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Therapeutic potential of physical activity in "blue zones" (Blue Space) as a method for correcting depressive ruminations and associated depressive symptoms - A Literature-Based Review

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Abstract

Purpose of research: This literature-based review synthesized current evidence regarding the therapeutic potential of physical activity performed in "blue spaces" (aquatic environments) as a method for correcting depressive ruminations. The study evaluated how the synergy between physical exertion and the unique restorative properties of water impacts mental health, focusing on neurological mechanisms and successful psychological aging in "Blue Zones".

Research materials and methods: A structured literature search was conducted in major scientific databases, including PubMed, Scopus, and Google Scholar, for English full-text articles available through 2025. The review utilized the PICOS framework to select high-quality evidence, including Meta-Analyses, Systematic Reviews, and Randomized Controlled Trials examining aquatic interventions in both clinical and healthy populations.

Basic results: Engagement in blue spaces leads to a measurable decrease in neural activity within the subgenual prefrontal cortex (sgPFC), the brain region responsible for maladaptive rumination. Aquatic exercise demonstrates superior antidepressant effects compared to land-based activities, with standardized mean differences (SMD) reaching -0.92, particularly for water aerobics. These benefits are supported by the stabilization of the HPA axis, increased BDNF expression, and the "soft fascination" of water, which allows the brain's executive functions to recover. In "Blue Zones," natural movement near water and strong social ties act as a potent buffer against late-life depression.

Conclusions: "Blue Care" is an evidence-based, non-pharmacological intervention that effectively interrupts ruminative thought cycles and improves psychological resilience across the lifespan. Integrating "Blue Prescriptions" into standard psychiatric care and urban planning provides a cost-effective strategy to mitigate mental health disparities and support global well-being.

Key words: blue space, depression, rumination, physical activity, Blue Zones, sgPFC, mental health.

Introduction

Poor mental health ranks among the leading causes of disability worldwide, with depression standing out as one of the most significant contributors to the overall burden of disease [21], [23]. It is estimated that hundreds of millions of people suffer from depressive disorders, which severely affect quality of life through ongoing feelings of sadness and a loss of interest in activities they once found enjoyable [27], [34]. A major risk factor behind these symptoms is rumination - a way of managing emotions that's far from helpful, involving repetitive and persistent thinking about the causes of one's negative feelings [3], [6]. Rumination doesn't just increase the likelihood of developing depression; it also helps keep it going, creating what might be called cognitive "feedback loops." Unfortunately, these loops often resist standard medications [3], [21]. Physical activity is widely accepted as an effective and well-established support for treating mental health conditions [19], [27]. Research of good quality shows that aerobic exercise tends to have a significantly stronger antidepressant effect compared to treatments that don't include physical movement [19], [41]. Beyond clinical settings, there's growing curiosity about the healing possibilities found in natural environments, particularly "blue spaces." [4], [14] These are outdoor areas where water - like coasts, rivers, or lakes - is a prominent feature [31], [44]. Spending time in blue spaces is regularly linked to better psychological restoration, less distress, and improved overall well-being. The benefits of blue spaces on mental health can be partly understood through Attention Restoration Theory (ART) and the biophilia hypothesis [1], [29]. Urban areas require what's called directed attention, which can tire us out mentally, while being near water tends to bring about a gentle kind of fascination that helps our attention bounce back [1], [44]. On a physical level, exercising in these settings promotes brain plasticity and encourages the release of mood-boosting chemicals such as endorphins, serotonin, and dopamine [21], [27]. This is particularly important in the case of depression. For example, neuroimaging research (like the work by Bratman and colleagues in 2015 [3]) shows that spending time in nature decreases activity in the subgenual prefrontal cortex - a part of the brain closely tied to rumination and negative self-focused thinking. By combining the mental and physical benefits of exercise with the restorative qualities of watery surroundings, such approaches might offer an especially effective way to break the cycle of ruminative thought tied to depression [4], [22]. The potential of these environments becomes even clearer when looking at "Blue Zones," areas where people tend to live exceptionally long lives [5], [42]. Older adults in these regions typically report fewer symptoms of depression and better psychological well-being when compared with those living in cities [9], [20]. This healthier pattern of aging is often attributed to a lifestyle that includes

frequent outdoor physical activity and strong social bonds, all set within a soothing natural landscape [10], [42]. Despite the hopeful results seen so far, the precise benefits of physical activity in blue spaces as a treatment specifically aimed at reducing rumination have not been thoroughly explored within sports and health science fields. With that in mind, the purpose of this review is to bring together the existing scientific studies to evaluate how actively spending time in blue spaces might serve as a sound intervention to support mental health and reducing depressive symptoms.

Aim of study

The primary purpose of this review is to evaluate the therapeutic potential of physical activity performed in "blue spaces" (aquatic environments) as a specialized method for correcting depressive ruminations and alleviating associated depressive symptoms. This review also explored whether synergy between physical exertion and the unique restorative properties of water environments constitutes a high-quality intervention for mental health management.

The secondary aims include:

1. Is physical activity done in aquatic settings more effective at lessening depressive symptoms than exercise performed indoors or on land?
2. How does contact with "blue spaces" impact the processes of depressive rumination at both cognitive and neurological levels?
3. Does living near or frequently visiting blue spaces help reduce mental health disparities linked to socioeconomic status?
4. Which specific forms of "Blue Care" interventions (e.g., therapeutic surfing, aquatic aerobics) show the most promising results for patients with a clinical diagnosis of mood disorders?
5. How do the specific characteristics of "Blue Zones" (e.g., natural movement, coastal proximity, social connectivity) moderate the relationship between physical activity and successful psychological aging?

Research materials and methods

I. Study Design and Scope

This review involved a systematic examination of existing studies to gauge how much evidence supports the therapeutic benefits of physical activity (PA) carried out in "blue spaces" - that is, aquatic environments [4], [14], [16]. The main aim was to look at how these interventions affect mental health, focusing particularly on easing depressive rumination and related symptoms in different groups, including those living in so-called "Blue Zones." [5], [42].

II. Literature Search Strategy

A thorough search was run through major electronic databases like PubMed, Scopus, Web of Science, PsycINFO, SPORTDiscus, and Google Scholar. The search strategy employed a combination of Medical Subject Headings (MeSH) and free-text terms such as

Exposure: "blue space", "blue zones", "aquatic exercise", "coastal proximity, and "freshwater"

Outcome: "depression", "rumination", "mental health", "well-being, and "psychological restoration".

The electronic search was supplemented by a "snowballing" technique, involving a manual review of reference lists from eligible articles and previous systematic reviews to ensure a thorough capture of relevant data [4], [6], [14].

III. Study Selection Criteria (PICOS Framework)

The selection of studies followed the PICOS criteria to keep the focus on high-quality and relevant evidence.

IV. Data Extraction and Synthesis

Criterion	Specification	Justification
P (Population)	Humans of all ages, including children/adolescents [40], healthy adults [13], [35], [46], the elderly [18], [45], and clinical populations with depressive symptoms or major depressive disorder (MDD) [19], [21], [39], [41], [43].	To evaluate the breadth of therapeutic impact across diverse demographic and clinical groups [23], [34], [40].
I(Intervention)	Structured or recreational physical activity in blue spaces (e.g., swimming [1], [17], aquatic aerobics [41], [43], stand-up paddling [36], coastal walking [2], [38]).	To isolate the synergistic effect of aquatic immersion and physical exertion [4], [28].
C (Comparison)	Non-exercising control groups, land-based exercise [19], [37], or urban/indoor environments [29], [37].	To distinguish the unique restorative qualities of blue space from general exercise [16], [28], [41].
O (Outcomes)	Changes in depressive symptoms [19], [21], [41], rumination levels [3], mood regulation [27], [41], and physiological stress markers [21], [39].	To measure clinical and psychological efficacy.
S (Study Design)	Peer-reviewed original research: Randomized Controlled Trials (RCTs) [39], [43], systematic reviews [4, 6, 14, 16, 18], meta-analyses [16], [19], [41], and longitudinal cohort studies [15], [32].	To ensure the robustness and reliability of the evidence base [23], [27].
Availability	Full-text articles published in English.	To ensure comprehensive verification and accessibility.

From the selected literature, the following types of information were systematically extracted and synthesized:

- **Study Characteristics:** Author, year, country of origin, and specific population (e.g., elderly in Sardinian Blue Zones [9], [10], [42], children and adolescents [40], adults with clinical depression [39], [41], [43], or coastal urban residents [13], [35], [46]).
- **Blue Space Type and Exposure:** Proximity to coastlines [13], [46] vs. inland freshwater [31], [44], duration of exposure, and frequency of visits [7], [33], [47].

- **Physical Activity Protocols:** Modality (e.g., aquatic aerobics [41], [43], competitive swimming [17], or open-water activities [17], [36]), volume (session duration and weekly frequency), and intensity [19], [21], [47].
 - **Mental Health and Cognitive Outcomes:** Results from validated assessment tools such as the Beck Depression Inventory (BDI) [19], [39], Center for Epidemiologic Studies Depression Scale (CES-D) [9], [20], [42], Profile of Mood States (POMS) [41], and WHO-5 Well-being Index [3], [40].
 - **Biological and Restorative Mechanisms:** Changes in oxidative stress markers [39], neurotransmitter regulation (serotonin, dopamine) [21], [23], [27], neural activity in the subgenual prefrontal cortex (sgPFC) [3], and perceived restorativeness [1], [11], [44].
- The synthesis of these sources allowed for detailed narrative discussion, bolstered by numerical effect sizes reported in the meta-analyses included. The high methodological quality of the included studies [19], [41] provides a solid basis for evidence-based conclusions regarding "blue care" as a quality intervention for mental health management and the correction of depressive ruminations.

Results

Objective

The purpose of this section is to present a structured overview of the findings from the literature regarding the therapeutic potential of physical activity in "blue spaces." The data focus on the impact of these environments on the reduction of depressive symptoms, the correction of maladaptive rumination, and the neurobiological foundations of mental health.

Overview of Findings

Synthetic analysis of the included literature indicates a consistent positive relationship between engagement with blue spaces and various indicators of mental health [11], [14], [28]. A systematic review encompassing 23 studies found improvements across all measured mental states, including depression, anxiety, and mood [14]. Furthermore, meta-analytic evidence demonstrates that aquatic exercise leads to a statistically significant reduction in mental disorder symptoms (SMD = -0.77) [17], [21]. Particularly strong effects were noted for water aerobics (SMD = -0.92) and activities conducted at a low intensity (SMD = -1.07) [17], [20]. Recent clinical reviews also highlight the crucial role of physical activity in child and adolescent mental health, providing a protective effect against the early onset of mood disorders [45], [46].

Thematic Analysis

1. Benefits of Aquatic Physical Activity

Physical activity (PA) is recognized as a key protective factor against depression and anxiety [21], [47]. The research highlights several specific benefits:

- **Antidepressant Effect:** Aerobic exercise has a large therapeutic effect in treating major depressive disorders, comparable in some cases to pharmacotherapy [21], [46].
- **Self-Esteem and Well-being:** Aquatic interventions significantly improve self-esteem, with clinical groups showing up to a 19.4% improvement [1].
- **Biological and Neurobiological Mechanisms:** Physical activity (PA) is recognized as a key protective factor against depression and anxiety [21], [47]. The research highlights several specific biological pathways:
 - **HPA Axis Regulation:** Recent clinical evidence [46], [47] indicates that regular physical activity modulates the hypothalamic-pituitary-adrenal (HPA) axis, leading to stabilized cortisol levels and a more resilient physiological response to stress.
 - **BDNF Expression:** PA stimulates the release of brain-derived neurotrophic factor (BDNF), which supports neuroplasticity and neuronal survival. This mechanism is critical in reversing neurodegenerative changes in the hippocampus and prefrontal cortex caused by chronic depression [46].
 - **Oxidative Stress and Biochemistry:** A 12-week aquatic exercise program for elderly individuals with depression resulted in a 53% reduction in Beck Depression Inventory (BDI) scores. This was associated with a significant decrease in oxidative stress (46% reduction in protein carbonylation) and a dramatic increase in antioxidant levels (GSH by 170%, SOD by 160%) [15].

2. The Role of "Blue Spaces" and Proximity

Aquatic environments offer unique restorative properties that often exceed those of indoor or land-based exercise [12], [18], [30].

- **Proximity and Visibility:** Living less than a kilometer from the coast appears linked to better mental well-being and a reduced risk of common psychological disorders [10], [44]. Visibility of blue space from a residential window is strongly correlated with lower levels of psychological distress, regardless of socioeconomic status [8].
- **The Mediation Mechanism:** Physical activity has been shown to mediate the relationship between blue space proximity and mental health [2, 18]. While walking is the primary mediator in coastal areas, inland waters require more active engagement to yield full psychological benefits [2], [27].
- **Blue Zones Specificity:** Inhabitants of longevity zones, such as the Sardinian Blue Zone, report significantly fewer depressive signs and higher life satisfaction [7], [16]. This has been linked to a lifestyle based on "natural movement" (gardening, walking), along with strong social ties and a constant connection to their natural surroundings [22], [42].

3. Impact on Depressive Ruminations

Rumination, the repetitive analysis of negative emotions, is a major risk factor for depression. Research indicates that nature contact has breakthrough effects:

- **Reduction in Neural Activity:** A 90-minute walk in a natural setting (compared to an urban one) significantly decreases self-reported rumination and neural activity in the subgenual prefrontal cortex (sgPFC) [25].
- **"Break from Diagnosis":** Interventions such as Stand-Up Paddling (SUP) or open-water swimming offer participants an "accretive practice" - a habit that provides a respite from internal negative voices [5], [28]. Participants report that the concentration required for balance and the soothing movement of water creates a sense of "calmness and freedom" [5].

Table 1. Summary of Blue Space Activity Impact on Mental Parameters

Activity Type	Primary Mental Effect Evaluated	Effect Scale / Result	Source
Water Aerobics	Reduction of depression/anxiety	SMD = -0.92 (Significant)	[17], [20]
Swimming (Leisure)	Mood improvement / BDI reduction	46.3% BDI reduction	[15], [18]
Stand-Up Paddling	Break from rumination / Calmness	Long-term (up to 42 months)	[28]
Open-Water Swimming	Autonomy, competence, well-being	~9% increase in positive well-being	[5], [12]
Walking near Water	Reduced sgPFC activity (rumination)	Significant stress/anxiety decrease	[25], [27]

Activity Type	Primary Mental Effect Evaluated	Effect Scale / Result	Source
General Sport (Youth)	Prevention of mood disorders	Reduction in clinical symptoms	[45], [46]

Summary of Results

Research confirms that physical exercise in blue spaces is an effective, non-pharmacological method for correcting rumination and depressive symptoms [21], [28], [47]. The physical effort along with water’s sensory qualities - like its sound, resistance, and buoyancy - form a unique combination that helps lower inflammation and quiets brain areas involved in harmful thought cycles. Recent findings underline that these advantages extend across all age groups - from children to the elderly residing in Blue Zones [42], [45].

Discussion

The findings presented in this review offer a well-rounded evidence base suggesting that therapeutic potential of "Blue Care" - the intentional integration of physical activity within aquatic settings - may serve as a particularly effective method for managing mental health and correcting depressive ruminations. [4], [22].

1. Comparative Efficacy: Aquatic vs. Terrestrial and Indoor Environments

i. The first research question explored here is whether exercising in aquatic environments actually provides a unique therapeutic benefit compared to land-based settings. While the general benefits of physical activity (PA) for mental health are well-documented across all 47 reviewed sources, the synthesis of data reveals that "Blue Spaces" act as a powerful catalyst, enhancing the antidepressant effects of exercise through several unique mechanisms.

The Superiority of Effect Sizes (SMD) Meta-analytic data provide a clear statistical advantage for aquatic interventions. While traditional aerobic exercise typically yields moderate effect sizes in reducing depressive symptoms, aquatic exercise frequently reaches significantly higher values, with standardized mean differences (SMD) ranging from -0.77 to -0.92 [16], [41].

- **The "Water Aerobics" Phenomenon:** Structured water-based group activities demonstrate notable effects (SMD = -0.92), especially among clinical populations and older adults [41], [43].
- **Intensity and Compliance:** low-intensity activities in water often outperform high-intensity land-based workouts with an SMD of -1.07 for low-intensity aquatic physical activity [16]. This suggests that the environment itself compensates for lower physical exertion, making it an ideal intervention for patients with Major Depressive Disorder (MDD) who might find traditional high-intensity exercise too challenging [19], [41].

Hydrostatic and Physiological Synergy The aquatic setting introduces physical factors not present on land, which seem to support therapeutic outcomes.

- **Buoyancy and Hydrostatic Pressure:** The physical property of buoyancy reduces the "perceived exertion," allowing patients to engage in longer sessions with less physical pain or fatigue [22], [43]. At the same time, hydrostatic pressure may have a calming effect on the nervous system by providing constant, gentle tactile stimulation, which could help regulate the hypothalamic-pituitary-adrenal (HPA) axis [21].
- **Thermal Regulation:** Immersion in water - especially natural open-water - triggers bodily thermoregulation responses linked to mood improvement and decreased systemic inflammation, a known contributor to depression [17], [21].

"Soft Fascination" vs. "Directed Attention"

Drawing from Attention Restoration Theory (ART), it is important to consider how different environments influence cognitive resources.

- **Terrestrial/Indoor Barriers:** Places like gyms or urban parks often demand “directed attention” to deal with distractions such as obstacles, noise, or social judgment. For someone already mentally fatigued or caught in depressive rumination, this can add to cognitive strain [29], [37].

- **The Blue Space Advantage:** Aquatic settings provide what is called “soft fascination” -sensory stimuli such as the rhythmic sound of waves, light dancing on the water’s surface, and open horizons. These aspects capture attention in a gentle, effortless way, allowing the brain’s executive functions to rest and recover [1], [14], [44]. This quieter, less demanding environment is likely why water-based exercise is more effective at interrupting cycles of negative thought compared to activity in busy urban or indoor spaces [3], [35].

Clinical Implications for Treatment Adherence

A crucial finding in recent clinical reviews [45, 18] is that the "enjoyment factor" of blue spaces leads to higher adherence rates. For children and adolescents, as well as the elderly, the sensory-rich environment of water makes physical activity feel less like "therapy" and more like "recreation" [40], [45]. This transition from a medicalized view of exercise to an experiential one is vital for the long-term management of chronic depressive symptoms and the prevention of relapse [21], [23].

2. Cognitive and Neurological Mechanisms of Rumination Correction: The Synergy of Environment and Biology

The second research question aims to clarify the particular routes through which blue spaces contribute to the reduction of depressive rumination. Reviewing the existing studies points toward a twofold process, involving changes in brain regions as well as hormonal regulation.

Neurological Deactivation of the "Rumination Center" (sgPFC) An important discovery in environmental psychology, first reported by Bratman and colleagues [3], highlights the subgenual prefrontal cortex (sgPFC) as a key brain area affected by exposure to nature. This area tends to be overactive in people with depression and is connected to inward-focused withdrawal and persistent negative thinking (ruminations).

- **The Findings:** Research demonstrates that a 90-minute engagement in a natural aquatic or "blue" setting leads to a measurable decrease in blood flow and neural activity within the sgPFC [3].

- **The Mechanism:** Unlike urban environments that demand "directed attention" (leading to cognitive fatigue), blue spaces evoke "soft fascination." This allows the brain's Executive Control Network to rest, while simultaneously silencing the Default Mode Network (DMN), which is responsible for the "internal monologue" of rumination [3], [13], [19].

Neurobiological and Endocrine Synergy The correction of ruminative patterns is not only a result of visual stimuli but also of the biochemical changes triggered by physical activity in water, as emphasized in recent clinical reviews [21], [23], [34].

- **HPA Axis Stabilization:** Persistent rumination keeps the body in a heightened state of vigilance, which disrupts the hypothalamic-pituitary-adrenal (HPA) axis and results in consistently high cortisol levels. Exercise in aquatic environments helps restore balance by lowering cortisol and reducing the inflammation that often exacerbates depressive thinking [21], [40].

- **BDNF and Neuroplasticity:** Physical exertion in blue spaces stimulates the production of **Brain-Derived Neurotrophic Factor (BDNF)** [21], [23]. BDNF acts as "fertilizer" for the brain, promoting neurogenesis in the hippocampus - a region often shrunken in chronic ruminators. This increased plasticity allows the brain to "rewire" itself, making it easier for the individual to break away from established negative thought loops and adopt more adaptive cognitive patterns[21], [34]

The "Blue Care" Sensory Buffer The distinctive qualities of water - the steady rhythm of its sound, shifting patterns of light on its surface, and the sensation of buoyancy - create what some describe as a "sensory buffer" [4], [22], [30]. This environment prompts a switch from internal focus (dwelling on problems) to **externalized sensation** (feeling the water, balancing the body). For those suffering from clinical depression, this shift offers a kind of cognitive calm, where the usual negative internal chatter is replaced by immediate, calming sensory experience. Participants often refer to this as a "break from diagnosis," a moment that interrupts the ongoing cycle of rumination [1], [5], [28].

3. Mitigation of Socioeconomic Mental Health Inequalities: Blue Space as a "Health Equalizer"

The third research question touches on a significant public health concern: can natural aquatic settings lessen the psychological harm associated with socioeconomic disadvantage? The literature reviewed gives quite strong support to the "Equigenic Hypothesis," which proposes that blue spaces may be especially effective at narrowing health disparities compared to other environments [13], [31].

The Proximity-Income Interaction Research by Garrett et al. [13] and White et al. [46] demonstrates a significant interaction between residential proximity to the coast and household income. In urban settings, individuals living in low-income households typically report higher rates of psychological distress and common mental disorders (CMDs). However, this "deprivation gap" in mental health is significantly narrower for those living within 1 km of the coast [13].

- **The "Equalizer" Effect:** It has been observed that individuals with higher incomes generally experience better health outcomes, likely due to greater access to healthcare services and leisure activities. This suggests that, the beneficial effects of blue spaces appear to be most evident among those in the lowest income brackets. So that access to bodies of water offers an almost "free" form of therapy, compensating for the absence of privately owned health-promoting resources [13], [46]

- **Visible Blue Space and Psychological Distress** Beyond physical proximity, the mere **visibility of water** from the home environment serves as a protective factor. Studies using geospatial data (e.g., Nutsford et al. [35]) indicate that increased visibility of blue space is associated with lower psychological distress. Crucially, this effect remains significant even after controlling for the "wealth effect" (the fact that sea-view properties are often more expensive). This implies that the restorative quality of blue space is a biological and psychological response to the environment, not just a byproduct of living in an affluent neighborhood [35], [23].

Physical Activity as the Social Mediator Another way blue spaces help to reduce inequality is through promoting specific forms of physical activity. Coastal paths, promenades, and similar environments encourage walking, which is perhaps the most common and accessible physical activity across different social groups [2], [18].

- **Inland vs. Coastal:** In coastal areas, the availability of walking paths mediates the relationship between the environment and mental health across all social classes [2], [38].

- **Reducing Social Isolation:** Blue spaces often act as social gathering points, as seen in studies of "Blue Zones" and adolescent populations [42], [40]. Group activities like community swimming or surfing decrease feelings of isolation - a major risk factor for depression, especially among low-income urban dwellers and older adults [12], [43].

Policy Implications for Urban Planning From a clinical and social perspective, these findings underscore the importance of prioritizing "Blue Care" initiatives in urban renewal projects. Improving access to waterfronts in disadvantaged neighborhoods goes beyond mere beautification - it represents a meaningful public health strategy for mental well-being [28], [46]. By providing a setting for physical activity that naturally silences ruminative thought loops, blue spaces offer a pathway to psychological resilience for populations that are otherwise most vulnerable to the global burden of depressive disorders [14], [47].

4. Clinical "Blue Care" Interventions: Surf, Swim, and Aerobics Regarding the fourth question, the most promising results for clinical populations are found in structured, group-based aquatic interventions [4], [22].

- **Water Aerobics:** Most effective for rapid reduction of acute depressive symptoms in the elderly (SMD = -0.92) [41], [43]. The group dynamic combined with low-impact resistance provides both social support and physiological relief [18], [39].

- **Stand-Up Paddling (SUP) and Surfing:** These provide what is termed a "break from diagnosis" [4]. The high attentional demand required for balance on water forces a cessation of internal ruminative voices, offering long-term improvements in autonomy and competence [36].

- **Open-Water Swimming:** Through the physiological challenge of cold-water immersion and sensory expansiveness [17], [30]. The immersive nature of wild swimming promotes a self-determined approach to wellbeing, which is particularly effective in breaking established cycles of negative thinking [17].

5. Blue Zones and Successful Psychological Aging: The Synergy of Environment, Movement, and Social Fabric

The fifth research question focuses on how certain features of "Blue Zones" - those areas known for having the highest numbers of centenarians - shape the connection between physical activity and mental well-being in older adults. Looking closely at the Sardinian Blue Zone, along with other regions noted for longevity, challenges traditional views on psychological aging by introducing the idea of "Blue Care."

The Concept of "Natural Movement" (Lifestyle vs. Exercise) In many Western, urban settings, physical activity tends to be seen as a specific, often indoor, chore requiring deliberate effort and self-discipline. That is quite different from what happens in Blue Zones, where longevity seems tied to what researchers call "Natural Movement"[42], [30].

- **Environmental Integration:** Inhabitants of the Sardinian Blue Zone engage in low-intensity but constant physical exertion, such as sheep herding, vertical gardening, and walking on steep, rugged terrain near the coast [9], [42].

- **Cognitive Impact:** This model of activity prevents "decision fatigue" associated with planning workouts and fosters a state of constant, gentle mindfulness. Regular, moderate physical effort in contact with blue and green spaces effectively lowers the risk of late-life depression and anxiety, as evidenced by significantly lower scores on the CES-D scale among Blue Zone seniors compared to their urban counterparts [9], [20].

Social Connectivity and the Coastal Buffer One of the things that sets Blue Zones apart is that physical activity is rarely done alone.

- **Social Synergy:** Activities like group fishing or walking to a village center not only promote movement but also encourage social interaction. Strong social support acts as a potent stress buffer, which, when combined with movement, enhances endorphin release and stabilizes the neuroendocrine system (HPA axis) [43], [18].

- **Coastal Restorative Load:** In coastal Blue Zones like Sardinia or Okinawa, the constant presence of the sea contributes a kind of ongoing restorative effect. According to Fastame and colleagues [9], [10], the combination of diet, group movement, and this "blue" environment supports the maintenance of cognitive sharpness and psychological strength even among those over ninety years old.

A Model for Successful Psychological Aging Blue Zones provide empirical evidence that successful aging is facilitated by an environment that "nudges" individuals into activity and interaction.

- **Inhibiting Rumination:** The Blue Zone lifestyle, rooted in a sense of purpose (*Ikigai*) and constant interaction with a demanding natural landscape, leaves little cognitive space for the maladaptive, self-referential thought loops characteristic of depression [30].

- **Clinical Implications:** These findings suggest that "Blue Care" interventions for seniors in urbanized societies should move beyond simple "aquatic exercise classes." Instead, they should aim to replicate the Blue Zone model by creating aquatic activity groups that foster a sense of community, purpose, and permanent orientation toward the regenerative effects of water [12], [43].

Practical Implications

These observations suggest that interventions inspired by "Blue Care" for seniors in cities should go beyond just offering aquatic exercise classes. Instead, there's a need to create water-based activity groups that foster a real sense of community, purpose, and ongoing connection to the healing qualities of water [12], [43]. The findings also make a strong case for incorporating "Blue Care" into mainstream approaches to mental health. Clinicians might consider prescribing water-related activities - not simply as recreation but as a meaningful non-drug addition to psychiatric treatments [4], [28], [41]. Aquatic environments offer more than exercise; they present therapeutic spaces that often improve patient engagement due to a higher "enjoyment factor" and lower perceived effort [45], [22]. Healthcare providers should keep in mind that lifestyle changes involving aquatic activities are not just add-ons - they can be central to a well-rounded treatment plan addressing the biological, psychological, and social aspects of mood disorders [21], [40], [43].

Furthermore, there are significant implications for urban planning and public policy. Given the "health-equalizing" properties of blue spaces, urban developers should prioritize the preservation and accessibility of waterfronts in socioeconomically disadvantaged areas [13], [44], [46]. Enhancing the visibility of water and creating safe infrastructure for "natural movement" near aquatic sites can serve as a cost-effective public health intervention to reduce the psychological distress burden in densely populated cities [23], [45], [46].

Strengths and Limitations

A primary strength of this study is the integration of diverse evidence, ranging from neurological fMRI data to large-scale epidemiological surveys and clinical trials [3], [21], [47]. That said, it is important to recognize a few limitations. For instance, much of the research related "Blue Zone" phenotype is culturally and geographically specific to Mediterranean or coastal island populations (e.g., Sardinia), which may limit its direct to apply the findings directly to populations living in landlocked or heavily urbanized continental areas. [16], [42]. Another point, is the relatively limited attention given to seasonality. Most studies focus on temperate or warm climates; therefore, it is unclear if the restorative effects of blue spaces remain consistent in sub-arctic regions or during winter months [14]. Lastly, a significant portion of the data relies on self-reported measures (such as the BDI or CES-D scales), which,

while validated, are subject to subjective bias compared to objective biological markers [15], [39].

Future Research Directions

While the available evidence is encouraging, there remains a clear demand for more rigorous and large-scale studies examining how aquatic environments affect mental health. Although there is plenty of research on "green spaces," the study of "blue spaces" is still fairly limited in environmental psychology and psychiatry. Future inquiries should lean toward longitudinal studies to assess whether the "Blue Care" effect endures beyond short-term exposure. Additionally, more neuroimaging research is needed to explore brain plasticity changes well beyond the subgenual prefrontal cortex (sgPFC) caused by ongoing contact with blue environments [15], [32].

Given the increasing trend toward urbanization worldwide, investigating "Virtual Blue Spaces" via high-definition virtual reality also seems promising, especially for people who have limited mobility and cannot access natural aquatic settings. Moreover, future work should look into the specific "dose-response" patterns -that is, how often and how long exposure to aquatic environments should happen to sustain mental health benefits for different age groups. This could help establish a kind of non-pharmacological guideline or standard of care [43], [45].

Conclusion

The synthesis of evidence presented in this review supports the idea that physical activity in blue spaces serves as a high-quality, non-drug intervention in managing mental health issues, particularly for easing depressive rumination. The way physical activity interacts with the distinct sensory features of aquatic settings seems to offer benefits that go beyond what land-based exercise can provide.

The following key conclusions can be drawn from this study:

1. **Superior Therapeutic Efficacy:** Aquatic exercise shows considerably greater effect sizes in lowering depressive symptoms - with standardized mean differences reaching as high as -0.92 - compared to indoor or land-based activities. The unique physical characteristics of water, like buoyancy and hydrostatic pressure, help participants engage more comfortably and feel less exertion. This makes aquatic exercise particularly suitable for clinical populations.
2. **Neurological Rumination Blockade:** Being in contact with blue spaces appears to deactivate the sgPFC, a brain area involved in self-focused negative thought cycles. This sort of environmental "quieting" of rumination is supported by biological mechanisms, such as modulation of the hypothalamic-pituitary-adrenal (HPA) axis and increased Brain-Derived Neurotrophic Factor (BDNF) expression.
3. **Socioeconomic Equalization:** Blue spaces seem to function as something like a "health equalizer," helping to reduce mental health disparities. Living near or being able to see bodies of water appears to ease the psychological strain often linked with lower socioeconomic status. In this way, these aquatic environments serve as a broadly accessible and natural source of restoration.
4. **Lifespan Applicability:** Exposure to blue spaces benefits people across their entire lives, from preventing mood disorders in children and adolescents to supporting healthy psychological aging in areas known as "Blue Zones." These zones illustrate how incorporating natural movement in and around water into everyday routines plays an important role in fostering mental resilience and may contribute to longer lifespans.
5. **Shift in Clinical Paradigm:** The medical field faces a pressing challenge: to pay more attention to non-drug approaches when addressing depression. The idea of "Blue Prescriptions" - encouraging time spent in aquatic environments - should become a recognized part of comprehensive psychiatric care. This shift calls for more extensive research and thoughtful urban design to guarantee fair access to these beneficial blue spaces.

To sum up, "Blue Care" might be seen as a promising new direction within environmental psychology. By moving away from solely clinical treatments and toward embracing the soothing qualities of water, society gains a relatively inexpensive and natural method to tackle depression on a broad scale - improving mental health and overall quality of life for people of all ages.

Disclosure

Author's contribution

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