Checklist Military Version (PCL-M)

Table 2. PTSD symptom changes (PTSD Checklist Military Version [PCL-M] scores) across treatment and percentages achieving metrics of clinically significant PTSD symptom reduction (n=86 with pre-and-post-treatment data).

Baseline PCL-M	**Post-treatment PCL-M**	**Mean change in PCL-M score**	**F-value/p-value**	**Hedge's g/95% CI (effect size)**
53.73(15.8)*	39.3(12.9)	14.4 (14.2)	88.0/<.001	.99 (.74-1.25)
Percent achieving PCL-M symptom reduction levels across treatment				
<10 PCL-M reduction	36.0%			
10-19 PCL-M reduction	28.0%			
20-29 PCL-M reduction	18.6%			
>30 PCL-M reduction	17.4%			

* The baseline PCL-M value differs from the overall sample PCL-M mean reported in Table 1 because 25/111 participants discontinued before completing a minimum of four sessions).

Table 3. Comparisons of treatment-related PTSD symptom changes by demographic variables (n=86).

Demographic factor	PCL-M mean treatment change by group	Test result/p-value
Gender (male-female)	Female=14.6(13.1); Male=14.3(14.6)	t=.10, p=.93
Active-duty vs. veteran	Active-duty=13.1(13.5); veteran=14.5(14.4)	t=.29, p=.77
Race	White=13.6(13.1); Black=9.7(16.2); Other=20.7(14.3)	f=2.8; p=.06
Parenting status	Parent=13.7(14.8); Non-parent=15.1(13.6)	t=.45; p=.65
Housing status	Homeless/transition=15.1(18.5); Housed=14.3(13.6)	t=.20; p=85
Military branch	Army=15.0(14.1); Marines=14.5(17.7); Navy=14.7(13.9)	f=.32; p=.90