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Posttraumatic Stress Disorder Symptom Changes Among Veterans Participating in Trauma-Informed Aquatic Therapy: A 1-Year Retrospective Study

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ABSTRACT

This study assessed posttraumatic stress (PTSD) symptom changes among active-duty and military veterans before and after participating in a non-exposure-based trauma-informed aquatic therapy treatment. Participants engaged in up to eight treatment sessions over 8–10 weeks. Each individual treatment session was practitioner-led, lasted approximately 50-min, and performed at a private treatment facility. This single-arm retrospective trial enroled 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 up to 8 treatment sessions using the PTSD Checklist Military Version (PCL-M). A total of 86/111 enroled 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 change for the 86 participants with 4+ sessions was 14.4 (14.2) points, $p < 0.001$. Sixty-four percent of the latter showed a PCL-M score change $\geq$ 10 points and 36% showed a change $\geq$ 20 points. The results of this retrospective trial provide preliminary support for trauma-informed aquatic therapy as a potential non-exposure-based treatment for reducing PTSD symptoms among military populations.

1 | Introduction

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 (Wisco et al. 2022; Reisman 2016). 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 (Edmondson et al. 2013; 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 treatment providers can now offer multiple evidence-based interventions to patients. As indicated in the latest

version of the Veteran Affairs/Department of Defence 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 (Watkins et al. 2018; Sloan et al. 2023). 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 (Mitchell et al. 2023; Krediet et al. 2020). Clinical trials examining non-exposure based behavioural treatments for PTSD, such as mindfulness meditation (Boyd et al. 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 a focus on 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.

Toward this latter goal, the objective of the current paper is to describe treatment results using a novel non-exposure-based PTSD behavioural therapy called trauma-informed aquatic therapy (Corcoran et al. 2016; 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 licenced practitioner trained to guide participants through gentle poses and movements in a heated pool. The goal of this treatment was to reduce PTSD symptoms by promoting increased feelings of relaxation, safety, and trust.

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 retrospective analysis describes results applying trauma-informed aquatic therapy across a full calendar year in 2023 among active-duty and military veteran populations with a documented PTSD diagnosis. The primary hypothesis for this study was that participants would report statistically and clinically significant reductions in PTSD symptoms at the end of their treatment compared to baseline status.

2 | Methods

2.1 | 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. Participants were allowed to receive other PTSD/mental health treatments while engaging in their trauma-informed aquatic therapy. The study was approved by the university IRB as a retrospective trial of anonymous pre-existing data.

2.2 | Study Design

The study consisted of a retrospective clinical trial design comparing participant's pre-treatment (baseline) PTSD symptoms to their symptoms after designated treatment sessions using 2023 data. Although the trauma-informed aquatic therapy treatment consisted of 8-sessions by design, all participants' PTSD symptoms were also assessed after treatment sessions 4 and 6—in addition to following session 8—to maximise the capture of relevant treatment changes and patterns of change among those terminating treatment early. The decision to evaluate PTSD symptoms at these intervals was made by leadership at Healing Wave Aquatics to regularly quantify their treatment effects without added excess participant burden.

3 | 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. 2013)) at baseline and after designated treatment sessions (pre-treatment, and post-sessions 4, 6, and 8). Participants completed the PCL-M with Healing Wave Aquatics support staff (not the trauma-informed aquatic therapy instructors) at these time points. 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 $\geq$ 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 dec). 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).

3.1 | 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.

3.2 | Trauma-Informed Aquatic Therapy Intervention

The trauma-informed aquatic therapy treatment in this study consisted of up to eight weekly individual 60-min sessions with licenced 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 1980s. 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 created to provide a safe, trustworthy environment in which participants could experience novel postural and movement experiences geared toward 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 content 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.

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 toward 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

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

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 emphasised 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 emphasised to minimise distractions to improve participants' focus on their body and breath.

3.3 | Statistical Analyses

In our retrospective analyses for the study, 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. We also employed non-parametric tests as a maximally conservative approach to evaluating treatment-related changes in PTSD symptoms.

Primary analyses consisted of a Wilcoxon signed-rank test comparing pre-treatment to post-treatment PCL-M scores (participants who dropped out of treatment prior to session 4 were not included due to a lack of post-treatment data). 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 is a widely used effect size because of its ease of interpretation and being robust to sample size variability. Values ≥ 0.80 are conventionally interpreted as large effect sizes (Lakens 2013 nov 26). As a secondary analysis to quantify clinical significance, we further categorised 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 Mann-Whitney U tests (for two group comparisons) and Kruskal–Wallis tests (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 $g = 0.50$), an α level of 0.05 and a 2-sided test. In this calculation, the minimum number of sample pairs for achieving a power level $\geq 80\%$ was 34 (Dhand and 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.

4 | 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 = 0.16) 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, regarding attrition, 25 participants discontinued treatment

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	9.9
Trade school or college	76.5
Master's degree or greater	13.5
Employed (%)	42.3
Have children (%)	52.2
Currently enroled 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 (0.16)
PTSD symptoms at baseline[a]	56.2 (16.2)

[a]Assessed using the PTSD checklist military version (PCL-M).

before session 4 (when the first post-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, gender, employment or education status, pre-treatment PCL-M scores, years of military service, or active-duty versus veteran status (all comparisons $p > 0.05$ using a Mann-Whitney U Test).

4.1 | PTSD Symptom Changes Across Treatment

Table 2 summarises 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 ($p < 0.001$), corresponding to a Hedge's g effect size value of 0.99 (95% CI = 0.74–1.25). 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. In addition to the Table 2 data, mean PCL-M scores across the baseline, session 4, session 6, and session 8 visits were (52.2 [16.3], $N = 111$), (44.2 [15.2], $N = 76$), (47.7 [14.4], $N = 43$), and (39.3 [12.9], $N = 86$), respectively.

4.2 | Factors Associated With PCL-M Treatment Changes

Table 3 describes the results of statistical tests (Mann-Whitney U test for two group comparisons and Kruskal–Wallis test for multiple groups) 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.

5 | Discussion

This report describes retrospective clinical trial results statistically evaluating the association of trauma-informed aquatic therapy with changes in PTSD symptoms in a military population with an established PTSD diagnosis. Parallelling other recently trial-tested potential treatments for PTSD such as psychedelics (Mitchell et al. 2023; Krediet et al., 2020) 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 programme, trauma-informed aquatic therapy requires a therapeutic pool setting, a series of weekly visits, and the hands-on guidance of licenced practitioners trained in the therapy. Trauma-informed aquatic therapy is theorized to help reduce PTSD symptoms through progressive increases in safety, trust, and relaxation resulting from the session content (Corcoran et al. 2016). Because military populations are particularly vulnerable to trauma and PTSD (Wisco et al. 2022; Reisman 2016 oct; Armenta et al. 2018) they were the focus of this retrospective treatment trial.

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	*Z*-value/ *p*-value	Hedge's *g*/95% CI (effect size)
53.73 (15.8)[a]	39.3 (12.9)	14.4 (14.2)	6.7/< 0.001	0.99 (0.74–1.25)
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%	

[a]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	*p*-value
Gender (male-female)	Female = 14.6 (13.1); Male = 14.3 (14.6)	0.99
Active-duty versus veteran	Active-duty = 13.1 (13.5); veteran = 14.5 (14.4)	0.77
Race	White = 13.6 (13.1); Black = 9.7 (16.2); Other = 20.7 (14.3)	0.06
Parenting status	Parent = 13.7 (14.8); Non-parent = 15.1 (13.6)	0.37
Housing status	Homeless/transition = 15.1 (18.5); Housed = 14.3 (13.6)	0.85
Military branch	Army = 15.0 (14.1); Marines = 14.5 (17.7); Navy = 14.7 (13.9)	0.25

Although preliminary, the results from the initial study are promising in their support of trauma-informed aquatic therapy for reducing PTSD symptoms. 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 $g = 0.99$, 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 ($\geq$ 10 points (Weathers et al. 1993)) and more than one-third showed symptom decreases exceeding 20 points on the PCL-M. The magnitude of these PTSD symptom reductions during trauma-informed aquatic therapy compares favourably with effect sizes reported for established evidence-based treatments summarised 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 summarising 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 results is the high level of external validity. Specifically, the programme enroled 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 enrol 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' nature of the current results, therefore, may increase the generalisability 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.

5.1 | Limitations and Future Research Questions

The high external validity from the current study design necessarily came at the expense of lower internal validity. For example, the retrospective nature of this initial trial design prevented inclusion of a randomized 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. Similarly, because the trauma-informed treatment in this study was partly tailored for each participant (e.g., higher external validity for real-world application), it lacked the rigorous treatment standardisation often emphasised in clinical trials to optimise internal validity. Notably, the treatment customisation in this study included personal modifications to both the trauma-informed aquatic exercises and communication between the treatment providers and participants. Variations in each (or their combination) could affect treatment responses. Thirdly, although the trauma-informed aquatic therapy is similar to other non-exposure-based treatments for PTSD such as meditation, it is important to highlight that the aquatic treatment used in this study requires specialised resources such as a heated pool and trained providers, making it comparatively more difficult for participants to practice long-term.

To establish the PTSD symptom reduction benefits specific to the treatment, it will be critical in subsequent research to include methodological features that control for the non-specific factors of the trauma-informed aquatic therapy, such as warm water, therapeutic environments, and physical touch. Because we allowed participants to concurrently receive other mental health treatments while in their aquatic therapy, these overlapping treatments could also explain at least part of the PTSD symptom reductions we observed. Future studies may consider limiting other treatments or at least tracking them to control as covariates. Similarly, it will be necessary to modernise 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), to include a follow-up assessment to evaluate the stability of symptom improvements, 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 programme is also now integrating measures of depression (Kroenke et al. 2001 sep) and positive emotions (Watson et al. 1988) to capture treatment-related changes in these important dimensions. Although it is a strength of the current study that all participants had a medical diagnosis of PTSD to participate in treatment, we did not include diagnostic interviews (such as the Clinician-Administered PTSD Scale for DSM-5) to verify this condition as is often performed in prospective clinical trials.

5.2 | Summary

The current retrospective report provides the first quantitative assessment of a novel, non-exposure-based behavioural 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 for PTSD symptoms and encourage future research including methods to adjust for nonspecific treatment factors, include control groups, measure treatment mechanisms, evaluate the durability of

treatment effects, and potentially compare directly to more established PTSD treatments.

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The authors have nothing to report.

Ethics Statement

This study was IRB approved as part of the submission process.

Consent

The authors have nothing to report.

Conflicts of Interest

Dr. Rutledge declares no conflicts of interest. Elizabeth Berg is the Executive Director of Wave Academy (Healing Wave Aquatics) in San Diego, the company providing the treatment and data evaluated in this manuscript.

Data Availability Statement

Data used for the analyses reported in this manuscript are available by request.

Permission to Reproduce Material

The authors have nothing to report.

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