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Breaking the surface: Psychological outcomes among U.S. active duty service members following a surf therapy program

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ABSTRACT

Objectives: Although surf programs for individuals with psychological and physical conditions exist, data evaluating such programs are limited. This study examined psychological outcomes among 74 active duty service members participating in the Naval Medical Center San Diego surf therapy program.
Design: The study used a single-group, longitudinal design involving repeated measurement to assess outcomes following the program and within sessions.
Method: Service members completed self-report questionnaires before and after the 6-week program and before and after each surf therapy session.
Results: Total scores for symptoms of depression ($\beta = -2.31$, $p < .01$), anxiety ($\beta = -3.55$, $p < .001$), PTSD (probable PTSD subgroup only; $\beta = -14.55$, $p < .001$), and negative affect ($\beta = -6.40$, $p < .001$) significantly decreased from pre-to post-program, while positive affect significantly increased ($\beta = 9.46$, $p < .001$). During each session, depression/anxiety symptoms significantly lessened ($\beta = -3.35$, $p < .001$) and positive affect significantly improved ($\beta = 8.97$, $p < .001$). The magnitude of within-session changes did not differ across sessions ($p > .05$). Results for subgroups with probable PTSD or major depressive disorder were comparable to those of the full sample.
Conclusions: Immediate benefits of surf therapy included significantly reduced depression/anxiety and increased positive affect. As a complementary intervention, surf therapy may improve depression, anxiety, and PTSD symptoms with potentially unique benefits on affect.

Many U.S. active duty service members suffer from physical injuries (Fischer, 2014) and psychological conditions (Blakeley & Jansen, 2013), such as posttraumatic stress disorder (PTSD) and major depressive disorder (MDD). PTSD and MDD can have widespread effects on service members and society through impairments in social and occupational functioning, co-occurring psychological and physical conditions, medical care and lost productivity costs, and even suicide (Tanielian et al., 2008). Although traditional therapies (e.g., evidence-based psychotherapies, pharmacotherapy) for these conditions exist, individuals may not prefer, have access to, or benefit from these approaches. As a result, there has been increasing interest in complementary approaches that may also be effective in treating psychological symptoms, either alone or in conjunction with traditional treatments.

Previous research has indicated that various forms of physical activity—such as cardiovascular exercise and resistance training—can have positive effects on mental health outcomes (Rosenbaum, Tiedemann, Sherrington, Curtis, & Ward, 2014). For example, among individuals with MDD, physical activity has been shown to have a large and significant effect on depression symptoms (Schuch et al., 2016).

Abbreviations: CSQ-8, 8-Item Client Satisfaction Questionnaire; GAD-7, Generalized Anxiety Disorder 7-Item Scale; ISI, Insomnia Severity Index; LEC-5, Life Events Checklist for DSM-5; MDD, major depressive disorder; MLM, multilevel modeling; NAS, Negative Affect Schedule; NMCSD, Naval Medical Center San Diego; PANAS, Positive and Negative Affect Schedule; PAS, Positive Affect Schedule; PCL-5, PTSD Checklist for DSM-5; PHQ-4, 4-Item Patient Health Questionnaire; PHQ-8, 8-Item Patient Health Questionnaire; PTSD, posttraumatic stress disorder; NPRS, Numerical Pain Rating Scale

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Exercise may also be beneficial in improving the psychological health of individuals with PTSD (Hegberg, Hayes, & Hayes, 2019; Rosenbaum et al., 2015; Whitworth & Ciccolo, 2016). These studies support the growing theoretical notion of 'exercise as medicine,' which suggests that physical activity may offer therapeutic benefits for a variety of psychological conditions among numerous populations, including the military (Caddick & Smith, 2017; Greer & Vin-Raviv, 2019). More specifically, physical activity is thought to facilitate psychological improvements through the release of hormones, enhanced physiological functioning, and group-level social processes (Caddick & Smith, 2017; Craft & Perna, 2004).

Research indicates that exercise is an effective tool for improving psychological health, but physical activity that occurs in a natural environment may yield even greater benefits. Natural environments can replenish depleted cognitive attention (Berman, Jonides, & Kaplan, 2008), reduce stress (Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010), and create feelings of well-being (Ryan et al., 2010); this suggests that the benefits of physical activity may be enhanced when the activity takes place in a natural setting (Caddick Smith, & Phoenix, 2015). In accord with this argument, a recent meta-analysis found that performing physical activity outdoors in a natural environment, compared with indoors, produced greater reductions in tension, anger, and depression (Thompson Coon et al., 2011).

Although exercise in any natural environment may contribute to psychological well-being (Barton & Pretty, 2010; Pretty, Peacock, Sellens, & Griffin, 2005), exercising outdoors in the presence of water has been shown to produce the greatest improvements in self-esteem and mood (Barton & Pretty, 2010). Programs that encompass water-based activities within a natural environment have demonstrated psychological benefits for veterans who served in Iraq and Afghanistan (Lundberg, Bennett, & Smith, 2011). Similar findings were reported for veterans participating in fly-fishing (Bennett, Piatt, & Van Puymbroeck, 2017), kayaking (Dustin, Bricker, Arave, Wall, & Wendt, 2011), and sailing (Gelkopf, Hasson-Ohayon, Bikman, & Kravetz, 2013). Given that surfing is an activity requiring immersion in water, it may serve as a particularly therapeutic physical activity.

Interacting with others in a social environment is another element of psychological interventions that has been consistently shown to improve psychological health (Umberson & Montez, 2010). Relationships developed during sports programs can improve mood, increase the desire to develop social connections more broadly, and normalize past experiences (Carless, Peacock, McKenna, & Cooke, 2013; Mowatt & Bennett, 2011). Military personnel who participated in a 5-day adaptive sports and adventure training course experienced positive social outcomes as a result of their involvement (Carless et al., 2013). In the specific context of surfing, Caddick, Smith, and Phoenix (2015) found that U.K. veterans with PTSD who participated in group-based surfing commonly described feeling connected to and supported by others in this environment, rather than feeling socially isolated. Although surfing could be regarded as a solitary sport, a great deal of time is spent waiting for waves, which provides opportunities to socialize with others in the water (Fleischmann et al., 2011). As a result, surfing may provide an opportunity to combine the demonstrated advantages of participating in water-based sports and engaging in activities that result in social interaction, ultimately serving to improve psychological health.

Receiving psychological benefits through the activity of surfing (termed "surf therapy") may be especially valuable among service members—particularly those experiencing symptoms associated with PTSD and MDD. Researchers note that the stigmatization of mental health in the military may prevent some service members from seeking help (Dickstein, Vogt, Handa, & Litz, 2010; Sharp et al., 2015). Surf therapy may be a welcomed alternative, as it is one way to alleviate symptoms without the perceived risk of negative labeling (Caddick et al., 2015; Caddick & Smith, 2017). Additionally, as noted by Caddick et al. (2015) through qualitative interviews, surfing is an activity that requires mindfulness and may be a source of respite from psychological symptoms and traumatic memories. Two quantitative studies have also supported the benefits of surf therapy among military veterans. The first, a pilot study by Rogers, Mallinson, and Peppers (2014), provided preliminary evidence indicating that surfing benefits mental health symptoms. Following a 5-week surf program for veterans who served in Iraq and Afghanistan and had PTSD, MDD, or both, participants ($N = 14$) reported significantly lower levels of PTSD and depressive symptoms (Rogers et al., 2014). Similarly, in a study evaluating a surfing program for combat veterans with PTSD ($N = 95$), Crawford (2016) found that PTSD and depression symptom scores significantly decreased from pre-to post-program. In addition, although symptom scores significantly increased during the follow-up period, statistically significant reductions in PTSD and depression were still evident 30 days following program completion (Crawford, 2016).

In sum, limited research supports surfing as a complementary form of treatment to improve psychological health. However, additional research is needed to obtain a more nuanced understanding of the benefits of surf therapy, including immediate benefits following engagement in surfing as well as cumulative benefits across the course of multiple surf sessions. Although there is some evidence to suggest that people experience improved mental health directly following engagement in physical activity occurring in a natural environment (Thompson Coon et al., 2011), this has not been examined in the context of surfing.

The objective of this study was to evaluate the effects of participating in a surf therapy program provided by Naval Medical Center San Diego (NMCSD) on psychological outcomes among active duty service members. To address the limitations of previous research, in addition to examining global changes in outcomes following participation in the program, we assessed the immediate effects of participation by comparing within-session (pre-to post-surf session) outcomes. This also allowed us to explore whether the immediate effects of participation were constant across sessions, or enhanced or diminished with additional exposure. In addition, to augment knowledge about the range of outcomes affected by surf therapy, we examined effects on positive and negative affect, as well as on symptoms of PTSD, depression, anxiety, pain, and insomnia. To determine the generality or specificity of surf therapy effects, each of these issues was examined both in the full sample and in subsamples of participants with probable PTSD or MDD. The final study objective was to assess patient satisfaction with the program. These aims collectively serve both to evaluate this specific program and to empirically inform the development, implementation, and evaluation of similar programs.

1. Method

1.1. Participants

U.S. active duty military service members enrolling in the surf therapy program at NMCSD ($N = 74$) participated in this study; all had been referred to the program due to a psychological (e.g., PTSD, depression) or physical (e.g., amputated limb, traumatic brain injury) diagnosis. Inclusion criteria were broad, as the study was implemented as a part of routine clinical care. In order to participate in the surf therapy program, all service members had to receive medical clearance. The only exclusion criterion was previous participation in the surf therapy program; this was implemented to control for the dose of intervention received. If a participant did not consent to study participation, he or she completed the standard program intake and received surf therapy without completing any study questionnaires. Of the 79 service members approached, 74 (94%) consented to study participation.

1.2. Program

The surf therapy program evaluated within the current study is

unique in that it is provided as part of routine clinical care (i.e., a scheduled medical appointment) in the Health and Wellness Department at NMCSD. This surf therapy program does not include a designated therapeutic component or discussion sessions (e.g., Rogers et al., 2014), rather, the program relies on an outdoor experiential approach (Hawkins, Townsend, & Garst, 2016) in which participants engage directly in nature and also with one another in order to achieve therapeutic benefit. For the study, the surf therapy program was conducted following established standard operating procedures; the sole modification was the addition of self-report assessments throughout the program. Each program cycle lasted 6 weeks, and each cohort had approximately 20 service members. Surf sessions were 3–4 h in duration and occurred in a group setting at a Southern California beach. Participants surfed throughout the length of each session, but were given the freedom to take rest breaks, as needed. Each participant was paired with at least one surfing instructor who worked with them to meet individually tailored goals (e.g., reduce anxiety in the water, safely and independently surf waves) throughout the duration of the program. All surf instructors were volunteers certified through the Armed Services Young Men's Christian Association and who had attended an annual training on patient safety, basic mental health education (e.g., symptoms and behaviors associated with PTSD and MDD), and program policies and procedures.

Prior to each surf session, an optional hour of group yoga was provided on the beach, at the same location where the surf therapy took place. The style of yoga provided included a combination of Ashtanga and Vinyasa elements.

1.3. Procedures

Following a standard program eligibility evaluation by a physician in the Health and Wellness Department at NMCSD, participants were given the opportunity to receive weekly surf therapy for 6 weeks, as routinely provided. The institutional review board at NMCSD approved the protocol (NMCSD.2016.0032), and all study participants signed voluntary informed consent documents before participating. Consenting participants completed self-report assessments at pre- and post-program, as well as before and after each weekly surf session. Thus, participants completed up to 14 assessments over the 6-week study period.

1.4. Measures

The self-report assessments used for the study are established and validated measures commonly used with military/veteran samples.

1.4.1. Pre-program measures

At the pre-program assessment, participants completed a demographic questionnaire that solicited basic background information such as age, sex, military branch, and rank. They also completed a treatment utilization questionnaire, which asked about any concurrent treatments.

1.4.2. Pre- and post-program measures

The presence and severity of depressive symptoms were evaluated with the 8-item Patient Health Questionnaire (PHQ-8; Kroenke et al., 2009a); this measure can be scored diagnostically or responses can be summed to yield a total severity score. Patients were classified as having probable MDD if they responded with a rating of 2 (*More than half the days*) or higher to at least 1 item assessing either loss of interest and/or feeling down or depressed, and to at least 4 of the 6 other depressive symptoms on the measure. Internal consistency for the PHQ-8 at pre-program was $\alpha = 0.87$.

The presence and severity of generalized anxiety disorder symptoms were assessed using the Generalized Anxiety Disorder 7-Item Scale (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006), which assessed the frequency with which each symptom was experienced in the past 2 weeks. A total severity score was computed by summing the 7 items (pre-program $\alpha = 0.91$).

PTSD symptomatology was evaluated using the PTSD Checklist for DSM-5 (PCL-5; Weathers, Litz, Keane, Palmieri, Marx, & Schnurr, 2013). The PCL-5 is a self-report instrument that contains the revised Life Events Checklist for DSM-5 (LEC-5; Weathers, Blake, Schnurr, Kaloupek, Marx, & Keane, 2013) and an extended Criterion A assessment, as well as 20 items that directly correspond to each DSM-5 diagnostic criterion for PTSD. The measure can be scored diagnostically or item responses can be summed to yield a total severity score. Participants were classified as having probable PTSD if they reported a Criterion A traumatic event (based on the LEC-5) and provided a rating of at least 2 (*Moderately bothersome*) to at least one symptom each in clusters B and C and at least 2 symptoms each in clusters D and E. The PCL-5 demonstrated excellent internal consistency (pre-program $\alpha = 0.95$).

Affect was assessed using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), a 20-item self-report instrument consisting of 10 positive and 10 negative emotions experienced in the past several hours. At pre-program, Cronbach's alphas were $\alpha = 0.89$ for the positive affect subscale and $\alpha = 0.90$ for the negative affect subscale.

Current level of pain was measured with a single-item self-report instrument, the Numeric Pain Rating Scale (NPRS; McCaffery & Beebe, 1989). Pain was rated on an 11-point scale from 0 (*No pain*) to 10 (*Worst possible pain*).

The severity and impact of insomnia within the past week was assessed with a 7-item self-report measure, the Insomnia Severity Index (ISI; Morin, 1993). Items were rated on a 5-point scale and ratings were summed to yield a total ISI score. Cronbach's alpha for the ISI at pre-program was $\alpha = 0.91$.

1.4.3. Post-program measures

Patient satisfaction with the surf therapy program was evaluated at post-program only, using an 8-item self-report measure, the Client Satisfaction Questionnaire (CSQ-8; Larsen, Attkisson, Hargreaves, & Nguyen, 1979). Items were rated on a 4-point scale and summed to create a total satisfaction score. Internal consistency for the CSQ-8 in this study was $\alpha = 0.77$.

1.4.4. Pre- and post-session measures

Insomnia severity over the past week was assessed with the ISI at pre-session only (as change was not expected from pre-to post-session). The remaining measures were completed before and after each session and asked about *current* symptoms across all domains (i.e., how participants felt in the current moment). Depression and anxiety symptom severity was measured with the 4-item PHQ (PHQ-4; Kroenke, Spitzer, Williams, & Löwe, 2009b), a self-report measure that consists of two depression items from the PHQ-8 and 2 anxiety items from the GAD-7. Positive affect was assessed using the 10-item Positive Affect Schedule (PAS) of the PANAS, and pain was evaluated with the one-item NPRS.

1.5. Data analyses

All individuals who were eligible for study participation were included in the analyses. Individuals who did not complete the post-program assessment were coded accordingly, and analyses were conducted to evaluate differences between completers and non-completers. Preliminary analyses also examined whether scores on pre-program measures predicted levels of program participation (i.e., the number of surf therapy or yoga sessions attended).

To evaluate both immediate and cumulative effects of individual surf therapy sessions on psychological symptoms and affect, longitudinal repeated measures data for participants were analyzed using multilevel modeling (MLM) in SPSS version 23 software. MLM analyses

were conducted in two ways. In both cases, model specifications included intercept as random, time as repeated, covariance structure as autoregressive, and restricted maximum likelihood as the approach to handling missing data. Scores on continuous predictor variables were mean-centered. Tests of statistical significance were supplemented with consideration of effect size indices (Cohen's *d* based on complete data at given time points, adjusted for repeated measures).

To examine the overall effects of program participation, we first examined whether the intercepts and random time slopes varied across participants for each of the dependent variables (PHQ-8, PCL-5 [PTSD subgroup only], GAD-7, PAS, Negative Affect Schedule [NAS], NPRS, and ISI scores). Time was coded as 0 (pre-program; intercept) and 1 (post-program). For outcome variables exhibiting significant variation from pre-to post-program, a second model assessed the impact of demographic (age, sex) and program (number of surf and yoga sessions attended) factors on program outcomes.

Analyses examining within-session changes paralleled those examining changes across the course of the program. Initial models assessed for variability in the intercepts and random time slopes for the dependent variables (PHQ-4, PAS, and NPRS scores) over the course of single surf therapy sessions. Time was coded as 0 (pre-session; intercept) and 1 (post-session) for sessions 1–6. Once again, if significant variability was demonstrated in the outcomes of interest over time, a second model included age, sex, number of surf sessions attended, and number of yoga sessions attended as fixed effects in the 2-level models. To determine whether the magnitude of within-session changes varied across the course of the 6-week surf therapy program, we also tested the interaction between time (pre-/post-session) and session (1–6). Because insomnia was only assessed before (not after) each surf therapy session, the insomnia analysis did not include the time factor; as a result, only changes in insomnia across the 6 surf therapy sessions were examined.

2. Results

2.1. Demographic and pre-program analyses

Over half of the sample (n = 40, 54.0%) met criteria for probable PTSD, 43% (n = 32) met criteria for probable MDD, and 32.4% (n = 24) met criteria for both probable PTSD and MDD. The majority of participants (n = 56, 75.7%) reported that they were concurrently receiving at least one other treatment in addition to surf therapy (see Table 1). The most common concurrent treatments included psychotherapy (n = 33, 44.6%), other Health and Wellness Department programs (e.g., strength training, tai chi; n = 29, 39.2%), and psychiatry (n = 18, 24.3%). The most frequent primary referral diagnoses indicated by providers upon program admission were PTSD (n = 13, 17.3%), depression (n = 13, 17.3%), and physical conditions (e.g., pain, injury; n = 12, 16.0%).

On average, participants attended 1.7 (SD = 1.9, range = 0–6) of the optional yoga sessions. Nearly 40% (n = 28) attended no yoga sessions, about one-quarter (n = 20, 27.0%) attended 1 session, and about one-third (n = 26, 35.2%) attended 2 to 6 sessions. Participants attended a mean of 4.4 (SD = 1.7, range = 1–6) surf sessions; more than 70% (n = 46) attended 5 or more sessions. The number of surf sessions attended was significantly greater for participants reporting higher levels of pain at pre-program (r = 0.26, $p < .05$) but was unrelated to scores on the other measures (i.e., PHQ-8, PCL-5, ISI, GAD-7, PANAS; $ps > .14$). There was a trend (ps = .08-.09) for the number of yoga sessions attended to be lower among participants with higher levels of negative affect at pre-program; the number of yoga sessions attended was unrelated to the other outcome measures examined ($ps \geq .13$).

Two-thirds (n = 49; 66.0%) of participants completed the surf therapy program, defined as completing a post-program assessment (which was only administered during the final week's surf session). Comparisons of completers and non-completers revealed no differences in scores on pre-program measures (PHQ-8 [p = .96]; PCL-5 [p = .99]; GAD-7 [p = .78]; PAS [p = .83]; NAS [p = .80], ISI [p = .38], and NPRS [p = .14]) or in the likelihood of having probable PTSD (p = .32) or probable MDD (p = .69). Program completers attended significantly more surf (5.4 vs. 2.4, respectively, $p < .001$) and yoga (2.0 vs. 0.6, respectively, $p < .001$) sessions than non-completers.

Table 1
Sample characteristics.

Characteristic	Full Sample (N = 74)	Probable PTSD (n = 40)	Probable MDD (n = 32)
	n (%)	n (%)	n (%)
Age, Mean (SD)	28.4 (7.5)	29.3 (8.4)	29.2 (7.0)
Sessions Attended, Mean (SD)			
Surf Therapy	4.4 (1.7)	4.4 (1.7)	4.6 (1.6)
Yoga	1.7 (1.9)	1.2 (1.7)	1.2 (1.6)
Sex			
Male	41 (55.4)	21 (52.5)	18 (56.3)
Female	33 (44.6)	19 (47.5)	14 (43.8)
Service Branch			
Navy	55 (73.3)	31 (77.5)	25 (78.1)
Marine Corps and Coast Guard	17 (22.7)	8 (20.0)	6 (18.8)
Missing	3 (4.0)	1 (2.5)	1 (3.1)
Rank			
E1–E4	32 (43.2)	18 (45.0)	13 (40.6)
E5–E6	28 (37.8)	14 (35.0)	11 (34.4)
E7–E9	5 (6.8)	2 (5.0)	3 (9.4)
Officer	6 (8.1)	4 (10.0)	4 (12.5)
Missing	3 (4.1)	2 (5.0)	1 (3.1)
Concurrent Treatment			
Any Treatment	56 (75.7)	30 (75.0)	25 (78.1)
Psychiatry	18 (24.3)	10 (25.0)	9 (28.1)
Psychotherapy	33 (44.6)	17 (42.5)	18 (56.3)
Health and Wellness	29 (39.2)	18 (45.0)	15 (46.9)
Referral Diagnosis			
Depression	13 (17.3)	6 (15.0)	7 (21.9)
Posttraumatic Stress Disorder	13 (17.3)	12 (30.0)	8 (25.0)
Physical	12 (16.0)	6 (15.0)	3 (9.4)
Other Psychological	9 (12.0)	3 (7.5)	1 (3.1)
Anxiety	6 (8.0)	3 (7.5)	3 (9.4)
Adjustment Disorder	5 (6.7)	1 (2.5)	3 (9.4)
Missing/Unknown	17 (22.7)	9 (22.5)	7 (21.9)

Note. SD = standard deviation, E = enlisted rank, Officer = officer rank, including warrant officer. Marine Corps and Coast Guard categories were combined due to small cell size. Because concurrent treatment categories are not mutually exclusive, the sum across treatment categories is greater than 100%. Referral diagnosis is the diagnosis provided by the referring provider and was not available for all participants.

2.2. Pre-to post-program analyses

Table 2 provides means and standard deviations for pre- and post-program variables. For initial MLM models demonstrating significant variability in intercepts and time slopes (i.e., PHQ-8, GAD-7, PAS, and NAS; PCL scores [computed only for those with probable PTSD]), a second step was conducted that included age, sex, number of surf sessions, and number of yoga sessions as predictors of outcomes. Because neither age ($ps \geq .13$) nor sex ($ps \geq .05$) was consistently related to outcomes in these models, these variables were omitted from the final model. The significance of number of surf and yoga sessions attended in predicting outcomes varied across samples (i.e., full, probable PTSD, probable MDD); however, these program variables were retained in the model to allow us to test their interactions with time; such interaction effects test whether the magnitude of change in an outcome depends on the "dose" of treatment received. Due to smaller sample sizes in the probable PTSD and probable MDD subsamples, interactions were only tested in the full sample. Thus, the final models included 3 main effects (time [pre-/post-program], number of surf sessions, and number of

Table 2
Means (M) and standard deviations (SD) of pre-to post-program outcome variables.

Variable	Full Sample						Probable PTSD						Probable MDD					
	Pre-Program			Post-Program			Pre-Program			Post-Program			Pre-Program			Post-Program		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
PHQ-8	74	12.41	5.95	49	10.22	5.53	40	14.75	5.52	25	12.00	5.74	32	17.78	3.43	22	12.55	5.57
GAD-7	74	12.66	5.70	49	9.37	5.48	40	14.78	4.92	25	11.12	5.52	32	16.41	3.77	22	11.23	5.18
PAS	74	23.99	8.66	49	33.47	10.29	40	23.55	7.97	25	34.20	9.29	32	21.00	6.69	22	33.55	9.81
NAS	74	24.16	9.56	49	18.20	8.02	40	28.85	8.89	25	19.48	8.93	32	30.03	8.33	22	19.41	8.15
PCL-5	–	–	–	–	–	–	40	54.33	13.31	25	39.36	19.14	–	–	–	–	–	–
ISI[a]	74	15.54	7.11	67	14.55	7.10	40	17.60	5.99	38	16.89	6.23	32	19.50	5.35	31	17.97	5.96
NPRS[a]	71	2.74	2.31	73	2.80	2.47	38	3.21	2.23	40	3.65	2.60	31	3.50	2.34	32	3.64	2.52

Note. PTSD = posttraumatic stress disorder, PHQ-8 = 8-Item Patient Health Questionnaire, GAD-7 = Generalized Anxiety Disorder 7-Item Scale, PAS = Positive Affect Schedule, NAS = Negative Affect Schedule, PCL-5 = PTSD Checklist for DSM-5, ISI = Insomnia Severity Index, NPRS = Numerical Pain Rating Scale. PCL-5 scores were only applicable to those with probable PTSD.

[a] Denotes that *M* and *SD* were derived from the pre-program assessment and the last available score for the participant since these questionnaires were administered on a weekly basis.

yoga sessions) and—in the full sample only—2-way interactions between time and both number of surf and yoga sessions.

2.3. Effects of surf therapy program participation

In the final model, there were significant main effects of time on PTSD and depression symptom severity, as well as on levels of positive and negative affect in the full sample and both subsamples (see Table 3). These effects indicate that severity of depression and anxiety symptoms decreased, negative affect declined, and positive affect increased among surf therapy participants. In the full sample, the magnitude of changes in each of these outcomes was moderate, with the greatest effect observed on positive affect ($d = 0.78$), the smallest effect observed on depression ($d = 0.42$), and moderate effects on anxiety ($d = 0.61$) and negative affect ($d = 0.60$).

Although participants in both subsamples showed the same pattern of significant effects on these outcomes, the magnitude of changes in some outcomes was larger among those with probable PTSD or probable MDD than in the full sample. Service members with probable PTSD demonstrated a large increase in positive affect over the course of surf therapy ($d = 1.02$), along with moderate decreases in negative affect, anxiety, and depression ($ds = 0.76$, 0.59, and 0.40, respectively). Importantly, self-reported PTSD symptom severity also significantly and clinically decreased from pre-to post-program among those with probable PTSD (the only group in which this outcome was examined), with a large effect size ($d = 0.94$). Finally, the subsample of participants with probable MDD manifested notably larger changes over the course of participation in the surf therapy program than either the full or probable PTSD samples, with large effect sizes for all outcomes (positive affect, $d = 1.30$; negative affect: $d = 0.98$; depression symptom severity: $d = 0.96$; anxiety symptom severity: $d = 0.92$).

2.4. Effects of surf and yoga sessions attended

Main effects of surf and yoga sessions attended reflect overall tendencies to score higher or lower on outcomes depending on the number

Table 3
Summary of multilevel analyses examining within-group effects on pre-to post-program outcomes.

Variable	PHQ-8	GAD-7	PAS	NAS	PCL-5[b]
Full Sample ($N = 75$)					
Intercept	14.73 (1.18)***	16.23 (1.21)***	14.54 (2.35)***	30.59 (2.30)***	–
Time	−2.31 (0.85)**	−3.55 (0.87)***	9.46 (1.70)***	−6.40 (1.62)***	–
Surf Sessions Attended	0.62 (0.39)	0.71 (0.37)†	0.16 (0.62)	1.15 (0.59)†	–
Yoga Sessions Attended[a]	−0.59 (0.34)	−0.62 (0.32)†	−0.32 (0.50)	−1.26 (0.45)**	–
Time × Surf Sessions Attended	−0.44 (1.12)	−1.16 (1.12)	1.71 (2.06)	−0.80 (1.86)	–
Time × Yoga Sessions Attended[a]	0.71 (0.42)	0.54 (0.43)	−0.89 (0.84)	0.35 (0.81)	–
Probable PTSD ($n = 40$)					
Intercept	17.01 (1.71)***	18.02 (1.60)***	12.74 (3.10)***	37.82 (3.26)***	67.65 (3.99)***
Time	−2.74 (1.25)*	−3.74 (1.21)**	10.63 (2.23)***	−9.43 (2.30)***	−14.55 (3.21)***
Surf Sessions Attended	0.67 (0.50)	0.68 (0.44)	0.27 (0.78)	0.54 (0.82)	1.36 (1.29)
Yoga Sessions Attended	−1.07 (0.47)*	−1.11 (0.41)*	−0.40 (0.67)	−1.04 (0.68)	−2.74 (1.29)*
Probable MDD ($n = 32$)					
Intercept	22.80 (1.38)***	21.66 (1.63)***	8.04 (2.80)**	40.94 (3.40)***	–
Time	−5.06 (1.11)***	−5.21 (1.22)***	12.73 (2.15)***	−10.92 (2.35)***	–
Surf Sessions Attended	−0.02 (0.41)	−0.04 (0.43)	0.12 (0.78)	0.30 (0.88)	–
Yoga Sessions Attended	−0.10 (0.40)	0.09 (0.40)	−0.49 (0.74)	0.17 (0.73)	–

Note. PTSD = posttraumatic stress disorder, MDD = major depressive disorder, PHQ-8 = 8-Item Patient Health Questionnaire, GAD-7 = Generalized Anxiety Disorder 7-Item Scale, PAS = Positive Affect Schedule, NAS = Negative Affect Schedule, PCL-5 = PTSD Checklist for DSM-5. Standard errors are in parentheses. Coefficients for main effects were derived from a main-effect only model; coefficients for interaction effects control for all main effects. This table shows results for outcome variables that significantly changed from pre-to post-program (i.e., results for pain and insomnia are not shown).
Interactions were tested in the full sample but not in subsamples due to small cell sizes.
†$p = .05$–$.08$, *$p < .05$, **$p < .01$, ***$p < .001$.

[a] The results provided are for the continuous number of yoga sessions variable; coding this variable dichotomously (did/did not attend at least one session of yoga) yielded similar results.

[b] PCL-5 scores were only applicable to those with probable PTSD.

Table 4
Summary of multilevel analyses examining within-group effects on session outcomes.

Variable	PHQ-4	PAS
Full Sample (N = 75)		
Intercept	9.33 (0.41)***	14.69 (1.26)***
Within Session	−3.35 (0.31)***	8.97 (0.95)***
Session	−0.04 (0.05)	0.34 (0.17)†
Surf Sessions Attended	0.07 (0.18)	0.59 (0.62)
Yoga sessions Attended[a]	−0.26 (0.15)†	0.05 (0.49)
Within Session × Session	0.00 (0.11)	0.09 (0.35)
Within Session × Surf Sessions Attended	−0.00 (0.23)	0.39 (0.71)
Within Session × Yoga Sessions Attended[a]	0.02 (0.18)	−0.05 (0.53)
Probable PTSD (n = 40)		
Intercept	11.15 (0.50)***	12.22 (1.81)***
Within Session	−3.98 (0.30)***	9.87 (1.37)***
Session	0.02 (0.08)	0.53 (0.24)*
Surf Sessions Attended	−0.04 (0.18)	0.51 (0.84)
Yoga Sessions Attended	−0.18 (0.15)	0.62 (0.76)
Probable MDD (n = 32)		
Intercept	12.35 (0.54)***	9.13 (1.88)***
Within Session	−4.38 (0.36)***	10.81 (1.46)***
Session	0.00 (0.08)	0.49 (0.22)*
Surf Sessions Attended	−0.37 (0.21)†	0.85 (0.84)
Yoga Sessions Attended	0.06 (0.18)	0.12 (0.76)

Note. PTSD = posttraumatic stress disorder, MDD = major depressive disorder, PHQ-4 = 4-Item Patient Health Questionnaire, PAS = Positive Affect Schedule. Standard errors are in parentheses. Coefficients for main effects were derived from a main-effect only model; coefficients for interaction effects control for all main effects. This table shows results for outcome variables that significantly changed within-session (i.e., results for pain and insomnia are not shown). Interactions were included in the model for the full sample, but not in models for the subsamples due to small cell sizes.
†p = .05–.08, *p < .05, ***p < .001.
[a] Analyses were conducted with the number of yoga sessions as a continuous variable and as a dichotomous variable (attended at least one session of yoga = yes/no). Results were comparable and are presented with the number of yoga sessions as a continuous variable.

of sessions attended, averaging across both pre- and post-program assessments (see Table 3). Interactions between time (pre-/post-program) and number of surf or yoga sessions attended, which would indicate that the number of sessions attended influenced the magnitude of change in outcomes over the course of the surf therapy program, were not significant for any of the outcomes examined (for surf sessions, $ps \geq .30$; for yoga sessions, $ps \geq .09$; see Table 3).

2.5. Within-session analyses

2.5.1. Within- and between-session effects

MLM analyses showed that, averaging across sessions, depression/anxiety decreased significantly and positive affect increased significantly from pre-to post-session (see Table 4). In contrast, there was not a significant difference in levels of pain before versus after surf therapy sessions ($ps \geq .14$, ds = 0.04–0.49; negligible to small effect). These patterns were consistent for the full sample and for the probable PTSD and probable MDD subsamples (see Figure 1). Average within-session changes in depression/anxiety were large (full sample range: 1.02–1.27; probable PTSD range: d = 1.02–1.78; probable MDD range: d = 0.99–1.81), and changes in positive affect within sessions were moderate to large (full sample range: 0.75–1.26; probable PTSD range: d = 0.69–1.39; probable MDD range: d = 0.94–1.69).

The main effect of session assesses whether scores changed over the course of the 6 surf therapy sessions, averaging across pre- and post-assessments for each session. This effect was not significant for depression/anxiety in the full sample or either subsample. For positive affect, however, the effect in the full sample approached significance, and it attained significance in both the probable PTSD and probable MDD subsamples. In each case, positive affect significantly increased across the 6 program sessions. Because insomnia was measured only at pre-session (not at post-session), within-session changes could not be examined. However, we did assess for changes in insomnia across the 6 surf therapy sessions. There was no significant change in insomnia levels across surf sessions in the full sample, probable PTSD subsample, or probable MDD subsample ($ps \geq .19$). In the full sample only, the interaction of within- and between-session change was tested. This interaction was not significant (p = .98), indicating that the amount of within-session change was consistent across the 6 sessions.

2.5.2. Effects of number of surf and yoga sessions attended

Analyses also examined whether overall levels of depression/anxiety and positive affect (averaging across pre- and post-session assessments and across sessions) varied as a function of the number of surf or yoga sessions participants attended. The number of surf sessions attended was not related to levels of positive affect in any sample, and it was not related to levels of depression/anxiety in the full sample or the probable PTSD subsample ($ps \geq .34$). In the probable MDD subsample, however, an association between number of surf sessions attended and depression/anxiety symptom severity approached significance (p = .08). Among those with probable MDD, overall levels of depression/anxiety (again, averaging across pre-/post-assessments and surf sessions) tended to be lower in those who attended more surf sessions.

The 2-way interaction between the number of surf sessions attended and within-session change was examined only in the full sample. This interaction was non-significant, indicating that the amount of within-session change did not vary depending on the number of surf sessions attended ($ps \geq .68$). The interaction between the number of yoga sessions attended and within-session change in the full sample was also non-significant, showing that the extent of within-session changes in outcomes was not influenced by the number of optional yoga sessions attended ($ps \geq .69$).

2.5.3. Program satisfaction

Participants were highly satisfied with the surf therapy program as indicated by a mean score of 31.0 out of a possible 32.0 (SD = 1.6; range 25–32) in the full sample; ratings were nearly identical in the PTSD (M = 31.0, SD = 1.5) and MDD subsamples (M = 31.2, SD = 0.9).

3. Discussion

Surf therapy programs have become increasingly popular, but little research has evaluated the effects of such programs. The current study sought to add to the literature on surf therapy as a complementary therapeutic intervention by examining not only overall program outcomes but also the immediate effects of surf therapy on participants. Results demonstrated significant pre-to post-program changes in the full sample for the majority of outcome variables. Similar to previous surf therapy studies (Crawford, 2016; Rogers et al., 2014), analyses indicate significant decreases in PTSD and MDD symptoms. Demonstrated effects of surf therapy not previously documented include reductions in both anxiety and negative affect as well as significant increases in positive affect from pre-to post-program. Furthermore, participants were highly satisfied with the program, with a mean satisfaction rating of 31 out of a maximum score of 32. As has been noted in previous literature (e.g., Caddick & Smith, 2017), it is important that surf therapy programs are not conceptualized as standalone therapies, especially while research on the topic is still in its infancy. Similarly, the program outcomes presented in the current study should be conceptualized as resulting from a complementary treatment, since 75% of participants were receiving other forms of treatment (e.g., psychotherapy, physical therapy, medication). The results, therefore, contribute preliminary support for the augmented quality of care that surf therapy may provide.

Results similar to the full sample findings were found for

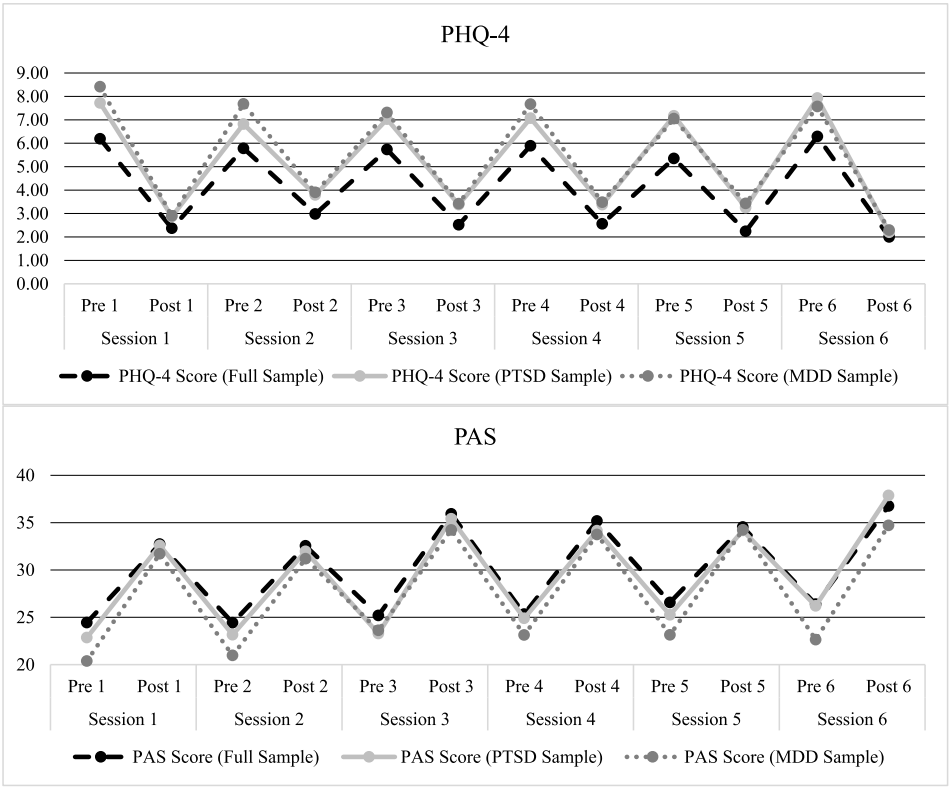

Fig. 1. Means of pre-to post-session outcome variables.
Note. PHQ-4 = 4-Item Patient Health Questionnaire, PTSD = posttraumatic stress disorder, MDD = major depressive disorder, PAS = Positive Affect Schedule. This figure shows results for outcome variables that significantly changed within session (i.e., results for pain and insomnia [across sessions] are not shown).

subsamples of participants with probable PTSD or MDD; this is not entirely surprising given that the majority of the sample met probable criteria for one of these disorders. Participants with probable PTSD also showed statistically and clinically significant reductions in self-reported PTSD symptoms (i.e., approximately 15 points on the PCL-5), and those with probable MDD exhibited statistically and clinically significant decreases in self-reported depressive symptoms (i.e., from a mean score in the moderately severe range to one in the moderate range). Interestingly, the magnitude of changes due to program participation was generally larger for participants with probable PTSD or MDD than for the full sample, with the largest effect sizes shown for participants with probable MDD. This finding is particularly noteworthy with regard to decreases in negative affect and increases in positive affect, which are not only symptoms consistent with PTSD and MDD, but symptoms that often remain after traditional treatment has been successfully completed (e.g., McClintock et al., 2011). Results suggest that surf therapy may influence psychological symptoms more generally, but could be used as a complementary intervention that specifically targets the lack of enjoyment and diminished positive affect that individuals with PTSD and/or MDD experience. Importantly, the benefits of the surf therapy program did not vary depending on the number of surf therapy or optional yoga sessions attended, indicating there was not a dose-response effect of either activity on these outcomes.

Within-session data showed that depression/anxiety symptoms significantly decreased while positive affect increased over the course of each surf session, both in the full sample and among participants with probable PTSD or MDD. The degree of symptom severity change experienced over the course of a single session was generally comparable whether it was the participant's first or last surf therapy session and regardless of whether they had attended the optional yoga session. As such, the effects of a surf therapy session could be seen as paralleling the effects of a single dose of medication, with the effects of either being relatively short-lived and requiring repetition or re-administration to sustain the effects. Consistent with Crawford's (2016) recommendation, these findings further suggest that routine engagement in surf therapy and incorporating surfing as an ongoing part of the individual's life may provide the most consistent benefit.

In contrast to the findings for mental health symptoms and affect, neither pain nor insomnia evidenced significant changes as a result of participating in the surf therapy program. Self-reported pain levels did not change from pre-to post-program, across sessions, or within sessions. The exertion required for surfing may have been physically therapeutic to some (e.g., Fleischmann et al., 2011), but perhaps did not affect or even exacerbated pain for others. Likewise, insomnia did not improve from pre-to post-program or from week to week. This finding was not entirely unexpected; even if participants slept better the days on which they surfed, improved sleep quality may not be sustained for an entire week following a surf session. Assessing insomnia more frequently (e.g., daily rather than weekly) or collecting objective sleep data would likely provide greater insight.

There are several important strengths of this study. To begin, the study investigated an activity that is being increasingly used therapeutically but has seldom been examined empirically. The NMCSD surf therapy program, in particular, was delivered as part of standard clinical care at a military treatment facility, allowing for minimal exclusion criteria and thereby increasing the generalizability of results. Generalizability was further enhanced by including participants with a variety of physical and psychological diagnoses, collecting data in the naturalistic setting in which the activity took place, and including a larger sample size than most prior research. Additional analyses of subsamples of participants with probable PTSD or MDD replicated results for the full sample and showed even stronger benefits of surf therapy within these groups. In terms of methodology, the assessment measures used in the study covered a range of health outcomes and were well validated and commonly used with military/veteran samples. Finally, participants were assessed before and after each surf therapy session so that the immediate effects of surf therapy could be directly ascertained.

As with any research, limitations are important to consider. First, the study lacked a control group for comparison. In addition, because a follow-up assessment was not included in this study, it cannot be determined whether the reported gains or continued engagement in

surfing from pre-to post-program were maintained following program completion. Also, most participants were receiving surf therapy as a complementary intervention to more traditional treatments, which makes it difficult to isolate the unique effects of the surf therapy program over the course of 6 weeks. Thus, it is unclear whether changes in outcomes over the course of the surf therapy program were attributable largely to surf therapy, concurrent treatments, time, or other factors. The study's exclusive reliance on self-report measures is a weakness, as these measures have inherent limitations. Approximately two-thirds of participants attended fewer than two sessions of optional yoga, which limits the conclusions that can be made about the impact of yoga on program outcomes. Lastly, although it is expected that social interaction had some effect on improvements to mental health, this study did not specifically evaluate this factor, unlike previous qualitative studies (Caddick et al., 2015; Carless et al., 2013). Despite these limitations, our findings greatly expand current knowledge about the effects of surf therapy and pave the way for additional research in this area.

As research evaluating surf therapy is still in its infancy, there are many avenues for future research. In addition to increasing the sample sizes of surf therapy studies, comparison groups should be included. For example, the comparison of solitary and group-based surf therapy may be informative to better understand the additive effects of social interaction. Furthermore, randomized controlled trials would be more optimally suited to explore the unique effects of surf therapy compared with other interventions or physical activities. More specifically, previous research highlights the positive effects of other nature-based physical activities (e.g., walking/hiking; Barton & Pretty, 2010; Thompson Coon et al., 2011). Including such activities as comparison groups in randomized controlled trials would provide insights into the unique effect of surf therapy, as well as the generalizability of the current study's results to activities that may be more accessible. Within this more rigorous design, both assessor-administered and self-report measures should be included to assess outcomes of interest in a more thorough and valid manner. As science in this area progresses, research comparing the effects of surf therapy (or physical activities more generally) as a complementary intervention to standard treatments (e.g., psychotherapy, pharmacotherapy, physical therapy) versus standard treatments alone would yield important clinical knowledge.

4. Conclusions

Surf therapy, as a largely complementary intervention, is associated with reductions in PTSD and depressive symptoms (Crawford, 2016; Rogers et al., 2014). In addition to replicating the findings of previous studies, the present study documented additional benefits of a 6-week surf therapy program, including reductions in both anxiety and negative affect, as well as improvements in positive affect. To augment the conclusions of existing surf therapy research, which has relied upon single-group designs, we also explored immediate effects of surf therapy; results of these analyses revealed significant reductions in depression/anxiety and significant increases in positive affect over the course of each surf therapy session. Improvements in depression/anxiety and positive affect were noted regardless of whether participants engaged in optional yoga or the number of surf therapy sessions attended over the course of the program. Importantly, these results were noted for the full sample and for participants with probable PTSD or MDD. Given that lack of enjoyment in activities and emotional numbing can be present and impairing in individuals with these disorders, surf therapy may improve symptoms among those who need it most. Our findings suggest that a dose of surf therapy provides mental health benefits and that routine surf sessions provide opportunities for positive outcomes.

Conflicts of interest

None.

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