Lifestyle Medicine

WILEY

Lifestyle Medicine Open Access

ORIGINAL ARTICLE OPEN ACCESS

The Influence of Immersion Environment on Mood: Comparing Sea Versus Laboratory Cold Exposure

John Stephen Kelly

Institute of Applied Sciences, College Lane, University of Chichester, Chichester, UK

Correspondence: John Stephen Kelly (j.kelly@chi.ac.uk)

Received: 22 April 2025 | **Revised:** 5 September 2025 | **Accepted:** 23 October 2025

ABSTRACT

Background: Cold water immersion (CWI) has gained attention as a potential strategy for improving mental health. Although studies demonstrate consistent mood-enhancing effects following sea swimming and controlled CWI, the role of environmental context remains unclear. No previous studies have directly compared natural and artificial immersion settings using a within-subjects design. This study aimed to isolate the influence of immersion environment on acute mood outcomes.

Methods: Twenty-seven healthy university students (16 males, 11 females; age 20 ± 4 years, height 1.71 ± 0.08 m, mass 70.4 ± 9.2 kg) completed a within-subject crossover design comparing two CWIs: one in the sea and one in a laboratory tank, 1 week apart. Mood was assessed using the Profile of Mood States—Short Form (POMS-SF) before and after a 5-min chest-deep immersion. Immersions were completed individually to minimise social facilitation. One- and two-way repeated measures ANOVAs analysed total mood disturbance (TMD) and subscales, with Bonferroni-corrected post hoc *t*-tests.

Results: Mood improved significantly following both immersions and across all subscales. Paired-sample *t*-tests showed greater reductions in TMD ($t_{(26)} = -2.69$, $p = 0.012$, $d = -0.52$) and larger increases in esteem-related affect ($t_{(26)} = 2.41$, $p = 0.023$, $d = 0.46$) after sea immersion compared to laboratory immersion. A trend in favour of sea immersion was also observed for vigour ($t_{(26)} = -1.998$, $p = 0.056$, $d = -0.38$). Although all negative subscales improved over time, no significant between-condition differences were found. Analysis of TMD change scores showed that 13 participants (48%) responded similarly across both conditions, 10 (37%) improved more in the sea, and 4 (15%) improved more in the laboratory.

Conclusion: CWI significantly improved mood across both conditions. Sea immersion produced slightly greater benefits, suggesting that natural environments may modestly enhance the psychological effects of cold exposure.

1 | Introduction

Mental health conditions remain a leading cause of global disability, with depression and anxiety contributing substantially to the burden of disease [1]. Despite increased recognition of the need for accessible and effective treatments, barriers such as cost, availability and stigma continue to limit engagement with traditional therapies. In response, lifestyle-based interventions, including physical activity, dietary change and environmental exposure, are being explored as scalable, low-cost alternatives [2]. Particularly valuable are interventions that are self-directed, widely accessible and rapidly effective.

Cold water immersion (CWI) has gained attention as a lifestyle strategy, with sea swimming increasingly visible in the media as a source of emotional healing and connection to nature. Documentaries such as *Wild Water* [3] and *Beyond the Blue* [4] showcase its communal and restorative dimensions. Structured cold exposure practices, including cold showers popularised in public health messaging, for example, *Just One Thing* [5], are

promoted for benefits such as improved mood, reduced anxiety and enhanced resilience. Although anecdotal support is strong, the academic evidence remains limited, particularly for domestic cold exposure [6, 7].

In recent years, greater attention has turned to the role of environment in human health. Emerging qualitative research suggests that wild or open water settings actively shape the psychological impact of immersion, not simply serving as passive backdrops. These effects are frequently framed through the biophilia hypothesis, the idea that humans possess an innate tendency to connect with nature and other forms of life [8]. Engagement with natural environments may evoke psychological restoration, emotional regulation and even spiritual resonance. Tipton [9] argues that modern humans have become 'thermostatic', buffered from the environmental challenges, such as cold, that once shaped physiological resilience.

A substantial body of research highlights the restorative qualities of blue spaces, including coasts, rivers and lakes [10, 11]. These settings are often associated with emotional release and relief from everyday pressures [12], aligning with the concept of salutogenic environments that actively support well-being [13]. Cold water may further amplify these effects by providing a full-body, multisensory experience [14].

For many, the sea is not simply a location but a therapeutic presence, linked to healing, transformation and ritual [15, 16]. These relationships often deepen over time, reinforcing place attachment and emotional security. Foley [17] describes wild swimming as a therapeutic landscape, whereas his later work introduces the concept of swimming as an accretive practice, a relationship that gains emotional value through repetition [18]. Gould et al. [19] illustrate this through their ethnography of the Bicheno Coffee Club, where shared immersion becomes an act of wayfaring [20], weaving environment into identity.

Although early accounts of wild swimming often focused on solitude and escape [21], more recent research highlights its relational aspects. Researchers such as Gould et al. [19], Christie and Elliott [12] and Foley [17] emphasise shared rituals and collective meanings that emerge within local swimming communities. These social dimensions are embedded in place and ritual, reinforcing bonds between people and their waterscapes.

At the same time, wild swimming involves emotional tension. Alongside clarity and connection, swimmers describe fear, vulnerability and uncertainty; confronting cold, depth and the unseen [12, 22]. Foley [17] suggests that these contradictions, between comfort and risk, may enhance the meaning and resonance of immersion. The environment, in this framing, is not neutral; it is a relational agent, cocreating therapeutic outcomes [23]. In socially embedded, natural contexts [24], cold water becomes a medium not only for mood regulation, but for meaning-making and identity.

Yet these compelling qualitative accounts are rarely tested against empirical outcome measures. It remains unclear whether reported experiences of connection and transformation are reflected in validated mood scales. However, quantitative studies have examined cold exposure in isolation, overlooking the contextual or symbolic elements of place. A gap therefore persists between experiential narratives and psychological data. Bridging this divide requires research that can quantify change while accounting for the environmental setting.

There is growing quantitative evidence that cold exposure does improve mood. Several studies have reported reductions in negative affect and increases in positive mood following immersion. Kelly and Bird [25], for example, found significant decreases in total mood disturbance (TMD) after a single sea swim. Reed et al. [26] observed improved mood and lower cortisol following 15 min of laboratory-based CWI, and Yankouskaya et al. [27] reported increased positive affect and enhanced interaction between emotion-regulating brain networks following cold immersion.

These outcomes are commonly attributed to neurophysiological responses involving adrenaline, noradrenaline and dopamine [28, 29], as well as shifts in autonomic tone [30] and inflammatory pathways [7]. However, studies differ in immersion type, temperature and setting and rarely attempt to disentangle physiological from environmental factors. For example, Massey et al. [31] observed cumulative mental health improvements from open water swimming but gave limited attention to environmental components. Conversely, laboratory studies offer control but lack ecological richness [26, 27]. This methodological tension, between physiological plausibility and ecological complexity, remains unresolved.

As a result, a central question remains: Does the environment matter? Is setting merely a supportive backdrop, or a key ingredient in the psychological effect? Does immersion in the sea; dynamic, symbolic, relational; yield the same benefits as immersion in a controlled indoor setting?

Therefore, this study was designed to explore this question directly. By comparing matched CWIs in laboratory and natural sea environments and using mood as a validated, sensitive proxy for mental well-being, the aim was to examine whether environmental context contributes meaningfully to the psychological effects of cold exposure. Participants were immersed individually, without group interaction or social facilitation, which are known to influence affective responses [32]. This approach enabled examination of the intrinsic effects of environment, independent of the communal or symbolic dynamics often associated with wild swimming [33]. Although the broader literature points to plausible psychophysiological mechanisms, this study focused specifically on mood to isolate the contextual influence of place. This is the first study to directly compare natural and artificial CWI environments using a within-subject design, and in doing so, it moves beyond the question of whether cold water works, toward a more nuanced exploration of how, where and why such benefits may emerge.

2 | Materials and Methods

2.1 | Participants

Twenty-seven healthy participants (16 males, 11 females; age 20 ± 4 years, height 1.71 ± 0.08 m, mass 70.4 ± 9.2 kg, BMI 24.1 ± 3.2) were recruited from a university student population

via convenience sampling. The sample was drawn from students enrolled in sport-related degree programmes, including Sport and Exercise Science, Physical Education and Sport Psychology. All participants were physically active, confident in the water and had no previous experience with cold water swimming or structured immersion practices. Recruitment was conducted through in-lecture announcements, university email notifications and word-of-mouth referrals.

No formal a priori sample size calculation was conducted. The sample size was determined pragmatically on the basis of the participant availability and logistical feasibility within the study timeline. However, this sample size is consistent with similar studies in this field (e.g., [25, 31]).

Initial screening was conducted using a structured health history questionnaire to assess eligibility. Participants were excluded if they had a clinical diagnosis of anxiety, depression or other mood-related disorders or were taking medication for mental health conditions. Additional exclusion criteria included a history of cardiovascular disease, such as arrhythmia, hypertension or hypotension, or circulatory disorders such as Raynaud's disease or peripheral vascular disease. Individuals taking medication for cardiovascular conditions were also excluded. These criteria were applied to minimise the physiological risks associated with cold exposure, including the potential for blood pressure fluctuations, cardiac arrhythmias [34] and non-freezing cold injuries [35].

All participants provided written informed consent prior to taking part, and the study received ethical approval from the University of Chichester (UoCBEB01).

2.2 | Procedures

A baseline mood assessment was completed 7 days prior to the first immersion trial, with each participant completing the Profile of Mood States—Short Form (POMS-SF) individually in a quiet indoor setting. This provided a baseline reference point against which pre- and post-immersion mood scores could be interpreted. Participants were randomly assigned to complete either the sea or laboratory immersion first, with the second immersion scheduled 7 days later. Immersions were counterbalanced to reduce order effects, and participants were tested individually to minimise the potential for social facilitation or group-based emotional contagion. Although the odd sample number ($n = 27$) prevented complete counterbalancing, the allocation was nearly equal between order groups.

2.2.1 | Sea Immersion Protocol

The sea immersion took place at a local beach over two, 4-day periods in November, with each participant attending at a pre-scheduled time. Participants were transported to the beach from the university campus (approximately 7 miles) in a university vehicle. No participants reported any issues related to travel, such as motion sickness, and all were accustomed to regular driving or commuting as part of their daily routine. Sessions were timed to coincide with high tide, as this represents the period of lowest water movement and most stable sea conditions [36]. Sea and air temperatures were recorded daily using an Oregon Scientific weather station (THWR800) approximately 8 m from the shore, in the immediate vicinity of the participant. Across all immersion days, the mean sea temperature was 13.6°C (range 12.6–14.2°C); air temperature averaged 8.8°C (range 6–11.5°C), and sea states were generally calm.

Upon arrival participants changed into (and out of) swimwear using public toilet block facilities located adjacent to the beach parking area. While basic, these facilities offered sufficient privacy and shelter for pre- and post-immersion clothing changes.

Participants were briefed on typical physiological responses to cold exposure, including cold shock, shivering and mild discomfort, and were advised to exit the water or signal if they experienced distress. Immersion would have been terminated immediately if participants showed signs of excessive shivering, disorientation, facial pallor, slowed responses, or verbalised discomfort. However, no adverse reactions or early terminations occurred. Participants were advised that mild afterdrop symptoms, such as continued shivering or feeling cold, might persist for 20–30 min after exiting the water. These were explained as normal physiological responses [34] and not cause for concern unless accompanied by confusion, unusual fatigue or ongoing discomfort. Clear instructions were given on the importance of changing into warm clothing quickly, and each participant was notified of the location of a cold safety pack in the university vehicle, including a warm drink, high-energy snacks and dry clothing. The researcher and supervising lifeguard monitored each participant during and after immersion, and participants were encouraged to report any sensations of dizziness, numbness or distress. No adverse reactions were reported. Immediately after the briefing and orientation, participants completed the POMS-SF before being guided down to the shoreline. Although the exact time taken to reach chest depth was not recorded, participants were instructed to immerse as quickly and steadily as possible but allow sufficient time to control their breathing and reduce cold shock [34, 37]. Once immersed, participants were asked to remain head-out and chest-deep and minimise unnecessary movement while maintaining their position for a total of 5 min, in line with protocols used in recent studies (Kelly, Delaney and Davidson, under review; [25]). After the immersion, participants exited the water, dried off, dressed in warm clothing and immediately completed the post-immersion POMS-SF. Participants were monitored at the site for a further 30 min. No adverse incidents were reported. To ensure safety, the site and procedures were subject to a full risk assessment; a qualified beach lifeguard was present throughout all immersions, and conditions were continuously monitored.

2.2.2 | Laboratory Immersion Protocol

The laboratory immersion tank was filled to chest depth and maintained at approximately the same average temperature as the sea immersion (14.0°C). Participants were briefed in the same manner as the sea immersion protocol, following which they completed the POMS-SF before stepping into the tank and sitting down. As with the sea condition, they were instructed to immerse

up to the chest quickly, controlling their breath upon entry. They remained seated and still for 5 min, following the same head-out immersion protocol. Entry in the laboratory condition was likely faster than the sea immersion due to the simpler logistics of sitting in a still tank. After exiting the tank, participants dried, dressed and completed the post-immersion POMS-SF, remaining in an adjacent room for a further 30 min. No adverse incidents were reported. Hot drinks were made available on request, and additional clothing and blankets were available.

Each immersion session was conducted individually to prevent the influence of social interaction or peer effects on mood. This approach was chosen to isolate the psychological effects of the environment itself, rather than any influence of group dynamics or shared experience, as previous research has shown that these social elements may modulate affective responses during outdoor swimming [16, 17].

In both the sea and laboratory conditions, a researcher was present throughout each immersion to monitor safety. In the laboratory, the researcher remained nearby at all times; in the sea, proximity varied depending on water depth and wave conditions, but the researcher remained in close visual contact and was prepared to intervene if necessary. No verbal interaction (other than briefing and instructions) occurred during immersion in either setting. This consistent, non-interactive monitoring approach aimed to balance participant safety with ecological validity, recognising that although many individuals immerse in groups, solo immersion is also commonly practised.

2.3 | Measures

Mood was assessed using the 40-item POMS-SF [38]. This self-report questionnaire yields a TMD score and seven subscales: tension, depression, anger, fatigue, confusion, vigour and esteem-related effect. Items are rated on a five-point Likert scale ranging from 0 (not at all) to 4 (extremely), with higher TMD scores reflecting greater overall mood disturbance.

2.4 | Data Analysis

Analyses were conducted using IBM SPSS Statistics (Version 23). Descriptive statistics were calculated for outcome measures and are presented in Table 1. The primary outcome was TMD. Further analyses were conducted on the subscales: vigour, esteem-related affect (ERA), fatigue, tension, anger, confusion and depression.

To assess pre-immersion stability, a one-way repeated measures ANOVA was conducted on TMD and each subscale across three conditions: baseline, pre-sea and pre-laboratory. Where a significant main effect was found, Bonferroni-corrected pairwise comparisons were used to identify the source of the difference, with an adjusted alpha level of $p < 0.017$.

The primary analyses used a repeated measures 2 × 2 ANOVA design, with time (pre-immersion vs. post-immersion) and condition (sea vs. laboratory) as within-subjects factors. This approach tested for main effects of time and condition and for their interaction, which would indicate whether mood changes differed by environment. To assess the proportion of variance explained by each ANOVA effect, partial eta squared (η^2) was reported. Effect sizes were interpreted using conventional thresholds: $\eta^2 = 0.01$ (small), $\eta^2 = 0.06$ (moderate) and $\eta^2 = 0.14$ (large), consistent with guidelines of Cohen [39]. In addition to the ANOVA, pre-to-post difference scores were computed for each condition and compared using paired-sample *t*-tests to evaluate the magnitude and direction of change across settings when appropriate. For each *t*-test, Cohen's *d* was calculated to estimate effect size, with standard benchmarks used for interpretation: 0.2 (small), 0.5 (medium) and 0.8 (large) [39, 40].

Although POMS-SF responses are derived from ordinal Likert-type scales, it is common practice in psychometric and health psychology research to treat aggregated subscale and total scores as continuous variables [41, 42]. This is especially the case when multiple items are summed or averaged, which helps approximate interval-level measurement and supports the use of parametric statistics [41, 43]. Repeated measures ANOVA and paired-sample *t*-tests were considered appropriate given the experimental design and their well-documented robustness to moderate violations of normality, especially in within-subject designs and when sample sizes exceed 20 [44–46]. Moreover, in repeated measures designs, the assumption of normality applies to the distribution of difference scores, which tend to approximate normality even when raw scores do not [47].

To explore individual response patterns, participants were categorised into tertiles on the basis of their change in TMD scores following immersion in each condition. This allowed for visualisation of consistency and magnitude of individual-level effects across settings.

A significance level of $p < 0.05$ was used for all analyses, unless adjusted for multiple comparisons.

3 | Results

The initial analysis explored baseline stability in mood across the three pre-immersion conditions: baseline, pre-sea and pre-laboratory. A one-way repeated measures ANOVA on TMD revealed no significant differences between these pre-immersion measurements ($F_{(2,52)} = 0.64$, $p = 0.531$). Mean TMD scores were stable: baseline ($M = 104.1 \pm 19.8$), pre-sea ($M = 105.9 \pm 17.0$) and pre-lab ($M = 104.8 \pm 15.6$). Similar results were found for each POMS-SF subscale, with no significant differences across pre-immersion time points. Although vigour showed a trend toward significance across the pre-immersion measurements ($F_{(2,52} = 3.57$, $p = 0.035$), this effect did not remain significant following Bonferroni correction. This stability suggests that participants' mood was consistent prior to the experimental interventions.

For TMD, there was a significant main effect of time ($F_{(1,26)} = 147.72$, $p < 0.001$, $\eta^2 = 0.36$), indicating an overall improvement in mood following immersion, but not condition. A significant interaction between time and condition ($F_{(1,26)} = 7.22$, $p = 0.012$, $\eta^2 = 0.12$) suggested that mood improvement was greater following sea immersion. Post hoc paired-sample *t*-tests

TABLE 1 | Mean (SD) scores for total mood disturbance and POMS subscales at baseline, pre- and post-immersion in sea and laboratory conditions.

		Sea immersion			Laboratory immersion		
Subscale	**Baseline**	**Pre**	**Post**	**Δ**	**Pre**	**Post**	**Δ**
TMD	104.1 (19.8)	105.9 (16.9)	**82.9 (14.5)**	−23.0 (9.4)	104.8 (15.6)	**87.1 (14.4)**	−17.7 (10.8)*
Vigour	6.1 (3.7)	5.7 (3.1)	**10.2 (3.5)**	4.5 (3.2)	5.6 (3.3)	**8.8 (3.5)**	3.2 (3.0)
ERA	13.4 (3.4)	12.6 (3.1)	**17.4 (3.3)**	4.8 (3.0)	11.9 (2.7)	**15.2 (2.9)**	3.3 (2.5)*
Fatigue	6.3 (4.2)	5.2 (3.1)	**2.2 (2.3)**	−3.0 (2.3)	5.7 (3.4)	**2.9 (2.8)**	−2.8 (2.6)
Tension	5.4 (4.6)	8.0 (3.8)	**2.6 (2.9)**	−5.4 (4.1)	6.5 (4.0)	**2.7 (3.5)**	−3.9 (3.7)
Anger	2.4 (3.2)	3.0 (5.1)	**1.3 (3.3)**	−1.7 (2.5)	2.6 (3.3)	**1.1 (1.8)**	−1.5 (2.7)
Confusion	5.4 (4.1)	4.6 (3.2)	**2.9 (2.5)**	−1.8 (2.2)	4.0 (3.2)	**2.7 (3.1)**	−1.3 (2.8)
Depression	4.0 (5.5)	3.3 (4.4)	**1.5 (3.5)**	−1.8 (2.0)	3.5 (5.0)	**1.7 (3.6)**	−1.8 (2.9)

Note: Δ = change scores from pre- to post-immersion. **Bold** = main effect of time; * indicates significant difference between Δ values.
Abbreviations: ERA, esteem-related affect; TMD, total mood disturbance.

on change scores confirmed a significant difference in favour of the sea condition ($t_{(26)} = -2.69$, $p = 0.012$, $d = -0.52$).

ERA also showed a clear pattern, with a main effect of time ($F_{(1,26)} = 86.40$, $p < 0.001$, $\eta^2 = 0.29$), a higher ERA post-immersion and a significant main effect of condition ($F_{(1,26)} = 8.45$, $p = 0.007$, $\eta^2 = 0.15$), higher in the sea immersion than the laboratory. The significant interaction between time and condition ($F_{(1,26)} = 5.82$, $p = 0.023$, $\eta^2 = 0.07$) suggested that this effect was greater in the sea immersion. Paired-sample *t*-tests on change scores supported this conclusion ($t_{(26)} = 2.41$, $p = 0.023$, $d = 0.46$), with a larger increase in ERA following sea immersion.

For vigour, there was a significant main effect of time ($F_{(1,26)} = 8.79$, $p = 0.006$, $\eta^2 = 0.21$), indicating a general increase following immersion. Although the interaction did not reach significance, there was a trend toward a stronger increase in vigour following sea immersion ($F_{(1,26)} = 2.00$, $p = 0.056$, $\eta^2 = 0.03$), with mean change in vigour of 4.5 in the sea condition compared to 3.2 in the laboratory. A paired sample *t*-test on the change scores supported this trend ($t_{(26)} = -1.998$, $p = 0.056$, $d = -0.384$).

All negative mood subscales showed a significant effect of time (fatigue: $F_{(1,26)} = 74.47$, $p < 0.001$, $\eta^2 = 0.22$; anger: $F_{(1,26)} = 15.43$, $p = 0.001$, $\eta^2 = 0.15$; tension: $F_{(1,26)} = 62.62$, $p < 0.001$, $\eta^2 = 0.19$; confusion: $F_{(1,26)} = 13.00$, $p = 0.001$, $\eta^2 = 0.11$; and depression: $F_{(1,26)} = 27.12$, $p < 0.001$, $\eta^2 = 0.09$), reflecting a reduction in symptoms post-immersion. No significant effects of condition or interactions were found for these subscales, suggesting that immersion, regardless of environment, was effective in reducing symptoms of negative mood, but that the extent of reduction did not significantly differ between the sea and laboratory settings.

To explore individual consistency in mood responses, participants were categorised into tertiles on the basis of their change in TMD following immersion in both the sea and laboratory conditions. A traffic light matrix (Figure 1) illustrates the degree of agreement across conditions.

Thirteen participants (48%) fell into the same tertile for both sea and lab conditions (low–low, mid–mid, or high–high), indicating consistent magnitudes of response regardless of environment. Ten participants (37%) showed a stronger mood improvement in the sea compared to the lab, with the largest group ($n = 5$) demonstrating a moderate response in the sea but only a low response in the laboratory. Four participants (15%) showed a stronger response in the laboratory than in the sea.

This pattern suggests that, although individual variability was evident, a greater proportion of participants exhibited larger mood improvements following sea immersion compared to the laboratory condition. The distribution of responders was skewed towards higher change scores in the sea condition, with few participants demonstrating a stronger effect in the laboratory setting.

4 | Discussion

This study investigated the acute effects of CWI on mood in a within-subjects design comparing immersion in matched laboratory and sea environments. Findings revealed significant improvements in mood following both immersion conditions, with significantly greater reductions in TMD and higher increases in ERA and vigour observed following sea immersion. These improvements were consistent across participants, with no adverse events reported. Large effect sizes for the main effect of time indicate that even a brief, 5-min immersion can acutely shift affective states in young, healthy individuals.

These results add to a growing body of evidence supporting the mood-enhancing effects of brief cold exposure. Previous studies have shown that a single session of cold immersion can improve overall mood [25], whereas longer term programmes involving outdoor swimming are also associated with mood improvements [31]. Laboratory-based studies such as Reed et al. [26] and Yankouskaya et al. [27] have also confirmed significant psychological effects of cold exposure under controlled conditions, with mood improvements accompanied by changes in cardiovascular markers or brain connectivity. Importantly, the present study extends these findings by isolating the influence of environmental context within a controlled design. Water temperature and immersion duration were matched, and participants were

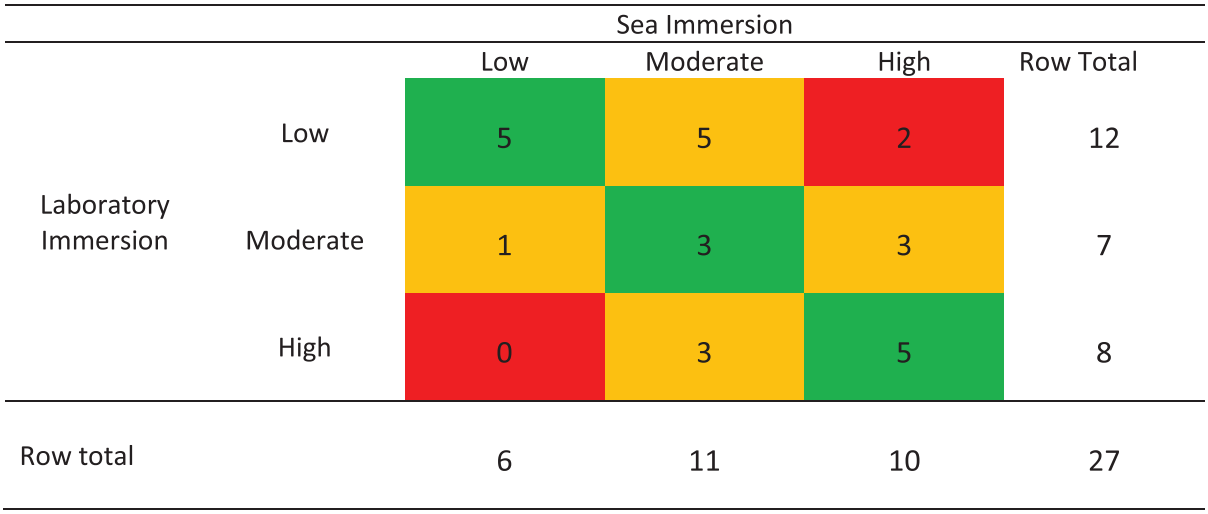

FIGURE 1 | Participant distribution across tertile categories (sea vs. laboratory immersion).

individually supervised and instructed to remain still in both settings. Although postural differences and environmental variables such as water movement could not be fully standardised, the study nonetheless provides evidence that immersion in a natural setting may enhance the psychological benefits of cold exposure.

One notable feature of the current findings is the relative consistency in response across individuals. An analysis of change scores for TMD revealed that 48% of participants showed similar levels of improvement in both conditions, whereas 37% improved more in the sea and 15% more in the lab. This pattern suggests that although cold exposure reliably improves mood overall, individual responses vary, and the environment may moderate the magnitude of change.

In comparison to other studies using the POMS-SF, the magnitude of TMD change in the present study was higher. Kelly and Bird [25] reported mean reductions in TMD of 10.8 points following a single immersion, whereas the current study observed reductions of 17 and 24 points in the lab and sea conditions, respectively. Massey et al. [31] found smaller and less consistent improvements across subscales in a group-based outdoor swimming programme and noted substantial individual variability. These differences likely reflect methodological and contextual variation: The current study employed a one-on-one testing approach and brief but intense cold exposure, all of which may have contributed to stronger and more consistent effects.

The role of environmental context remains an important consideration. Natural environments have been associated with improved mood, reduced stress and enhanced well-being across a range of studies [10, 11]. Theoretical models such as Attention Restoration Theory [48] and Stress Reduction Theory [49] suggest that natural settings promote psychological recovery and emotional regulation. The concept of blue space, in particular, highlights the multisensory and symbolic richness of water environments, including sounds, temperature contrast and symbolic associations [50]. Although these factors were not directly measured in the current study, their contribution cannot be excluded and may help explain the moderate amplification of mood improvements seen in the sea condition.

Qualitative accounts of outdoor swimming frequently describe immersion as a therapeutic, transformative experience [13, 19, 51]. Though the present study involved only a single, brief immersion, the immediate emotional benefits observed here resonate with themes identified in longer-term participant narratives, including enhanced vigour, a sense of clarity and relief from tension [12, 16]. However, the controlled and time-limited nature of this study means that broader symbolic or identity-related effects likely played a minimal role, and acute physiological mechanisms, such as sympathetic activation followed by parasympathetic rebound, are more plausible explanations for the observed changes [9, 52].

Although the role of physiology was not directly assessed in this study, previous research suggests that acute cold exposure induces rapid neurochemical shifts, including increased noradrenaline and beta-endorphins, both of which are implicated in mood regulation [7, 30]. The consistent and widespread improvement across POMS-SF subscales suggests a broad-spectrum psychophysiological effect, consistent with a general stress-induced mood reset. Reed et al. [26], using the PANAS scale, reported reductions in negative affect without a corresponding increase in positive affect, whereas the current study observed both reductions in negative dimensions and improvements in positive subscales, notably ERA and vigour.

4.1 | Limitations

This study has several limitations that should be acknowledged when interpreting the findings. First, the sample was comprised exclusively of young, physically active university students enrolled on sport and exercise programmes. All participants were screened for physical and psychological health, and the group likely represents a high-functioning, fit, healthy, resilient population. As such, the results may not generalise to older adults, individuals with underlying health conditions, or those with clinical levels of mood disturbance. Although participants' BMI values fell within the healthy range, detailed anthropometric data such as body composition were not collected, limiting the ability to explore how individual thermal characteristics may have influenced subjective responses.

Second, although water temperature and immersion duration were closely matched between conditions, complete standardisation of the physical stimulus was not possible. Differences in participant posture (semi-supine in the lab vs. upright in the sea) and the presence of movement to maintain position and natural currents in the sea condition may have altered convective heat loss and disrupted thermal boundary layers. Although these factors reflect the ecological reality of outdoor immersion, they also complicate efforts to isolate the psychological contribution of the environment itself.

Third, no physiological or thermal sensation data were collected as part of this study. The inclusion of heart rate, skin and core temperature or subjective thermal comfort ratings would have allowed a more detailed analysis of physiological–psychological coupling and may have helped to explain differences in mood outcomes across settings. The absence of these measures limits any mechanistic interpretation.

Fourth, mood was assessed using the POMS-SF shortly after immersion, once participants were dry and dressed. Although this approach prioritised comfort and ensured consistency across both conditions, it may have slightly attenuated immediate affective responses to cold. Ecological momentary assessment (EMA) tools or rapid post-immersion data capture may offer more sensitive insight in future research.

Fifth, although exploratory analyses showed no gender differences in mood response, the study was not specifically powered for subgroup comparisons. The small sample size within each gender group (16 male, 11 female) limits confidence in the null finding and suggests some caution in generalising across sexes.

Finally, the study was designed to assess only immediate mood changes, with no follow-up assessments conducted. As such, the duration and stability of the observed improvements remain unknown. Although repeated measures over extended time points could clarify whether these benefits are transient or sustained, doing so with traditional instruments such as the POMS-SF presents practical challenges. Repeated completion of detailed mood inventories can be burdensome for participants, potentially leading to disengagement or response fatigue. In this context, emerging approaches such as EMA [53] may offer a more valid and sensitive means of tracking affective changes over time. EMA methods enable in-the-moment data capture in naturalistic settings, reduce recall bias and can accommodate repeated low-burden assessments, making them particularly well suited for studying dynamic responses to cold exposure in both laboratory and real-world environments.

These limitations highlight the challenges of isolating environmental effects in CWI studies, particularly when trying to balance ecological validity with experimental control. Factors such as posture, water movement and participant comfort inevitably influence outcomes, and without physiological or follow-up data, interpretation must remain cautious. Nonetheless, identifying and acknowledging these issues provides a valuable foundation for improving study design in future research.

5 | Conclusion

The results of this study provide clear evidence that CWI produces significant acute improvements in mood, and that immersion in a natural environment may amplify these benefits. Although further research is needed to understand underlying mechanisms, longer term outcomes and the role of individual differences, these findings add to the growing literature supporting cold exposure as an accessible and potentially powerful mood regulation strategy. Importantly, the mood-enhancing effects were also observed in the laboratory condition, underscoring that meaningful psychological benefits can be achieved through controlled cold exposure. Nonetheless, safety considerations are essential. Sea immersions were conducted under risk-assessed conditions with lifeguard supervision. CWI carries potential risks and should be approached with caution, particularly in individuals with cardiovascular or respiratory conditions [34, 54]. Our findings should not be interpreted as a blanket recommendation or a 'how to guide' for unsupervised natural water immersion. Anyone considering cold water exposure, whether in natural or artificial settings, should first consult with a healthcare professional, particularly if they have cardiovascular or respiratory conditions. Participation should start in the warmer months, entry into cold water should be gradual, sessions should be kept brief, and individuals should never swim alone. Future applications of cold-water therapy should be supported by clear safety guidelines and individual risk assessment.

Acknowledgements

The author would like to thank the participants, the lifeguards and the drivers for their assistance. I am grateful to West Wittering's estate for providing access to the beach and to 2XS for providing changing facilities. I would also like to thank Beth Eagle-Brown and Jacob Latter for the help in data collection.

Funding

The author has nothing to report.

Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

The dataset supporting the findings of this study is available upon request from the corresponding author (J.S.K.: Kelly@chi.ac.uk).

References

1. World Health Organization, *Mental Health: Strengthening Our Response* (WHO, 2023), https://www.who.int/news-room/fact-sheets/detail/mental-health-strengthening-our-response.

2. J. Firth, M. Solmi, R. E. Wootton, et al., "A Meta-Review of "Lifestyle Psychiatry": The Role of Exercise, Smoking, Diet and Sleep in the Prevention and Treatment of Mental Disorders," *World Psychiatry* 19, no. 3 (2020): 360–380, https://doi.org/10.1002/wps.20773.

3. Wild Swimming Brothers, *Wild Water—A Short Film About Cold Water Swimming in the Lake District* (YouTube, 2021, February 22), https://www.youtube.com/watch?v=I4r5IYL1LUg.

4. Real Stories, *Beyond the Blue—Wild Swimming and Cold Water Therapy* (YouTube, 2022, March 15), https://www.youtube.com/watch?v=rQi_1TrtK84.

5. BBC, *Just One Thing: Cold Water* (YouTube, 2024, October 14), https://www.youtube.com/watch?v=nTwZ46QHHIM.

6. G. A. Buijze, I. N. Sierevelt, B. C. van der Heijden, and D. Eygendaal, "The Effect of Cold Showering on Health and Work: A Randomized Controlled Trial," *PLoS ONE* 11, no. 9 (2016): e0161749, https://doi.org/10.1371/journal.pone.0161749.

7. N. A. Shevchuk, "Adapted Cold Shower as a Potential Treatment for Depression," *Medical Hypotheses* 70, no. 5 (2008): 995–1001, https://doi.org/10.1016/j.mehy.2007.04.052.

8. E. O. Wilson, *Biophilia* (Harvard University Press, 1986).

9. M. Tipton, "Humans: A Homeothermic Animal That Needs Perturbation?" *Experimental Physiology* 104, no. 1 (2018): 1–2, https://doi.org/10.1113/EP087450.

10. E. Britton, G. Kindermann, C. Domegan, and C. Carlin, "Blue Care: A Systematic Review of Blue Space Interventions for Health and Wellbeing," *Health Promotion International* 35, no. 1 (2020): 50–69, https://doi.org/10.1093/heapro/day103.

11. M. Gascon, W. Zijlema, C. Vert, M. White, and M. Nieuwenhuijsen, "Outdoor Blue Spaces, Human Health and Well-Being: A Systematic Review of Quantitative Studies," *International Journal of Hygiene and Environmental Health* 220, no. 8 (2017): 1207–1221, https://doi.org/10.1016/j.ijheh.2017.08.004.

12. M. Christie and D. Elliott, "I Get Headspace Here… You Forget Everything When in Open Water': Motives for Participation and Perceived Benefits Derived From Open Water Swimming: A Rapid Ethnographic Study," *Sport in Society* 26, no. 12 (2023): 2108–2131, https://doi.org/10.1080/17430437.2023.2233428.

13. R. Foley and T. Kistemann, "Blue Space Geographies: Enabling Health in Place," *Health & Place* 35 (2015): 157–165, https://doi.org/10.1016/j.healthplace.2015.07.003.

14. E. Murray and J. Fox, "The Meaning of Open-Water Swimming for Adults in Ireland: A Qualitative Study," *Irish Journal of Occupational Therapy* 49, no. 2 (2021): 89–95, https://doi.org/10.1108/IJOT-10-2020-0016.

15. K. Bottley, "Winter Wild Swimming as Individual and Corporate Spiritual Practice," *Practical Theology* 12, no. 3 (2019): 343–344, https://doi.org/10.1080/1756073X.2019.1589731.

16. C. Kelly, "'I Need the Sea and the Sea Needs Me': Symbiotic Coastal Policy Narratives for Human Wellbeing and Sustainability in the UK," *Marine Policy* 97 (2018): 223–231, https://doi.org/10.1016/j.marpol.2018.03.023.

17. R. Foley, "Swimming in Ireland: Immersion in Therapeutic Blue Space," *Health & Place* 35 (2015): 218–225, https://doi.org/10.1016/j.healthplace.2014.09.015.

18. R. Foley, "Swimming as an Accretive Practice in Healthy Blue Space," *Emotion, Space and Society* 22 (2017): 43–51, https://doi.org/10.1016/j.emospa.2016.12.001.

19. S. Gould, F. McLachlan, and B. McDonald, "Swimming With the Bicheno "Coffee Club": The Textured World of Wild Swimming," *Journal of Sport and Social Issues* 45, no. 1 (2021): 39–59, https://doi.org/10.1177/0193723520928594.

20. T. Ingold, *Being Alive: Essays on Movement, Knowledge and Description* (Routledge, 2011), https://doi.org/10.4324/9781003196679.

21. R. Deakin, *Waterlog: A Swimmers Journey Through Britain* (Vintage Publishing, 2014).

22. J. S. Kelly and D. Dahl. "Cold Water Swimming: The Risk Is the Reward, Conference Presentation," in 10th International Mountain and Outdoor Sports Conference (2022).

23. H. Prince-Llewellyn and P. McCarthy, "Walking and Talking for Well-Being: Exploring the Effectiveness of Walk and Talk Therapy," *Counselling and Psychotherapy Research* 25 (2024): e12847, https://doi.org/10.1002/capr.12847.

24. F. Lauzier-Jobin and J. Houle, "A Comparison of Formal and Informal Help in the Context of Mental Health Recovery," *International Journal of Social Psychiatry* 68, no. 4 (2022): 729–737, https://doi.org/10.1177/00207640211004988.

25. J. S. Kelly and E. Bird, "Improved Mood Following a Single Immersion in Cold Water," *Lifestyle Medicine* 3, no. 1 (2022): e53, https://doi.org/10.1002/lim2.53.

26. E. L. Reed, C. L. Chapman, E. K. Whittman, et al., "Cardiovascular and Mood Responses to an Acute Bout of Cold Water Immersion," *Journal of Thermal Biology* 118 (2023): 103727, https://doi.org/10.1016/j.jtherbio.2023.103727.

27. A. Yankouskaya, R. Williamson, C. Stacey, J. J. Totman, and H. Massey, "Short-Term Head-Out Whole-Body Cold-Water Immersion Facilitates Positive Affect and Increases Interaction Between Large-Scale Brain Networks," *Biology* 12, no. 2 (2023): 211, https://doi.org/10.3390/biology12020211.

28. A. Braunsperger, M. Bauer, C. B. Brahim, et al., "Effects of Time-of-Day on the Noradrenaline, Adrenaline, Cortisol and Blood Lipidome Response to an Ice Bath," *Scientific Reports* 15, no. 1 (2025): 1263, https://doi.org/10.1038/s41598-025-85304-8.

29. W. López-Ojeda and R. A. Hurley, "Cold-Water Immersion: Neurohormesis and Possible Implications for Clinical Neurosciences," *Journal of Neuropsychiatry and Clinical Neurosciences* 36, no. 3 (2024): A4–A177, https://doi.org/10.1176/appi.neuropsych.20240053.

30. J. S. Kelly and J. P. Delaney, "A Short, Sharp, Shock: Healthy or Harmful? Conference Presentation," in *10th International Mountain and Outdoor Sports Conference* (2022).

31. H. Massey, N. Kandala, C. Davis, M. Harper, P. Gorczynski, and H. Denton, "Mood and Well-Being of Novice Open Water Swimmers and Controls During an Introductory Outdoor Swimming Programme: A Feasibility Study," *Lifestyle Medicine* 1, no. 2 (2020): e12, https://doi.org/10.1002/lim2.12.

32. J. Jetten, C. Haslam, and S. A. Haslam, *The Social Cure: Identity, Health and Well-Being* (Psychology Press, 2012), https://doi.org/10.4324/9780203813195.

33. C. Bates and K. Moles, "Bobbing in the Park: Wild Swimming, Conviviality and Belonging," *Leisure Studies* 43, no. 6 (2024): 887–899, https://doi.org/10.1080/02614367.2022.2085774.

34. M. J. Tipton, N. Collier, H. Massey, J. Corbett, and M. Harper, "Cold Water Immersion: Kill or Cure?," *Experimental Physiology* 102, no. 11 (2017): 1335–1355, https://doi.org/10.1113/EP086283.

35. C. M. Eglin, F. S. Golden, and M. J. Tipton, "Cold Sensitivity Test for Individuals With Non-Freezing Cold Injury: The Effect of Prior Exercise," *Extreme Physiology & Medicine* 2 (2013): 1–8, https://doi.org/10.1186/2046-7648-2-16.

36. T. Butt, P. Russell, and R. Grigg, *Surf Science: An Introduction to Waves for Surfing* (University of Hawaii Press, 2004).

37. K. Rew, *The Outdoor Swimmers' Handbook* (Ebury Publishing, 2022).

38. S. L. Curran, M. A. Andrykowski, and J. L. Studts, "Short Form of the Profile of Mood States (POMS-SF): Psychometric Information," *Psychological Assessment* 7, no. 1 (1995): 80–83.

39. J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed. (Routledge, 2013), https://doi.org/10.4324/9780203771587.

40. D. Lakens, "Calculating and Reporting Effect Sizes to Facilitate Cumulative Science: A Practical Primer for T-Tests and ANOVAs," *Frontiers in Psychology* 4 (2013): 863, https://doi.org/10.3389/fpsyg.2013.00863.

41. J. Carifio and R. Perla, "Resolving the 50-Year Debate Around Using and Misusing Likert Scales," *Medical Education* 42, no. 12 (2008): 1150–1152, https://doi.org/10.1111/j.1365-2923.2008.03172.x.

42. G. Norman, "Likert Scales, Levels of Measurement and the "Laws" of Statistics," *Advances in Health Sciences Education* 15 (2010): 625–632, https://doi.org/10.1007/s10459-010-9222-y.

43. G. M. Sullivan and A. R. Artino Jr., "Analyzing and Interpreting Data From Likert-Type Scales," *Journal of Graduate Medical Education* 5, no. 4 (2013): 541–542, https://doi.org/10.4300/JGME-5-4-18.

44. M. J. Blanca, R. Alarcón, J. Arnau, R. Bono, and R. Bendayan, "Non-Normal Data: Is ANOVA Still a Valid Option?" *Psicothema* 29, no. 4 (2017): 552–557, https://doi.org/10.7334/psicothema2016.383.

45. G. V. Glass, P. D. Peckham, and J. R. Sanders, "Consequences of Failure to Meet Assumptions Underlying the Fixed Effects Analyses of Variance and Covariance," *Review of Educational Research* 42, no. 3 (1972): 237–288, https://doi.org/10.3102/00346543042003237.

46. E. Schmider, M. Ziegler, E. Danay, L. Beyer, and M. Bühner, "Is It Really Robust? Reinvestigating the Robustness of ANOVA Against Violations of the Normal Distribution Assumption," *Methodology* 6, no. 4 (2010): 147–151, https://doi.org/10.1027/1614-2241/a000016.

47. A. Field, *Discovering Statistics Using IBM SPSS Statistics* (Sage Publications Limited, 2024).

48. R. Kaplan and S. Kaplan, *The Experience of Nature: A Psychological Perspective* (Cambridge University Press, 1989).

49. R. S. Ulrich, "Stress Reduction Theory," in *100 Key Concepts in Environmental Psychology*, eds. D. Marchand, E. Pol, and K. Weiss (Routledge, 2023), 232.

50. V. Strang, *The Meaning of Water* (Routledge, 2004).

51. E. C. Pike, "Aquatic Antiques: Swimming off this Mortal Coil?" *International Review for the Sociology of Sport* 47, no. 4 (2012): 492–510, https://doi.org/10.1177/1012690211399222.

52. P. Huttunen, H. Rintamäki, and J. Hirvonen, "Effect of Regular Winter Swimming on the Activity of the Sympathoadrenal System Before and After a Single Cold Water Immersion," *International Journal of Circumpolar Health* 60, no. 3 (2001): 400–406, https://doi.org/10.1080/22423982.2001.12113043.

53. S. Shiffman, A. A. Stone, and M. R. Hufford, "Ecological Momentary Assessment," *Annual Review of Clinical Psychology* 4, no. 1 (2008): 1–32, https://doi.org/10.1146/annurev.clinpsy.3.022806.091415.

54. J. J. Bierens, P. Lunetta, M. Tipton, and D. S. Warner, "Physiology of Drowning: A Review," *Physiology* 31, no. 2 (2016): 147–166, https://doi.org/10.1152/physiol.00002.2015.