Comparing meditative scuba diving versus multisport activities to improve post-traumatic stress disorder symptoms: a pilot, randomized controlled clinical trial

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ABSTRACT

Background: Post-Traumatic Stress Disorder (PTSD) is a chronic and disabling disease that currently has no fully effective therapeutic solution. Complementary approaches, such as relaxation, sport, or meditation, could be therapeutic aids for symptom reduction. Scuba diving combines sport and mindfulness training and has been found to have a positive effect on chronic stress and PTSD.

Objectives: The first objective of this pilot study is to compare the effectiveness of diving associated with mindfulness exercises (the Bathysmed® protocol) with multisport activity in reducing PTSD symptoms. The secondary objective is to compare the impact of the Bathysmed® protocol on mindfulness functioning in the two groups of subjects suffering from PTSD.

Method: This proof-of-concept took the form of a controlled randomized clinical trial. The primary endpoint was the severity of PTSD symptoms, measured by the PCL-5 (PTSD Check List) scale. Half of the group were exposed to the Bathysmed® protocol (the experimental condition), and the other half to a non-specific multisport program.

Results: Bathysmed® protocol improved PCL-5 scores more than the multisport program but the result was not significant. The protocol was significantly better than the multisport activity in reducing intrusion symptoms of PTSD after one month. Globally, trait mindfulness scores improved up to one month after the course, but the result was not significant. Three months after the course, there was no difference between the two groups with regard to PCL-5 and Freiburg Mindfulness Inventory scores.

Conclusion: Our study demonstrates the value of the Bathysmed® protocol even though it suffers from a lack of power and could only obtain partial but encouraging results. Mindfulness must be practiced over the long term to achieve stable benefits. This probably explains why no differences persisted three months after the course. Further work is needed to confirm the initial results obtained with this pilot study.

Una comparación de ensayo clínico piloto, aleatorizado y controlado del buceo meditativo (el protocolo Bathysmed®) versus actividades multideportivas para mejorar los síntomas del trastorno de estrés postraumático (TEPT)

Antecedentes: El trastorno de estrés postraumático (TEPT) es una enfermedad crónica e incapacitante que actualmente no tiene solución terapéutica totalmente eficaz. Enfoques complementarios, como relajación, deporte o meditación podrían ser ayudas terapéuticas para la reducción de síntomas. El buceo combina deporte y entrenamiento mindfulness y se ha encontrado que tiene un efecto positivo sobre el estrés crónico y el trastorno de estrés postraumático.

Objetivos: El primer objetivo de este estudio piloto es comparar la efectividad del buceo asociado a ejercicios de mindfulness (el protocolo Bathysmed®) con la actividad multideportiva para reducir los síntomas del TEPT. El objetivo secundario es comparar el impacto del protocolo Bathysmed® sobre el funcionamiento de mindfulness en los dos grupos de sujetos que padecen TEPT.

Método: Esta prueba de concepto tomó la forma de un ensayo clínico aleatorizado controlado. El criterio de valoración principal fue la gravedad de los síntomas de TEPT, medida por la escala

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HIGHLIGHTS

• Meditativa buceo diving
• PTSD; escala meditativa; mindfulness. 
• PTSD; Ataque terrorista
• El buceo meditativo fue más efectivo que la actividad multisport en reducir los síntomas de PTSD.

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1. Introduction

Post-Traumatic Stress Disorder (PTSD) is a chronic and disabling disease that currently has no fully effective therapeutic solution (Solomon & Mikulincer, 2006). Complementary approaches, such as relaxation, sport, or meditation could be therapeutic aids for symptom reduction. Mindfulness meditation programs have shown therapeutic benefits for PTSD in general (Gibert et al., 2015; Janssen et al., 2018) and chronic forms in particular (Hilton et al., 2017). Practicing Mindfulness practice is based on attention to the present, and acceptance (accepting inner events such as emotions, thoughts or physical sensations without judging them as either good or bad (Hayes & Feldman, 2004)). Attention training has had a positive impact on veterans PTSD symptoms (Badura-Brack et al., 2015). Acceptance is associated with less anxiety-depressive symptoms Intrusion symptoms could be reduced by shifting attention to the present moment, avoidance symptoms by increased openness to experience, alterations in cognition and mood by non-judgemental acceptance of trauma-related cognitions, alterations in arousal by reducing attentional bias towards trauma stimuli, and dissociative symptoms by increased connection and awareness of somatic sensations. (Boden et al., 2012; Boyd, Lanius, & McKinnon, 2018).

Sport has also been found to be beneficial for health and emotional regulation; physical activity is of interest in the prevention and treatment of anxiety-related mental illness (Anderson & Shivakumar, 2013), and is reported to play a more-than-beneficial role in stress-related pathologies (Kandola et al., 2018). These benefits are especially apparent when sport is practiced regularly. In the specific case of PTSD, the data are promising (Fetzner & Asmundson, 2015; Hegberg, Hayes, & Hayes, 2019). Scuba diving combines sport and mindfulness training, as it focuses on the diver’s breathing capacities. It has been found to have a positive effect on mindfulness abilities, chronic stress (Benetot et al., 2017) and PTSD (Morgan, Sinclair, Tan, Thomas, & Castle, 2019) although there is little literature on the subject. The two studies mentioned focus on the impact of simple recreational diving programs. No other practices were added to any of these programs.

In this context, a scuba diving training team has designed a mindfulness-associated diving program called the Bathysmed® protocol. This protocol combines the experience of diving and psycho-education on sophrology including breathing techniques.
The first objective of this pilot study is to compare the effectiveness of diving associated with mindfulness exercises (the Bathysmed® protocol) with multisport activity (sailing, canoeing, mountain hiking and snorkelling sessions) in reducing PTSD symptoms. The secondary objective is to compare the impact of the Bathysmed® protocol on mindfulness functioning in two groups of subjects suffering from PTSD, and identify any association between PTSD symptoms and changes in mindfulness.

2. Method

This proof-of-concept took the form of a controlled randomized clinical trial. The primary endpoint was the severity of PTSD symptoms, measured by the PCL-5 scale (PTSD Check List Scale) and its four sub-scales related to DSM5 (Diagnostic and Statistical Manual of Mental Disorders) (American Psychiatric Association, 2013) clusters of symptoms: intrusion; avoidance; change in mood and cognition; and arousal. Participants travelled together to Guadeloupe, a French Caribbean Island, from November 18 to 30, 2017. We chose this location to avoid the thermocline (colder water layer) which can be stressful for any diver. Half of the group were exposed to the Bathysmed® protocol (the experimental condition), and the other half to a non-specific multisport program that included two hours of physical activity per day (the control condition), during the ten-day stay. We measured the PTSD severity before and at the end of the program, and then one and three months afterwards. Trait mindfulness was measured in both groups at the same times. The DiveHope study was approved by the South East VI Ethics Committee on 10 October 2017 (Clinical Trial number: NCT03332290).

2.1. Participants

Thirty-four subjects (members of the association Life For Paris, an association of victims of the terrorist attacks of 13 November 2015 in Paris) participated. The primary inclusion criterion was that the individual suffered from PTSD at the time of recruitment, diagnosed with the Clinician-Administered PTSD Scale (CAPS) (Weathers et al., 2018) following his or her involvement in the Paris (France) terrorist attacks of 13 November 2015. CAPS is the gold standard for PTSD diagnosis, and has been revised to match the PTSD criteria given in the Diagnostic and Statistical Manual of Mental Disorder (DSM-5) (American Psychiatric Association, 2013). The diagnosis has been done by the study team physicians. The main exclusion criterion was a medical contraindication to the practice of scuba diving. Contraindications to scuba diving were checked by a hyperbaric medicine department with the appropriate authorizations. Scuba diving specialists were present during the diving sessions.

The participants did not pay anything to participate, received no monetary compensation and gave their informed consent in writing. The participants were flown from Paris to the Island of Guadeloupe. They were accommodated in a hotel. They travelled by bus each day to the diving club or to the sports facilities. The travel time was about 45 minutes.

2.2. Variables

The primary endpoint was assessed using the validated French version of the PTSD Check List Scale (PCL-5) (Ashbaugh et al., 2016), which is consistent with the DSM-5 definition of PTSD, at a threshold score of 33 (American Psychiatric Association, 2013). Trait mindfulness was measured by the validated French version of the 14-item Freiburg Mindfulness Inventory (FMI). A score over 38 indicates effective mindful functioning (Trousselard et al., 2010; Walach, Buchheld, Buttenmüller, Kleinknecht, & Schmidt, 2006). PCL-5 and FMI measurements were taken on arrival in Guadeloupe and before departure from Guadeloupe. All participants were measured at the same time. Post-course measurements (at one and three months) were carried out during sessions organized in Paris.

2.3. The Bathysmed® protocol and the multisport program

To measure the effects of scuba diving in combination with the practice of meditation, the 34 subjects were randomly assigned, before departure, to one of two groups: one group followed a multisport program, and the other followed the Bathysmed® protocol. Subjects did not know their group at the time of departure, and had accepted, in principle, to be assigned to either of the two groups.

2.4. The diving program

Diving may seem anxiogenic because of the environment, and the use of complex equipment. Therefore, a very progressive training program was implemented to reduce, or even eliminate this potential problem. In order to limit the risks as far as possible, and comply with the recommendations of the Divers Alert Network, the protocol did not include any long dives at depths greater than 20 metres. To further reinforce safety, and prevent barotrauma accidents, the first two dives took place in a swimming pool. This made it easy to evaluate the level of stress of subjects, and to form homogeneous groups for dives in the sea. Throughout the course, the depths reached increased very gradually, and the ratio of students to monitors varied from four to one (for very comfortable subjects), to two to one (for those who were less comfortable in the water), and one to one (for the most stressed individuals).
Since diving depth had little impact on the implementation of the protocol, all the objectives of the session could be achieved, even at a shallow depth of three metres.

All diving instructors held a professional diploma. They had also received specific training in stress management and sophrology. Sophrology is an exclusively verbal and non-tactile method, sophrology uses a set of techniques that act on both the body and the mind. It combines exercises that work on breathing, muscle relaxation and mental imagery (or visualization). In the Bathysmed protocol, we focused on breath control and body awareness. Each exercise was prepared before the dives as no oral communication was possible underwater.

The choice of location (the Cousteau reserve in Guadeloupe) made it possible to optimize the sessions by using dive sites that limited stress (warm and clear waters with a profusion of marine life) and allowed contemplation of the extensive underwater fauna and flora. All dives were made in Guadeloupe.

2.5. The Bathysmed protocol

The Bathysmed protocol was created specifically for the DiveHope study, and it introduces the use of a new form of scuba diving. In the short term, the protocol requires concentration, openness to experience, self-acceptance and care. In the longer term, it supports the intention to maintain these practices. There are 10 dives, and each session is structured in the same way: diving theory; psychoeducation; a review of diving exercises with demonstration videos; mental preparation based mainly on sophrology techniques and, finally, the meditative dive. The 10 dives take place over 6 days (4 days with 2 dives, 2 days with 1 dive). The whole group dives each time. One day in the middle of the course is a no dive day.

2.6. Diving theory

In France, scuba diving is covered by the Sport Code. It is not possible to exceed a six-metre zone without the presence of a qualified instructor. The 10 dives theory includes the classic level 1 theory defined by the French Diving Federation. It is the equivalent of the PADI Open Water certification. Participants must have a good understanding of the hyperbaric environment, which helps to prevent accidents. They are therefore taught all of the basic theoretical knowledge they need to reach this objective. This knowledge is tested with a multiple-choice questionnaire that is validated individually by each trainee.

2.7. Psychoeducation

The Bathysmed protocol includes an element of psychoeducation. The first objective is to reduce the level of anxiety related to diving, by providing explanations of the physiopathology of diving and stress, and the reasons driving the adoption of the Bathysmed protocol. The second objective is to increase adherence to the program. This is in line with the need to reinforce the intention to practice, which is one of the pillars of meditative practices. Psychoeducation focuses in particular on breathing techniques and sophrology explanations.

2.8. Presentation of meditative diving exercises in the classroom

In most meditative practices, the session is conducted verbally by an instructor. The transfer of the session to the underwater environment requires that students have a full understanding of what will happen, prior to the dive. The protocol specifies a standardized teaching method based on a video demonstration that is as close as possible to the actual session. This is followed by a practice run of the meditative training that will be reproduced during the next dive.

The Bathysmed protocol is very progressive, and is divided into three dive stages. Each stage has different objectives. The aim during the first four dives is to maintain attention on the present moment, and develop the re-appropriation of bodily sensations and concentration. The fifth to eighth dives are contemplative. In these sessions, the subject is helped to visualize the future from another angle. Finally, the last two dives consolidate confidence in the individual’s personal abilities, and focus on letting go.

2.9. The multisport program

The multi-sport group had activities at the same time as the other group had dives. These included various activities such as sailing, surfing, canoeing, mountain hiking and snorkelling. It was compulsory for the subjects to follow the activities.

2.10. Statistical analyses

All analyses were run using R software (V3.6.3). We did not calculate the minimum number of subjects as the literature is very sparse on this topic, and we were limited to 34 subjects for logistical reasons. In practice, we consider this study as a proof of concept. We compared the mean change in PCL-5 and FMI scores between the two groups with a Student’s t test. We also looked for an association between change in PCL-5 and PCL-5 scores. Finally, we analysed the size of the course effect for both groups with Cohen’s d.

3. Results

Both groups were composed of 11 female and 6 male subjects. The mean age for the Diving Group (DG) was
36 years (standard deviation (SD) = 6.9) and 34 years (SD = 5.6) for the Multisport Control Group (MSG). All had been diagnosed with PTSD according to the CAPS. Prior to the course, the average PCL-5 score was 38.9 (SD = 14.7, range from 10 to 66), the average FMI score was 31.4 (SD = 5.9, range from 22 to 44) and no difference was observed between groups in terms of gender, age, FMI and PTSD severity (PCL-5 scores).

All subjects in the MSG group completed all sessions. As for the DG group, out of the 187 dives initially planned (10 Bathysmed® protocol dives per subject, plus an optional night dive), 186 dives were carried out without any serious adverse events. One dive was cancelled because of ear pain linked to a mild inflammation of the eardrum.

Although implementation of the Bathysmed® protocol improved PCL-5 scores (Figure 1) more than the multisport program, the result was not significant (Table 1). However, the protocol was significantly better than the multisport activity in reducing intrusion symptoms of PTSD after one month, and was slightly better ($p < .1$) in improving trait mindfulness immediately after the course ended (Table 1). Globally, FMI scores improved up to one month after the course, but the result was not significant. Three months after the course, there were no differences between the two groups with respect to PCL-5 and FMI scores (Table 1).

The analysis of Cohen’s $d$ found a large effect of the course on the DG group for up to one month. This was not the case for the MSG group (Table 1). The magnitude of the effect size measured with the PCL-5 and the FMI was higher for every single measure, for the DG group, for up to one month.

PCL-5 and FMI changes were significantly correlated immediately after the course, and also three months later, but not after one month, although the direction of the effect did not change (Table 2).

### 4. Discussion

Although our pilot, proof of concept study only included a small number of subjects, it shows the possible interest of using diving practice as a therapy for subjects suffering from PTSD. Our results shows that the meditative diving, Bathysmed® protocol seems to be more beneficial than the multisport program up to one month after the course. However, the superiority of the diving protocol was only significant for intrusion symptoms of PTSD.

Intrusion symptoms play a special role in the physiopathology of PTSD. The intensity of re-experiencing past trauma in the present time is an indicator of patient outcomes (Brewin, 2015). The Bathysmed® protocol emphasizes the present moment. Divers are trained to be ‘more present’ during exercises, which could explain the rejection of traumatic memories. It has been proposed that shifting attention to the present moment reduces the attentional bias towards trauma stimuli (Boyd et al., 2018). Mindfulness-based therapies may increase activity in prefrontal regions and reduce activity in limbic regions. This could explain an effect on intrusion symptoms (Tang, Hölzel, & Posner, 2015). *Shifting attention to present moment could reduce attentional bias to trauma stimuli* (Boyd et al., 2018). Our result is all the more important since there is little evidence in the literature of the positive impact of other mindfulness exercises on intrusive symptoms (Boyd et al., 2018).

The effect size confirms these preliminary results. Overall, the Bathysmed® protocol tended to improve FMI scores more than the multisport program. The analysis of the effect size found a larger effect of the Bathysmed® protocol on PCL-5 and FMI scores and sub-scale scores for up to one month. However, we cannot draw any firm conclusions, because effect sizes are calculated separately for each of the two groups. None of the results that were identified up

![Figure 1. PCLS scores before, immediately after, one month after, and three months after the course.](image-url)
to one month after the program ended had persisted three months later.

There is little literature available on the persistence of the benefits of a mindfulness program. None of Beneton et al (Beneton et al., 2017) and Morgan et al (Morgan et al., 2019) studies did publish follow ups to our knowledge. However, in accordance with the recommendations of mindfulness programs, some statements suggest the need to a regular practice to maintain benefits. They mainly come from findings from both Event Related Potentials (ERPs) and neuroimaging studies. They suggest an effect of time on brain activity changes (Rubia, 2009). Some have made the assumption that long-term mindfulness practice may lead to automation of mechanisms/strategies (initially cognitive). Those mechanisms/strategies no longer require cognitive control effort (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007).

As expected, and consistent with the literature (Gilbert et al., 2015; Janssen et al., 2018), we found a constant association between changes in PCL-5 and FMI scores in both groups. However, the result at one month was not significant.

We could not expect a more general, homogeneous result for PCL-5 and FMI scores for two reasons. First, as mentioned earlier, our pilot study suffers from a lack of power. A larger number of subjects is needed to obtain more significant results. Second, to be effective, mindfulness must be practiced in the long term (Solhaug et al., 2019). Stable benefits only appear after several months of meditative practice. This probably explains why no differences persisted three months after the course. Nevertheless, our study shows the possible value of the Bathysmed® protocol. The protocol is a whole and must include psychoeducation to be effective. Diving alone might have been less effective but this still needs to be investigated. Amongst the limitations, we did not collect data on acceptability but all subjects in the diving group passed their first level diving diploma. The feasibility is more difficult. It happened far from home, diving is expensive. The cost makes it difficult to repeat the experience so often under the same conditions. Finally the limited number of subject and the diversity of their usual treatment did not allow us to take them into account.

Further work is needed to confirm the initial results obtained with this pilot study. The protocol is currently used in another pilot study in France including French military veterans (NCT03995992).

In this study, French military veterans suffering from PTSD were separated into two groups. One group follows a multisport program in the French Alps and the other group follows the Bathysmed® protocol in the Mediterranean (Toulon). In a more prospective way, the Bathysmed® team is working on a virtual reality device to be tested. Divers could exercise in the pool and be virtually in the sea. If it shows the same benefits, the feasibility of this new protocol would be greater.

### Table 2. Pearson's correlations between PCL5 and FMI scores.

|                  | Both groups | Diving group | Multi sports group |
|------------------|-------------|--------------|--------------------|
|                  | Pearson’s r | p            | Pearson’s r | p |
| BF-AF            | -0.59       | <0.01        | -0.54         | 0.03 | -0.62 | <0.01 |
| BF-1 M           | -0.22       | 0.22         | -0.01        | 0.66 | -0.23 | 0.4 |
| BF-3 M           | -0.63       | <0.01        | -0.63        | <0.01 | -0.65 | <0.01 |

BF: Before, AF: After, 1 M: 1 month after, 3 M: 3 month after.

### Author contribution

LG, MT, FB and VM conceived and designed the analysis. LG and MT recruited the subjects. LG, MT, FB, FL, MC, AM and VM collected the data. LG and MT performed the data analysis. LG and MT wrote the first manuscript. JAM and FCR reviewed the scientific part of the manuscript. All authors contributed to and have approved the final submitted version.

### Disclosure statement

No potential conflict of interest was reported by the author(s).
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Data availability

The data supporting the findings of this study are located on a military server and cannot be accessed publicly but are available upon request from the corresponding author, Dr Lionel Gibert after following the IRBA (French Army Institute for biomedical research) procedure (military data procedure).

References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorder (5th ed.). Washington, DC: Author.

Anderson, E., & Shivakumar, G. (2013). Effects of exercise and physical activity on anxiety. Frontiers in Psychology [Internet], 4. doi:10.3389/fpsyg.2013.00027

Ashbaugh, A. R., Houle-Johnson, S., Herbert, C., El-Hage, W., Brunet, A., & Mazza, M. (2016, October 10). Psychometric validation of the English and French versions of the posttraumatic stress disorder checklist for DSM-5 (PCL-5). Mazza M, editor. PLoS ONE, 11(10), e0161645. doi:10.1371/journal.pone.0161645

Badura-Brack, A. S., Naim, R., Ryan, T. J., Levy, O., Abend, R., Khanna, M. M., . . . Bar-Haim, Y. (2015, December). Effect of attention training on attention bias variability and PTSD symptoms: randomized controlled trials in Israeli and U.S. Combat veterans. American Journal of Psychiatry, 172(12), 1233–1241. doi:10.1176/appi.ajp.2015.14121578

Beneton, F., Michoud, G., Coulange, M., Laine, N., Ramdani, C., Borgnetta, M., . . . Trousselard, M. (2017, December 18). Recreational diving practice for stress management: An exploratory trial. Frontiers in Psychology, 8, 2193. doi:10.3389/fpsyg.2017.02193

Boden, M. T., Bernstein, A., Walser, R. D., Bui, L., Alvarez, J., & Bonn-Miller, M. O. (2012, Dec). Changes in facets of mindfulness and posttraumatic stress disorder treatment outcome. Psychiatry Research, 200(2-3), 609–613. doi:10.1016/j.psychres.2012.07.011

Boyd, J. E., Lanius, R. A., & McKinnon, M. C. (2018, Jan). Mindfulness-based treatments for posttraumatic stress disorder: A review of the treatment literature and neurobiological evidence. Journal of Psychiatry & Neuroscience, 43(1), 7–25. doi:10.1503/jpn.170021

Brefczynski-Lewis, J. A., Lutz, A., Schaefer, H. S., Levinson, D. B., & Davidson, R. J. (2007). Neural correlates of attentional expertise in long-term meditation practitioners. Proceedings of the National Academy of Sciences, 104(27), 11483–11488. doi:10.1073/pnas.0606552104

Brewin, C. R. (2015, Dec). Re-experiencing traumatic events in PTSD: New avenues in research on intrusive memories and flashbacks. European Journal of Psychotraumatology, 6(1), 27180. doi:10.3402/ejpt.v6.27180

Fetzner, M. G., & Asmundson, G. J. G. (2015, Jul). Aerobic exercise reduces symptoms of posttraumatic stress disorder: A randomized controlled trial. Cognitive Behaviour Therapy, 44(4), 301–313. doi:10.1080/16506073.2014.916745

Gibert, L., Verdonck, C., Tarquinio, C., Falissard, B., Hage, W. E., & Trousselard, M. (2015, 2018 Sep). Paris terrorist attacks: Care guidance for the massive influx of psychologically traumatized civilian casualties. Helping victims to develop their capacity to create a safe and protective environment by leveraging social resources like family, and inner resources like mindfulness should optimize global resilience. European Journal of Trauma Dissociation, 4, S2468749918300371. doi:10.1016/j.ejtd.2018.08.003

Hayes, A. M., & Feldman, G. (2004). Clarifying the construct of mindfulness in the context of emotion regulation and the process of change in therapy. Clinical Psychology: Science and Practice, 11(3), 255–262. doi:10.1093/clipsy.bph080

Hegberg, N. J., Hayes, J. P., & Hayes, S. M. (2019, Mar 21). Exercise intervention in PTSD: A narrative review and rationale for implementation. Frontiers in Psychiatry, 10, 133. doi:10.3389/fpsyg.2019.00133

Hilton, L., Hempel, S., Ewing, B. A., Apaydin, E., Xenakis, L., Newberry, S., & Maglione, M. A. (2017, Apr). Mindfulness meditation for chronic pain: Systematic review and meta-analysis. Annals of Behavioral Medicine, 51(2), 199–213. doi:10.1007/s12160-016-9844-2

Janssen, M., Heerkens, Y., Kuijer, W., van der Heijden, B., Engels, J., & Ebmeier, K. (2018, Jan 24). Effects of mindfulness-based stress reduction on employees’ mental health: A systematic review. Ebmeier K, editor. PLoS ONE, 13(1), e0191332. doi:10.1371/journal.pone.0191332

Kandola, A., Vancampfort, D., Herring, M., Rebar, A., Hallgren, M., Firth, J., & Stubbs, B. (2018, August). Moving to beat anxiety: Epidemiology and therapeutic issues with physical activity for anxiety. Current Psychiatry Reports, 20(8), 63. doi:10.1007/s11920-018-0923-x

Morgan, A., Sinclair, H., Tan, A., Thomas, E., & Castle, R. (2019, November). Can scuba diving offer therapeutic benefit to military veterans experiencing physical and psychological injuries as a result of combat? A service evaluation of Deeptherapy UK. Disability and Rehabilitation, 41(23), 2832–2840. doi:10.1080/09638288.2018.1480667

Rubia, K. (2009, September). The neurobiology of Meditation and its clinical effectiveness in psychiatric disorders. Biological Psychology, 82(1), 1–11. doi:10.1016/j.biopsycho.2009.04.003

Solhaug, I., de Vibe, M., Friborg, O., Sarlie, T., Tyssen, R., Bjørndal, A., & Rosenvinge, J. H. (2019, August). Long-term mental health effects of mindfulness training: A 4-year follow-up study. Mindfulness, 10(8), 1661–1672. doi:10.1007/s12671-019-01100-2

Solomon, Z., & Mikulincer, M. (2006, April). trajectories of PTSD: a 20-year longitudinal study. American Journal of Psychiatry, 163(4), 659–666. doi:10.1176/appi.ajp.2006.163.4.659

Tang, Y.-Y., Holzel, B. K., & Posner, M. I. (2015, April). The neuroscience of mindfulness meditation. Nature Reviews Neuroscience, 16(4), 213–225. doi:10.1038/nrn3916
Trousselard, M., Steiler, D., Raphel, C., Cian, C., Duymedjian, R., Claverie, D., & Canini, F. (2010). Validation of a French version of the Freiburg mindfulness inventory-short version: Relationships between mindfulness and stress in an adult population. *BioPsychoSocial Medicine, 4*(1), 1. doi:10.1186/1751-0759-4-8

Verdonk, C., Trousselard, M., Canini, F., Vialatte, F., & Ramdani, C. (2020). Toward a Refined Mindfulness Model Related to Consciousness and Based on ERP. *Perspectives on Psychological Science, 15*(4). doi:10.1177/1745691620906444

Walach, H., Buchheld, N., Buttenmüller, V., Kleinknecht, N., & Schmidt, S. (2006, June). Measuring mindfulness—The Freiburg Mindfulness Inventory (FMI). *Personality and Individual Differences, 40*(8), 1543–1555. doi:10.1016/j.paid.2005.11.025

Weathers, F. W., Bovin, M. J., Lee, D. J., Sloan, D. M., Schnurr, P. P., Kaloupek, D. G., & Marx, B. P. (2018, March). The clinician-administered PTSD scale for DSM–5 (CAPS-5): Development and initial psychometric evaluation in military veterans. *Psychological Assessment, 30*(3), 383–395. doi:10.1037/pas0000486