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REGULAR COLD-WATER IMMERSION AND SYMPTOMS OF DEPRESSION, ANXIETY, AND STRESS IN ADULTS: A SYSTEMATIC REVIEW WITH MECHANISTIC INSIGHTS

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ABSTRACT

Cold-water immersion (CWI), including cold-water swimming and winter sea bathing, has become increasingly popular as a lifestyle practice that may influence mental well-being. Exposure to cold water induces physiological responses related to stress regulation, which may affect psychological functioning. Despite growing public interest, the available scientific evidence remains limited and methodologically diverse. This systematic review aimed to examine the relationship between regular CWI and symptoms of depression, anxiety, stress, and related indicators of mental health in adults.

A systematic search was conducted in PubMed on 21 February 2026 in accordance with PRISMA 2020 guidelines. Studies were eligible if they involved adults and assessed mental health outcomes associated with repeated cold-water exposure. Five studies met the inclusion criteria: one randomized controlled trial, one feasibility study, one case-control study, one cross-sectional study, and one case report. Data extraction included study design, participant characteristics, exposure protocols, and reported outcomes. Risk of bias was assessed using established tools appropriate to study design.

Across approximately 570 participants, regular CWI was associated with improvements in selected indicators of psychological well-being. Reported outcomes included improved quality of life, better self-reported well-being, improved sleep, and reductions in depressive and anxiety-related symptoms in some studies. However, results varied across study designs and were limited by small sample sizes, lack of control groups in several studies, and heterogeneity in exposure protocols.

Regular cold-water immersion may be associated with improvements in mental well-being and selected psychological outcomes. The current evidence base remains limited, and further controlled studies are required.

KEYWORDS

Cold-Water Immersion; Winter Swimming; Depression; Anxiety; Mental Health; Systematic Review

CITATION

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Introduction

Interest in cold-water immersion (CWI), including cold showers, ice baths, and open-water swimming, has increased substantially in recent years (Cain et al., 2025; Tipton et al., 2017) as part of a broader trend toward non-pharmacological strategies for improving physical and psychological well-being. Originally used primarily in sports medicine to support recovery after intense physical activity (Tipton et al., 2017), CWI is now increasingly promoted as a potential intervention for enhancing mental health (Cain et al., 2025) and overall quality of life. This growing popularity has also attracted increasing scientific attention to the physiological and psychological effects of cold exposure. This trend also reflects increasing interest in accessible, non-pharmacological approaches to mental health that can be implemented outside clinical settings.

Exposure to cold water induces a complex physiological response involving activation of the sympathetic nervous system, increased release of catecholamines, and rapid changes in cardiovascular and respiratory function (Tipton et al., 2017; Castellani & Young, 2016). These responses are thought to contribute to heightened alertness, improved mood, and increased perceived energy following immersion. Experimental evidence suggests that even brief exposures to cold water may increase positive affect and reduce negative emotional states (Kelly & Bird, 2022), possibly through interactions between neural networks involved in emotion regulation and attentional control. In addition, repeated exposure to cold environments may induce adaptive physiological responses that alter stress reactivity and improve tolerance to environmental stressors.

Several observational and experimental studies have suggested potential mental health benefits associated with regular cold-water exposure. Reports from winter swimmers indicate improvements in mood, reductions in fatigue, and enhanced general well-being following habitual cold-water bathing (Huttunen et al., 2004). Some studies also suggest reductions in depressive symptoms and perceived stress among individuals

who regularly engage in cold-water swimming (Shevchuk, 2008). More recently, neuroimaging evidence has indicated that short-term cold-water immersion may influence functional connectivity between brain regions associated with emotional processing and cognitive control (Yankouskaya et al., 2023), providing a possible neurobiological explanation for the observed mood-enhancing effects.

Despite these promising findings, the current evidence base remains fragmented. Many studies examining the psychological effects of cold-water immersion are observational, involve small sample sizes, or lack appropriate control groups. As a result, causal conclusions remain limited. Some systematic reviews have reported improvements in stress, sleep quality, and subjective well-being following cold-water exposure (Cain et al., 2025), but the magnitude and consistency of these effects vary substantially across studies.

Furthermore, heterogeneity in study design, participant characteristics, exposure protocols, and outcome measures complicates the interpretation of existing findings. Cold-water exposure can occur in diverse contexts, ranging from brief cold showers to prolonged open-water swimming in natural environments, and these differences may influence both physiological responses and psychological outcomes. Additionally, individuals who regularly engage in cold-water swimming often exhibit lifestyle characteristics that may independently contribute to improved mental well-being, such as higher physical activity levels and greater exposure to natural environments.

Given the increasing popularity of cold-water immersion and its potential relevance as an accessible lifestyle intervention, a systematic synthesis of the available evidence is needed. The present systematic review therefore aims to examine the current literature on cold-water immersion and its effects on mental health outcomes, including depression, anxiety, stress, well-being, and quality of life. By evaluating evidence from randomized trials, feasibility studies, and observational research, this review seeks to clarify the extent to which cold-water immersion may influence psychological health and to identify key limitations and directions for future research.

Methodology

Study Design

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The review was not prospectively registered.

The objective was to evaluate the effects of repeated cold-water immersion (CWI) on mental health outcomes in adults.

Search Strategy

The primary search was conducted in PubMed on 21 February 2026. The following search strategy was applied:

("cold water immersion"[Title/Abstract] OR "winter swimming"[Title/Abstract] OR "cold water swimming"[Title/Abstract] OR "ice bathing"[Title/Abstract])

AND

(depression[Title/Abstract] OR anxiety[Title/Abstract] OR stress[Title/Abstract] OR "mental health"[Title/Abstract] OR mood[Title/Abstract])

AND (Humans[MeSH])

AND (English[lang])

The initial search identified 1,499 records. After limiting results to publications from the previous ten years, 756 records remained. Application of the refined search strategy yielded 91 records for title and abstract screening.

To verify the completeness of the search, supplementary searches were conducted in Scopus and Web of Science using equivalent search terms. These additional searches did not identify any further eligible studies beyond those retrieved from PubMed.

Eligibility Criteria

Studies were included if they met the following criteria:

1. Adult participants (≥ 18 years).
2. Repeated cold-water immersion defined as ≥ 2 intentional immersion sessions separated in time.
3. Mental health outcomes reported as primary or secondary outcomes (e.g., depression, anxiety, stress, mood, psychological well-being).
4. Original empirical research of any design.

Studies were excluded if they:

- Examined single-session cold exposure only,
- Focused exclusively on physiological or biomarker outcomes without validated mental health measures,

- Investigated whole-body cryotherapy or laboratory cold pressor tests without repeated immersion,
- Were non-human studies.

Multicomponent interventions (e.g., CWI combined with breathwork) were included but explicitly classified as multicomponent interventions during synthesis.

Case reports were included due to the limited number of available studies and the exploratory nature of the evidence base.

Study Selection

Titles and abstracts of 91 records were screened by two reviewers independently using predefined eligibility criteria.

Full-text articles were retrieved for potentially eligible studies. After full-text assessment, five studies met inclusion criteria and were included in the final qualitative synthesis.

The screening process was conducted independently by two reviewers.

Data Extraction

Data were extracted manually from full-text articles. Extracted information included:

- Study design
- Sample characteristics
- Intervention characteristics (temperature, frequency, duration)
- Comparator (if applicable)
- Mental health outcomes
- Main findings
- Follow-up duration

Risk of Bias Assessment

Methodological quality was assessed using validated design-appropriate tools:

- Randomized controlled trial: Cochrane Risk of Bias 2 (RoB 2)
- Cross-sectional observational study: Joanna Briggs Institute (JBI) analytical cross-sectional checklist
- Single-arm feasibility study: JBI quasi-experimental checklist
- Multicomponent pilot study: JBI quasi-experimental checklist
- Case report: JBI case report checklist

Risk of bias assessments were conducted narratively.

Certainty of Evidence

Due to substantial heterogeneity in study design, intervention protocols, and outcome measures, formal quantitative synthesis and certainty grading were not performed. The overall certainty of evidence was therefore interpreted narratively and considered low to very low, reflecting small sample sizes, methodological limitations of several included studies, and the presence of observational designs and a single case report.

Data Synthesis

Due to substantial heterogeneity in study design, intervention protocols, outcome measures, and methodological quality, a meta-analysis was not performed.

A narrative synthesis approach was used to summarize findings across studies.

Multicomponent interventions were analyzed separately and not interpreted as isolated effects of cold-water immersion.

Case report findings were described descriptively and not weighted as confirmatory evidence.

Results

Study selection

The database search identified 1,499 records. After limiting the search to publications from the last ten years, 756 records remained. Application of the refined search strategy combining cold-water immersion terminology with mental health–related outcomes yielded 91 records for title and abstract screening. Following full-text assessment, five studies met the predefined eligibility criteria and were included in the qualitative synthesis.

Supplementary searches in Scopus and Web of Science did not identify additional eligible studies beyond those retrieved from PubMed. The selection process is presented in the PRISMA flow diagram (Figure 1).

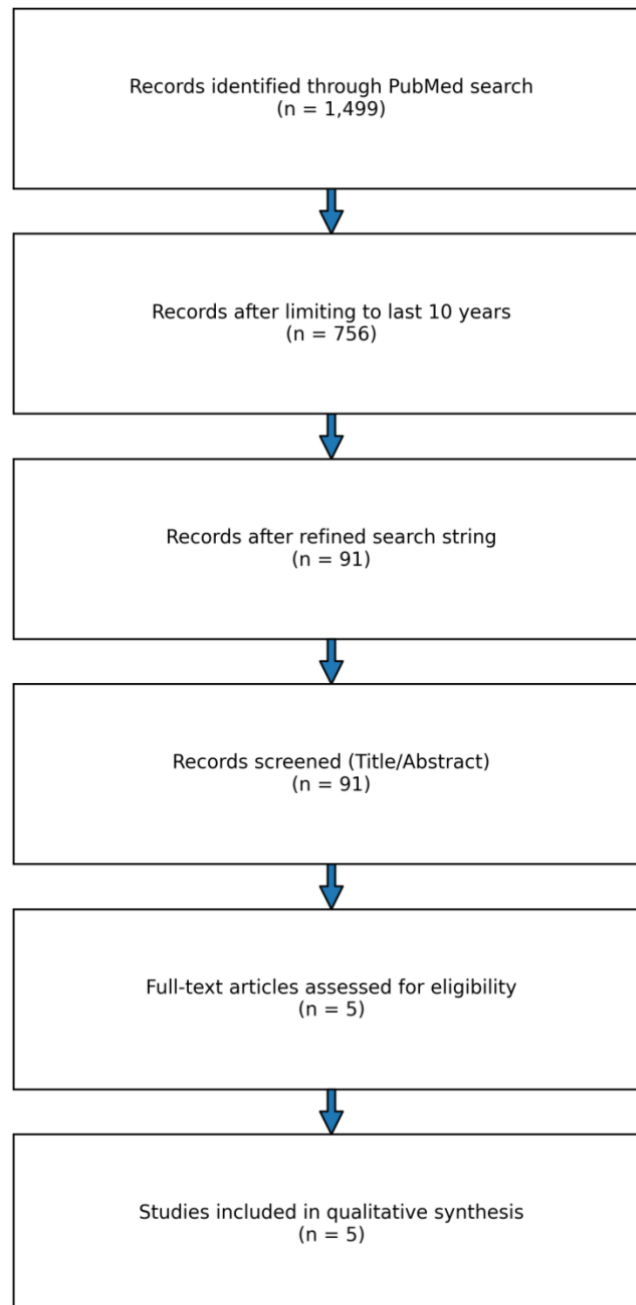


Fig. 1. PRISMA flow diagram illustrating the study selection process.

Study characteristics

Five studies with heterogeneous designs were included: one randomized controlled trial (RCT), one single-arm feasibility study, one cross-sectional observational study, one case–control observational study, and one case report.

Sample sizes varied considerably. The RCT and observational study enrolled larger community samples, whereas the feasibility study and multicomponent intervention included smaller groups. The case report described a single individual. Some investigations included individuals with clinically relevant conditions, such as depression or chronic disease, while others examined generally healthy winter swimmers.

Cold-water exposure protocols differed across studies. The RCT evaluated repeated immersion over a defined intervention period within a community-based framework. The feasibility study implemented supervised group cold-water swimming sessions twice weekly across several months. The observational study assessed habitual winter sea bathers with ongoing seasonal exposure rather than imposing a structured intervention. The multicomponent study combined repeated immersion sessions with guided breathwork practices delivered during the same intervention period. The case report described regular open-water swimming undertaken independently by the participant.

Water temperatures reflected natural winter conditions in outdoor settings and were consistently below thermoneutral levels. Duration and frequency of immersion were specified in interventional studies but varied between protocols. Follow-up periods ranged from short-term post-intervention assessments to repeated measures across several weeks. None of the included studies reported long-term follow-up extending beyond a few months.

Mental health outcomes were measured using validated instruments in all studies except the case report, which relied on standardized clinical assessment tools without comparator data. Reported outcomes included depressive symptoms, anxiety-related measures, perceived stress, sleep quality, and health-related quality of life.

A detailed overview of the included studies, including study design, population characteristics, and cold-water exposure protocols, is presented in Table 1.

Table 1. Characteristics of included studies

Study	Country	Study design	Participants	Population	Cold-water exposure	Outcomes assessed
Kurniasari et al., 2022	Indonesia	Randomized controlled trial	100	Adults with gout arthritis	Community-based repeated cold-water immersion intervention	Pain intensity; quality of life; anxiety; stress; depression
Hjorth et al., 2023	Denmark	Feasibility intervention study	13	Adults diagnosed with depression	Supervised cold-water swimming twice weekly for 20 weeks	Well-being; depressive symptoms; sleep quality
Demori et al., 2021	Italy	Cross-sectional observational study	228 participants (107 winter sea bathers; 121 non-bathers)	Healthy adults practicing winter sea bathing	Regular winter sea bathing during winter season	Psychological well-being; perceived stress
Czarnecki et al., 2024	Poland	Case–control study	231 (77 per group)	Adults practicing CWI or combined CWI + breathwork	Regular cold-water immersion compared with combined CWI + breathwork	Mental health indices; mindfulness; URTI duration
van Tulleken et al., 2018	United Kingdom	Case report	1	Adult with major depressive disorder	Regular open-water swimming over several months	Depressive symptoms; subjective well-being

Risk of bias within studies

Methodological quality differed by study design.

The randomized controlled trial applied random allocation procedures; however, participant blinding was not feasible due to the nature of the intervention. Outcomes were assessed using self-report instruments. Per-protocol analysis was reported, and complete blinding of assessors was not described. Overall, the study presented some concerns related to potential performance and attrition bias but did not demonstrate high risk across all domains.

The feasibility study used an open-label, single-arm design without a control group. The absence of randomization and comparator conditions limits causal inference. The sample size was small, and statistical testing was not emphasized due to feasibility objectives. Risk of bias was high in relation to study design.

The cross-sectional observational study compared habitual winter bathers with non-bathers at a single time point. Although validated measures were used, self-selection into winter bathing and limited adjustment for confounders increase the risk of bias, particularly regarding causal interpretation.

The multicomponent quasi-experimental study lacked randomization and did not isolate the immersion component from concurrent breathwork. The combined exposure limits attribution of outcomes to cold-water immersion alone. Risk of bias was considered high due to design limitations.

The case report provided detailed clinical information but is inherently limited by the absence of control conditions and susceptibility to regression to the mean and expectancy effects.

A detailed assessment of methodological quality across included studies is summarized in Table 2.

Table 2. Risk of bias assessment of included studies

Study	Study design	Assessment tool	Key methodological limitations	Overall risk of bias
Kurniasari et al., 2022	Randomized controlled trial	RoB 2*	Limited allocation concealment reporting; no participant blinding possible; per-protocol analysis	Some concerns
Hjorth et al., 2023	Feasibility study	JB1 ** quasi-experimental checklist	No control group; small sample size; descriptive analysis only	High risk
Demori et al., 2021	Cross-sectional study	JB1 ** cross-sectional checklist	Self-selection bias; lifestyle confounding; cross-sectional design	High risk
Czarnecki et al., 2024	Case-control study	JB1 ** quasi-experimental checklist	Multicomponent intervention; possible confounding; self-selection bias	High risk
van Tulleken et al., 2018	Case report	JB1 ** case report checklist	Single participant; no comparator group	Very high risk

*RoB 2 – Risk of Bias tool for randomized trials

**JB1 – Joanna Briggs Institute critical appraisal tools

Effects on depressive symptoms

Depressive symptom outcomes were assessed directly in several studies.

In the randomized controlled trial, repeated cold-water immersion was associated with improvements in mental health-related quality-of-life domains over the intervention period (Kurniasari et al., 2022). While depression was not always the primary endpoint, mental health composite measures demonstrated improvement compared with control conditions.

The feasibility study investigating cold-water swimming as an adjunctive intervention in individuals with depressive symptoms reported reductions in depression scale scores among participants who attended sessions regularly (Hjorth et al., 2023). Improvements were described descriptively, as formal hypothesis testing was limited by small sample size. Participants with irregular attendance did not demonstrate comparable changes.

The cross-sectional observational study did not assess major depressive disorder specifically but reported higher self-reported well-being among habitual winter bathers compared with non-bathers (Demori et al., 2021). Depression-specific scales were not consistently applied in this design.

The multicomponent intervention combining immersion with breathwork reported reductions in depressive symptom scores following the intervention period (Czarnecki et al., 2024). Because both components were delivered concurrently, the independent contribution of immersion cannot be determined.

The case report described marked improvement in depressive symptoms following initiation of regular open-water swimming (van Tulleken et al., 2018). Symptom reduction was temporally associated with the immersion practice, though no comparator data were available.

Effects on anxiety

Anxiety outcomes were reported in several studies, though measurement approaches differed.

In the randomized controlled trial, improvements were observed in selected anxiety-related quality-of-life domains at follow-up. Between-group differences were present for certain subdomains but were not consistently demonstrated across all anxiety measures.

The feasibility study reported descriptive reductions in clinician-rated symptom severity among regular participants, with some indication of anxiety improvement; however, formal statistical inference was not conducted due to feasibility design constraints.

The cross-sectional study identified lower perceived stress levels among winter bathers compared with non-bathers. Anxiety was not always assessed separately from stress or general psychological well-being.

The multicomponent study documented reductions in anxiety scores following the intervention period, though attribution to immersion alone was not possible.

The case report described subjective improvement in anxiety symptoms concurrent with regular immersion practice.

Overall, evidence for anxiety reduction was suggestive but limited by heterogeneity of measurement and study design.

Effects on stress and sleep

Perceived stress was directly evaluated in the cross-sectional observational study, which reported lower stress scores among habitual winter bathers compared with non-bathers. The randomized controlled trial did not demonstrate consistent statistically significant between-group differences in stress outcomes, although within-group improvements were observed.

Sleep quality was assessed in the feasibility study using validated instruments. Participants who attended sessions regularly demonstrated improved sleep scores over the intervention period. No control comparison was available. Sleep outcomes were not uniformly assessed across other studies, though the case report described improved sleep alongside mood changes.

Evidence for improvements in stress and sleep was limited and derived mainly from non-randomized studies.

A structured summary of mental health outcomes assessed across studies, including depression, anxiety, stress, sleep, and well-being, is provided in Table 3.

Table 3. Mental health outcomes reported in included studies

Study	Psychological outcomes measured	Measurement tools	Main findings
Kurniasari et al., 2022	Stress; anxiety; depression; quality of life	DASS-21; SF-36	Cold-water immersion improved quality of life and reduced anxiety at 4 weeks; no significant between-group effects for stress or depression
Hjorth et al., 2023	Depressive symptoms; well-being; sleep quality	HDRS; WHO-5; PSQI	Participants attending sessions regularly showed improved well-being, reduced depressive symptoms, and improved sleep quality
Demori et al., 2021	Perceived stress; psychological well-being	Self-report wellbeing questionnaires	Winter sea bathers reported higher well-being and lower perceived stress compared with non-bathers
Czarnecki et al., 2024	Depression; anxiety; mindfulness; general mental health indices	GHQ-28; FFMQ-SF	Participants practicing cold-water immersion showed better mental health indices than controls; combined CWI + breathwork showed greater improvements
van Tulleken et al., 2018	Depressive symptoms	Clinical psychiatric assessment	Regular open-water swimming associated with gradual reduction in depressive symptoms and medication discontinuation

Summary of findings

Five heterogeneous studies examined repeated cold-water immersion in relation to depressive symptoms, anxiety, stress, sleep, and related psychological outcomes in adults. One randomized controlled trial provided comparative evidence, while the remaining studies employed observational, quasi-experimental, or descriptive designs.

Across study types, the direction of association generally favored improvement in depressive symptoms and certain anxiety- and stress-related measures. Sleep improvements were reported in one feasibility study and described in the case report. Multicomponent intervention findings cannot be attributed solely to cold-water immersion.

Methodological limitations, including small sample sizes, lack of blinding, absence of control groups in several studies, and potential confounding in observational designs, restrict the strength of inference. The evidence base remains limited in scope and design rigor, with substantial heterogeneity across populations and intervention protocols.

Discussion

Overall interpretation of the evidence

The present systematic review examined the association between regular cold-water immersion (CWI) and symptoms of depression, anxiety, and stress in adults. Five studies met the predefined inclusion criteria and represented a heterogeneous set of study designs, including one randomized controlled trial, one feasibility intervention study, two observational investigations, and one clinical case report.

Overall, the available evidence suggests a potential association between repeated cold-water exposure and improvements in selected indicators of psychological well-being. Across the included studies, individuals who regularly engaged in cold-water immersion tended to report more favorable mental health outcomes compared with control groups or baseline assessments. Reported outcomes included improvements in quality of life, subjective well-being, and sleep quality, as well as reductions in depressive symptom scores in some cases.

Despite these promising observations, the strength of the evidence remains limited. The small number of experimental studies, together with substantial methodological variability across the included investigations, restricts the extent to which firm conclusions can be drawn regarding the effectiveness of cold-water immersion as a mental health intervention.

Evidence from controlled and interventional studies

Among the included studies, the randomized controlled trial conducted by Kurniasari and colleagues provides the most robust experimental evidence (Kurniasari et al., 2022). In this community-based study involving individuals diagnosed with gout arthritis, a program of cold-water immersion resulted in significant reductions in pain intensity and improvements in quality-of-life measures over a four-week period. Mediation analysis further suggested that improvements in quality of life were partly explained by reductions in pain levels.

Although the study population consisted of individuals with a specific somatic condition rather than patients with primary mood disorders, the findings remain relevant for understanding potential psychological implications of cold-water exposure. Chronic pain is strongly associated with psychological distress and reduced quality of life, and improvements in physical symptoms may contribute to enhanced emotional well-being. In this context, cold-water immersion may influence psychological outcomes indirectly through mechanisms related to symptom relief.

Additional insights are provided by the feasibility study conducted by Hjorth and colleagues (Hjorth et al., 2023), which examined a supervised cold-water swimming program among adults diagnosed with depression. The primary aim of this investigation was to evaluate feasibility and safety rather than treatment efficacy. Nevertheless, descriptive outcomes suggested improvements in well-being and sleep quality among participants who regularly attended the sessions. Scores on the World Health Organization Well-Being Index increased during the intervention period, while depressive symptom scores measured with the Hamilton Depression Rating Scale decreased among regular participants.

Because this study did not include a control group and did not apply statistical testing due to the small sample size, causal interpretations are not possible. However, the observed changes across several psychological indicators suggest that repeated participation in cold-water swimming may have had a beneficial influence on mood and general well-being in this small group of participants.

Evidence from observational studies

Observational studies included in this review provide additional context for the relationship between cold-water exposure and mental health outcomes. A cross-sectional investigation comparing winter sea bathers with non-bathers reported higher levels of subjective well-being and lower perceived stress among individuals who regularly engaged in cold-water immersion (Demori et al., 2021). These findings indicate that participation in winter swimming communities may be associated with more favorable psychological outcomes.

However, the cross-sectional nature of such studies limits the ability to establish causal relationships. Individuals who voluntarily participate in cold-water swimming may differ from the general population in several important respects, including levels of physical activity, lifestyle habits, or psychological resilience. These characteristics may independently influence mental health outcomes and therefore represent potential confounders.

Another observational study examined a multicomponent intervention combining cold-water immersion with breathing exercises (Czarnecki et al., 2024). Participants following the combined protocol demonstrated better general mental health scores compared with both the control group and individuals practicing cold-water immersion alone. In addition, the intervention was associated with shorter durations of upper respiratory tract infections and higher levels of dispositional mindfulness.

Interpretation of these findings is complicated by the multicomponent nature of the intervention. Because cold exposure was combined with structured breathing exercises, the specific contribution of cold-water immersion to the observed psychological outcomes cannot be clearly isolated. Consequently, this study provides indirect rather than independent evidence regarding the potential mental health effects of cold-water exposure.

Evidence from clinical case reports

The final piece of evidence included in this review is a clinical case report describing a patient who engaged in regular open-water swimming and experienced a substantial reduction in depressive symptoms over time (van Tulleken et al., 2018). According to the report, improvements in mood and emotional stability coincided with the initiation of repeated cold-water swimming.

Although case reports cannot establish treatment efficacy or generalizable effects, they may provide detailed descriptions of individual experiences that generate hypotheses for future research. In this instance, the temporal relationship between regular cold-water exposure and improvements in depressive symptoms suggests a possible association between the intervention and psychological outcomes. Nevertheless, alternative explanations, including increased physical activity, outdoor exposure, or lifestyle changes, cannot be excluded.

Methodological heterogeneity and interpretation challenges

A key feature of the existing literature is the considerable heterogeneity observed across studies. The term cold-water immersion encompasses a wide range of practices, including winter sea bathing, open-water swimming, brief immersion in cold baths, and structured programs that combine cold exposure with additional techniques such as breathing exercises. Variations in water temperature, immersion duration, frequency of exposure, and supervision protocols may influence both physiological responses and psychological outcomes.

Participant characteristics also vary substantially between studies. Some investigations involve individuals with specific medical conditions, while others include healthy volunteers or recreational swimmers. Baseline mental health status, physical fitness levels, and lifestyle factors may influence how individuals respond to repeated cold exposure. For example, people who regularly engage in open-water swimming may already participate in other health-promoting activities, such as physical exercise or social group participation, which could independently contribute to improved well-being.

Due to these variations in intervention protocols and participant characteristics, direct comparisons between studies remain challenging. As a result, the available literature provides preliminary insights rather than definitive evidence regarding the potential role of cold-water immersion in mental health interventions.

Mechanistic and contextual considerations

While the current evidence is primarily descriptive and heterogeneous, several biological and behavioral pathways may plausibly underlie the observed associations.

One potential mechanism involves activation of the sympathetic nervous system during acute cold exposure (Tipton et al., 2017; Castellani & Young, 2016). Rapid cooling of the skin stimulates peripheral thermoreceptors, which trigger sympathetic activation and the release of catecholamines, including norepinephrine. Increased norepinephrine availability has been associated with enhanced alertness, improved attention, and modulation of mood-related neural circuits (Faull et al., 2019; George et al., 2019). Repeated

exposure to cold water may contribute to adaptive regulation of noradrenergic signaling, although direct evidence from intervention studies remains limited.

Cold exposure may also influence the hypothalamic–pituitary–adrenal (HPA) axis (Herman et al., 2016), which plays a central role in the physiological response to stress. Acute cold exposure represents a transient stressor that can increase cortisol secretion. However, repeated exposure to controlled mild stressors may lead to adaptive adjustments in the stress-response system, a phenomenon often described as hormesis (Noruzi et al., 2023). Through such processes, individuals regularly engaging in cold-water immersion may develop increased physiological resilience to stress (Navarrete-Opazo & Mitchell, 2014).

Inflammatory pathways may represent another mechanism linking cold exposure to mental health outcomes. A growing body of research suggests that chronic low-grade inflammation contributes to the pathophysiology of depression and other mood disorders (Liu et al., 2017). Some experimental studies indicate that repeated cold exposure may influence immune signaling (Lubkowska et al., 2013) and reduce circulating inflammatory markers. If such anti-inflammatory effects occur in individuals practicing cold-water immersion, they could partly explain improvements in psychological well-being reported in some studies.

Thermoregulatory mechanisms may also contribute to the potential psychological effects of cold-water immersion. Alterations in thermoregulation have been observed in individuals with depressive disorders (Liu et al., 2017), including elevated core body temperature and impaired heat dissipation. Exposure to cold water may temporarily reduce core body temperature and influence thermoregulatory pathways that interact with serotonergic systems involved in mood regulation.

In addition to physiological mechanisms, behavioral and environmental factors may also contribute to the observed associations. Participation in cold-water immersion frequently occurs in outdoor settings and may involve social interaction, physical activity, and exposure to natural environments. Each of these factors has independently been associated with improved mental health outcomes and may contribute to the overall psychological experience associated with cold-water swimming.

The subjective experience of voluntarily engaging in an intense physical stimulus such as cold water may also influence psychological processes related to self-efficacy and coping (Khoury et al., 2015). Successfully completing repeated cold-water immersion sessions may reinforce perceptions of personal control and resilience, which are important components of psychological well-being.

It is therefore likely that the potential psychological benefits of cold-water immersion arise from the interaction of multiple physiological and behavioral mechanisms rather than from a single biological pathway.

Future research integrating physiological biomarkers, neuroendocrine measurements, and validated psychological outcomes will be essential to clarify causal pathways and determine the clinical relevance of cold-water immersion in mental health.

Strengths of the review

Despite the limited number of eligible studies, this review has several methodological strengths. A systematic search strategy was applied using predefined inclusion criteria, and the study selection process followed established principles for systematic reviews. The screening procedure was documented using a PRISMA flow diagram, which enhances transparency and allows the selection process to be reproduced.

Another strength lies in the inclusion of multiple forms of empirical evidence. Although the presence of different study designs introduces heterogeneity, it also provides a broader perspective on an emerging research topic in which randomized controlled trials remain scarce. By synthesizing findings from experimental, observational, and clinical reports, this review offers an overview of the current state of knowledge regarding cold-water immersion and mental health outcomes.

Limitations of the review

Several limitations should be considered when interpreting the conclusions of this review. First, the number of eligible studies was relatively small, reflecting the limited amount of research directly examining cold-water immersion in relation to mental health outcomes.

Second, the methodological quality of the included studies varied considerably. Only one randomized controlled trial was identified, while the remaining investigations consisted of observational studies, a feasibility study, and a case report. These designs are inherently more susceptible to bias and generally provide lower levels of evidence compared with well-designed randomized trials.

Third, substantial variability was observed in the cold-water exposure protocols across studies. Differences in water temperature, immersion duration, exposure frequency, and accompanying activities limit comparability and make it difficult to determine optimal intervention parameters.

Finally, publication bias cannot be excluded. Research examining cold-water immersion and mental health remains limited, and studies reporting positive outcomes may be more likely to be published. Future research should include larger randomized trials with standardized exposure protocols and validated psychological outcome measures.

Public health implications

From a public health perspective, the growing interest in cold-water immersion may reflect a broader shift toward accessible, low-cost lifestyle interventions aimed at improving mental well-being. Unlike pharmacological treatments, cold-water exposure requires minimal resources and can be practiced in community or natural settings, which may increase its feasibility at the population level. However, the current evidence base does not yet support formal recommendations for its use as a public health strategy. The heterogeneity of exposure protocols, limited number of controlled studies, and potential safety considerations indicate that further research is required before cold-water immersion can be considered within structured mental health promotion frameworks. Future studies should therefore examine not only clinical outcomes but also adherence, safety, and feasibility in real-world settings, particularly in diverse populations.

Conclusions

This systematic review identified five heterogeneous studies examining repeated cold-water immersion and its association with symptoms of depression, anxiety, stress, and related psychological outcomes in adults. Across study designs, findings generally suggested reductions in depressive symptoms and selected anxiety- and stress-related measures following repeated exposure. Sleep improvements were reported in limited contexts.

However, the strength of evidence remains low. Only one randomized controlled trial was available, and most studies were limited by small sample sizes, lack of control groups, and substantial heterogeneity in immersion protocols and outcome measures. Mechanistic explanations were largely theoretical, as no study combined longitudinal psychological assessment with direct biological mediation analyses.

At present, repeated cold-water immersion cannot be considered an evidence-based clinical treatment for depressive or anxiety disorders. The existing literature suggests possible beneficial associations, but well-designed randomized trials with standardized protocols and integrated biological assessment are required before firm clinical recommendations can be made.

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