



OPEN Exploring the psychological impacts of water-based outdoor physical activities on university students: a qualitative interview study

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Empirical research has extensively documented the psychotherapeutic value of various natural environments. However, the psychological health implications of water-based outdoor settings (aquatic ecosystems) remain inadequately conceptualized. And current scholarship predominantly documents physiological responses to marine environments, with limited theoretical frameworks explaining the complex psychological effects in water-based outdoor physical activities. 11 university students from the Xiamen University Diving Association participated in semi-structured interviews to share their experiences with water-based outdoor physical activities. The data were analyzed using inductive thematic analysis. Five experts unanimously validated the credibility and validity of the findings. This study extracted 8 themes and 21 sub themes: Fearful anticipation (fear, novelty seeking/desire for exploration); Safe-risking (safety needs, The impulse to take risks); Freedom with constraints (sense of freedom, sense of constraint); Solitude integration (enjoying solitude, team integration); Awe and confrontation with nature (awe for nature, confrontation with nature); Sense of meaning in life (belonging to nature, contemplation of ontological questions about life/world, self-efficacy); Sense of identity (professionalism, certification, risk management skills); Flow experience (temporal transformation, spatial transformation, action-awareness merging, task oriented, sense of control). This study suggests the distinctive psychological impacts of water-based outdoor physical activities on university students, offering insights for psychological interventions in physical education. It extends Maslow's Hierarchy of Needs by proposing a nested, context-dependent structure. While the findings provide innovative perspectives on water-based outdoor settings' influence on mental health, further research is necessary to confirm applicability across diverse contexts.

Keywords Water-based outdoor physical activities, Psychological impacts, Qualitative interviews, Thematic analysis

Sport and exercise psychology has consistently demonstrated that physical activities induce psychological effects on individuals. However, the recent confluence of outdoor physical activities and environmental psychology has led to a novel insight: the psychological impact of physical activities is significantly amplified when conducted within natural environments, outperforming the effects of physical activities in isolation¹⁻³.

On the one hand, natural environments are identified by the World Health Organization (WHO) as a critical health resource for humans, significantly influencing psychological well-being^{4,5}. Over 30 fields have extensively investigated nature's impact on human well-being, with evidence suggesting that spending time in natural spaces offers cost-effective health benefits. This topic has garnered attention in various countries. For instance, at the 150th-anniversary conference commemorating the concept of "Friluftsliv" in Norway, scholars emphasized the healing power of nature and its necessity for human health, development, and well-being⁶. The rise of

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Friluftsliv was partly a response to rapid urbanization following the Industrial Revolution, encouraging people to reconnect with nature and rediscover the joys of simple living. In China, a study on health promotion and disease prevention highlighted that “conformity with nature” is key to health and happiness⁷. In Scandinavia, the importance of nature, popularized by Ibsen and others, has never diminished⁶.

On the other hand, the combination of natural environments and physical activities generates interactive and synergistic effects on mental health. Specifically, the interactive effect refers to how natural landscapes attract individuals to engage in outdoor activities, thereby promoting health and further enhancing mental well-being through increased exposure to nature. The synergistic effect, in contrast, indicates that engaging in physical exercise in high-quality environments, such as those featuring water views, can amplify improvements in mental health, particularly in reducing depression, anxiety, and psychological stress^{8–10}.

Moreover, when comparing the psychological effects of indoor versus outdoor activities, individuals participating in outdoor activities report greater improvements in perceived health and vitality, as well as reductions in tension, anger, and depressive symptoms compared to those engaging in indoor interventions⁸. Cugusi et al. suggests that water-based activities in natural settings may complement the known benefits of indoor aquatic exercises and serve as an enjoyable alternative³.

Consequently, natural environments are increasingly utilized as spaces for preventive and therapeutic exercise training. The UK, for example, has developed strategies to enhance psychological well-being by leveraging the therapeutic elements of nature, leisure, and physical activity as a proactive approach to mitigate ill-being and empirical studies have corroborated the efficacy of such strategies in promoting psychological well-being¹¹.

Water-based outdoor physical activities refer to sports exercise conducted in environments such as oceans, rivers, lakes, and human-made aquatic settings. These exercises can be categorized into three types: in-water physical activities (e.g., swimming), on-water physical activities (e.g., kayaking), and underwater physical activities (e.g., diving). In recent years, these activities have garnered significant attention from scholars as effective means of promoting mental health through the integration of sports and natural environments. A growing body of scientific evidence supports the notion that individuals can derive substantial sociological, psychological^{12,13}, and physiological benefits from engaging in water-based outdoor physical exercises¹⁴. As scholars posit that whether engaging in on-water, in-water, or underwater physical activities, individuals can experience heightened happiness, improved health, enhanced social connectedness¹⁵. The underlying reasons for these benefits may include the following:

1. Water-based outdoor settings, such as vast oceans, majestic waterfalls, and tranquil lakes, offer unique sensory experiences due to their grandeur and mystery. These experiences can disrupt individuals’ everyday frames of reference¹⁶. Additionally, humans may inherently carry thalassophobia, or a fear of deep water¹⁷. This combination can evoke a sense of awe in individuals¹⁸.

Empirical research by scholars has shown that awe has the capacity to restructure cognitive frameworks¹⁹. It can induce a feeling of smallness in individuals²⁰, which in turn can increase psychological balance by modulating temporal distance, thereby alleviating anxiety. The increased temporal distance can promote a state of calmness in both body and mind, which is beneficial for mental health²¹.

2. Water-based outdoor physical activities provide a restorative environment that helps individuals “disengage” from everyday stress^{22,23}, thereby exerting a positive influence on mental health²⁴. Some scholars have also explored the mechanisms of this psychological effect through specific projects. For instance, a qualitative study found that open-water swimming (OWS) enables participants to focus on their surroundings²⁵. The rhythmic movement and immersive experience in the water facilitate reflection, which is beneficial to mental health²⁶.
3. Water-based outdoor physical activities, such as swimming, kayaking, and surfing, promote physical activity and enhance cardiorespiratory function and muscular strength. These physiological benefits contribute to improved mental health²⁷.

Additionally, qualitative studies have found that water-based outdoor physical exercises can enhance self-efficacy and self-esteem³⁰. These activities promote mental health by facilitating relaxation and stress reduction, as well as by enabling emotional regulation through escape, meditation, and reflective practice^{11,22,28}.

However, several issues remain to be addressed in the current research. First, the psychological effects of water-based outdoor physical exercises are still underexplored^{29,30}. Although evidence is accumulating on the potential benefits of outdoor sports in natural environments on mental well-being^{8,31,32}, the majority of the available literature is focused on physiological effects, such as the benefits of water-based exercise programs for people with rheumatologic disease, back pain³³, and chronic diseases³.

Second, there is limited qualitative research examining how individuals personally experience and perceive the psychological effects of water-based outdoor physical activities. Bridging this gap is crucial to advancing our understanding of how different natural environments can be harnessed to improve mental health outcomes.

Therefore, there is significant scope for future empirical research on the psychological effects of water-based outdoor physical activities. In particular, qualitative studies are essential for identifying and exploring the variables related to the psychological impacts of water-based outdoor physical activities. This will lay a solid theoretical foundation for future experimental research and provide a basis for clinical interventions, the design and optimization of school-based water sports programs, and the development of public policies.

The present study investigates the psychological effects of water-based outdoor physical activities through a thematic analysis of interviews conducted with members of the Diving Association at Xiamen University.

By employing qualitative methods, this research seeks to uncover new insights into the unique psychological benefits of water-based outdoor physical activities, contributing to both the academic discourse on natural environments and the practical application of these findings to enhance psychological well-being.

Methods

Participants

To recruit experienced participants, this study employed purposive sampling. Purposive sampling involves selecting participants based on their relevant experience with the research topic. This method helps to achieve a deeper understanding of the phenomenon under study and supports the rigor and credibility of the data and findings³⁴. In this study, participants were required to have experience with water-based outdoor physical activities. The inclusion criteria specified that participants must be at least 18 years old, have participated in such activities for a minimum of one year, and engage in the activities for no less than one hour each time. Participants were recruited from cities across different regions of China to ensure a diverse sample.

Therefore, this study was conducted in Southeast China, focusing on Xiamen University, located in a coastal region known for its proximity to diverse water-based outdoor settings. Eleven students from the university's Diving Association were recruited, all of whom regularly participate in recreational water-based outdoor physical exercises such as diving and dragon boat. In addition, while our study is based on students from a single university, it is important to highlight that our 11 participants come from 10 different cities across China, covering a wide range of geographical regions including the east, south, west, and north. This geographical diversity ensures that our sample includes individuals with diverse cultural backgrounds and experiences.

Detailed participant information is provided in Table 1. The sample size of 11 participants aligns with thematic analysis guidelines for qualitative studies³⁵. While small, this purposive sample provides rich, in-depth data specific to university students engaged in water-based outdoor physical activities. However, findings should be interpreted with caution, as they may not generalize to other populations or types of water-based outdoor physical activities.

Their average age 22.8, with an age range 18–28. The gender distribution is 6 male and 5 female. Their water-based outdoor physical activities pursuits encompass a wide range of activities such as diving, paddleboard, and other exciting water-based endeavors. These participants were recruited through the water-based outdoor physical activities association of Xiamen University. To ensure anonymity, names are given as pseudonyms.

Procedure

A semi-structured interview zeroed in on the diverse types of recreational water-based outdoor physical activities engaged in by students from Xiamen University. I confirm all the subjects have provided appropriate informed consent, all participants are students from one of the members of the research group who voluntarily participated in class. The interviews were approximately 120 min.

It delved into their feelings during and after these activities. Thoughtfully formulated questions aimed to uncover whether there are distinct aspects unique psychological effects to recreational water-based outdoor physical activities when compared with other physical activities. The interviews were conducted in accordance with a theoretical framework that encompassed three progressive stages of psychological engagement. Initially, participants' preliminary psychological responses were elicited. Subsequently, after a period of active involvement, a deeper comprehension of the subject matter was assessed. Finally, the emergence of more advanced psychological sentiments was explored. Please refer to the attachment for specific interview topics. The following presents an excerpted interview with a scuba diving participant (M2) as a case illustration.

Researcher: Initially, what were your feelings when you first engaged in this project?

Participant (M2): The novelty of this experience was incomparable to others. Participation presupposed the ability to swim. Underwater, one feels a sense of freedom, unencumbered by the pressures of the surface. The ability to perform stationary hovering at specific points underwater allows for an unobstructed view of the water-based outdoor settings, free from significant constraints and stress. The experience is highly immersive, with the process of donning and doffing diving equipment evoking a sense of professionalism. Additionally, the use of underwater hand signals adds an element of intrigue.

Code	Age	The length of involvement	Gender	Major	Sports discipline
Male1	28	15 years	Male	College of Ocean and Earth Sciences	Diving
Male2	27	3 years	Male	School of Life Sciences	Diving
Male3	27	4 years	Male	College of Ocean and Earth Sciences	Diving
Male4	21	2 years	Male	School of International Relations	Paddleboard, Canoeing, Dragon boat
Male5	20	2 years	Male	School of Economics	Dragon boat, Paddleboard
Male6	22	4 years	Male	School of Law	Dragon boat
Female1	18	3 years	Female	College of Arts	Diving
Female2	27	17 years	Female	School of Public Affairs	Diving, Swimming
Female3	20	2 years	Female	School of Public Affairs	Dragon boat, Paddleboard
Female4	20	2 years	Female	School of Public Affairs	Dragon boat, Canoeing
Female5	21	1 years	Female	School of International Relations	Dragon boat, Paddleboard

Table 1. Basic information about the participants.

Researcher: What underlies this sense of no pressure?

Participant (M2): The presence of an instructor instills a sense of security. Solo swimming would be fraught with a heightened sense of insecurity. Moreover, the need to surface for breathing is eliminated, as one can remain submerged without the compulsion to resurface for air. The overall experiential quality is robust, with the unique aspects of the activity, such as the use of specialized equipment and communication methods, contributing to its appeal.

Researcher: After engaging in scuba diving for a period, what is your most profound feeling?

Participant (M2): Scuba diving elicits a profound sense of tranquility; it is an introspective journey. This contrasts with activities like table tennis, which involve competitive interactions with others.

Researcher: Could you elaborate on this sense of tranquility? I need to focus on my breathing and the underwater environment. In a sense, although limited by the air supply in the scuba tank, the essence is one of freedom. It is freedom within constraints. It is safety and enjoyment amidst potential hazards. Up to now, what is the most unforgettable feeling scuba diving has brought you?

Participant (M2): It is the ability to cast aside worries, academic assignments, and intense competition. Underwater, one can transcend the confines of time and space, focusing solely on one's inner self. This sensation is truly exhilarating.

Ethical and regulatory considerations

This study was approved by Medical Ethics Committee of Xiamen University, and obtained written informed consent from all participants prior to their involvement. All authors have confirmed that the study adhered to the guidelines and regulations for reporting experiments involving humans and/or the use of human tissue samples.

Data analysis

In our study, we employed inductive thematic analysis as the most appropriate methodology for delving into the subjective experiences of students from Xiamen University. This approach was chosen because of its ability to accommodate the subtle distinctions between recreational water-based outdoor physical activities and other forms of physical activity, which is in line with the flexibility and theoretical integration capabilities of the thematic analysis framework as emphasized by Braun, Clarke, and Weate^{35,36}.

Our research methodology was supported by the complementary viewpoints of the research team. Researcher A adopted a 'Big Q' stance, while Researcher B held a 'small q' perspective³⁷. This dual approach facilitated a balanced analysis, approximating what is known as codebook thematic analysis or 'medium q', which lies between the two extremes. This methodological equilibrium was crucial for reconciling our diverse insider and outsider perspectives, research backgrounds, and epistemological stances³⁸.

Our analytical strategy aimed to cover the entire dataset rather than concentrating on a single aspect³⁵. This comprehensive approach was considered essential for understanding the experiences of participants engaged in recreational water-based outdoor physical activities in a coastal environment. It not only contributes to the specific field of water-based outdoor physical activities but also to the broader understanding of nature-based and outdoor physical activities, enhancing the transferability of our findings³⁹.

This study's sample size of at least 11 participants conforms to the thematic analysis guidelines proposed³⁶. Transcripts of interviews were carefully transcribed by the Transcriber in our study, who engaged in multiple readings to generate descriptive notes and manually identify initial codes. During the analysis phase, each participant's narrative was coded individually, and transcripts were reviewed iteratively. The coding process was primarily semantic³⁶, with codes directly reflecting the explicit statements of the participants. This semantic approach was deemed appropriate for exploring the experiences of individuals participating in this specific type of outdoor exercise in a coastal setting³⁵. In the analysis process, disagreements arose. For instance, between researchers L and Q, L believed that directly presenting the psychological feelings of the interviewees was of paramount importance. In contrast, Q argued for an analysis that followed the progression from superficial to deep psychological feelings, emphasizing the necessity of reorganizing themes in the order of psychological experience escalation. This approach would range from initial emotions (such as fear and novelty) to deeper cognitions (such as a sense of life meaning) and behaviors (such as flow experiences). Q posited that this method would better illustrate the process of psychological change. After discussions with all authors involved in the study, a consensus was reached that Q's perspective was more valid, aligning with the requirements initially set forth in the research design.

Throughout the analysis, we engaged in discussions about specific phrases, code development, and thematic evolution, considering the impact of our different epistemological approaches. This process emulated a 'critical friends' methodology^{40,41} to enhance the rigor of our analysis. After drafting the initial analytic narrative, we sought feedback from an institutional peer 'critical friend' who was unassociated with the project. Participant feedback was not solicited for member checks or reflections, following the guidelines set by Smith and McGannon⁴¹. The following illustrates a portion of the coding process:

"Diving in the sea, special tunnel diving, you will feel the surge of adrenaline, creating a sense of fear that cannot be felt in life"—(M1). This statement was coded as the sub-theme of Fear.

"Diving is truly a remarkable experience, characterized by a unique team spirit and the exhilarating surge of adrenaline that leaves a lasting impression. The underwater environment is completely different from that on land; the sensation of flying through the water is something that cannot be replicated on solid ground, making it a novel experience. I have a keen interest in marine life, and as soon as the diving course was offered, I eagerly signed up for it."—(M1).

Psychological and behavioral responses	Theme	Sub-theme
Initial emotional responses	Fearful anticipation	Fear, novelty seeking, desire for exploration
	Safe-risking	Safety needs, the impulse to take risks
Intermediate cognitive and behavioral responses	Freedom with constraints	Sense of freedom, sense of constraint
	Solitude integration	Safety needs, the impulse to take risks
Advanced cognitive and existential responses	Awe and confrontation with nature	Awe for nature, confrontation with nature
	Sense of meaning in life	Belonging to nature, contemplation of ontological questions about life, world, self-efficacy
	Sense of identity	Professionalism, certification, risk management skills
Advanced experiences	Flow experience	Temporal transformation, spatial transformation, action-awareness merging, task oriented, sense of control

Table 2. Basic information about the results.

These two sentences were coded as the sub-theme of Novelty. Upon analysis, it was determined that these two sub-themes represent a dialectical unity of opposites. They were thus distilled into the overarching theme of fearful anticipation.

Results

Using inductive thematic analysis, this study extracted 8 themes and 21 sub themes: Fearful anticipation (fear, novelty seeking/desire for exploration); Safe-risking (safety needs, the impulse to take risks); Freedom with constraints (sense of freedom, sense of constraint); Solitude integration (enjoying solitude, team integration); Awe and confrontation with nature (awe for nature, confrontation with nature); Sense of meaning in life (belonging to nature, contemplation of ontological questions about life/world, self-efficacy); Sense of identity (professionalism, certification, risk management skills); Flow experience (temporal transformation, spatial transformation, action-awareness merging, task oriented, sense of control). They are distributed according to the depth of psychological and behavioral responses, as shown in the following Table 2.

Initial emotional response

The themes of fearful anticipation (which encompasses fear, novelty-seeking, and the desire for exploration) and safe-risking (which integrates the need for safety with the impulse to take risks) emerge from participants' initial psychological experiences when engaging in water-based outdoor physical activities. These themes reflect unconscious physiological responses that shape individuals' psychological states during such activities. Fearful anticipation is characterized by the tension between anxiety and the innate drive to seek novel and exciting experiences. It encapsulates a complex interplay between fear, which acts as a protective mechanism, and novelty-seeking, a fundamental human inclination towards exploration. In contrast, safe-risking represents the simultaneous desire for security and the propensity to engage in risk-taking behaviors, where individuals strive to balance safety needs with the pursuit of adventurous challenges. Both themes reflect deeper, subconscious psychological and emotional responses, which influence participants' engagement with water-based outdoor physical activities. These initial psychological reactions offer valuable insight into the complex emotional dynamics that guide behavior in these contexts.

Fearful anticipation

The majority of participants (91%) emphasized the inherent tension of fearful anticipation in their engagement with water-based outdoor physical activities—a complex psychological state where fear coexists with the drive for exploration and novelty. Participants identified various environmental factors as both triggers of fear and sources of excitement, including lower water temperatures, the presence of unknown creatures, feelings of loneliness aside from the sound of heartbeats, and the inability to remain still due to the floating sensation. These factors contribute to a range of tactile, visual, and auditory sensations that differ from those on land, often inducing fear. For instance, environmental cues signaling the presence of a direct threat can prompt strong “fear” responses, triggering defensive behaviors. In contrast, more diffuse, distant, or unpredictable cues of threat can lead to “anxious” risk-assessment behaviors, which may persist until the uncertainty is resolved (Gray)⁴². As mentioned by the interviewer in this study,

“The surrounding environment is getting darker and the temperature is changing. There are also unknown creatures on the seabed, which will make you fearful. However, after mastering the skills, you still hope to go down and see the novel world”—(M1).

“I really think the Loong Boat sport is amazing. I can never forget the sense of teamwork and adrenaline surge.” —(M5).

“Diving is truly a remarkable experience, characterized by a unique team spirit and the exhilarating surge of adrenaline that leaves a lasting impression. The underwater environment is completely different from that on land; the sensation of flying through the water is something that cannot be replicated on solid ground, making it a novel experience. I have a keen interest in marine life, and as soon as the diving course was offered, I eagerly signed up for it.” —(M1).

In addition, humans may inherently carry thalassophobia, or fear of deep water¹⁷. Participants engaging in water-based outdoor physical activities often experience fear, as highlighted in this study's interview: "Diving in the sea, especially in a special tunnel dive, you will feel a surge of adrenaline, creating a sense of fear that cannot be felt in everyday life." One notable danger participants may face is nitrogen intoxication, which occurs when diving to depths of 30 m or more. At this depth, nitrogen gas dissolves into the bloodstream and competes with nerve synapses for space. Human nerve conduction relies on ion exchange, and much like carbon monoxide poisoning, nitrogen displaces oxygen, forming nitrogen gas that lacks nerve conduction functionality. This condition clouds cognitive function and manifests differently among individuals—some may laugh, dance, or, alarmingly, remove their oxygen masks. Moreover, reactions slow progressively. For example, a diver might look at their watch, see parameters like "30," yet fail to comprehend its meaning. As one participant in this study noted,

"I personally am not afraid; I just feel that the water pressure in the sea is different. For example, I am at the swimming pool and have reached five meters. I will feel uncomfortable. After entering the sea, they will laugh wildly. Because there is a lack of oxygen in the sea. There will be various expressions. Moreover, due to the distance from the coastline, there is a lack of safety, which makes it easier for muscles to exert force. This is also an emergency mechanism for releasing stress. I haven't experienced diving in this environment yet, but I see others have it and need these states to adjust." —(M1).

These factors contribute to a heightened awareness of potential threats, such as the risk of nitrogen intoxication during diving, which can cause disorientation and confusion due to altered nerve function. While these dangers evoke a natural fear response, they simultaneously drive participants to seek the thrill of discovery and a sense of accomplishment in overcoming such fears.

This paradoxical emotional state is further amplified by the unique and unpredictable underwater environment, described by participants as entirely distinct from life on land. For some, the risks associated with diving are a source of apprehension, while for others, the adrenaline rush and the chance to observe marine life up close enhance the allure of water-based outdoor physical activities. Additionally, the sense of camaraderie and team spirit fostered by activities like dragon boating helps participants conquer their fears, transforming the experience into a shared adventure.

Ultimately, fearful anticipation encapsulates the dynamic interplay between fear and the desire for exploration, illustrating how participants are drawn to the challenges of water-based outdoor physical activities despite its inherent risks. This theme underscores the underlying motivation to seek novel and thrilling experiences while balancing the instinctual need for safety and security. Participants are attracted to water-based outdoor physical activities not only for its physical benefits but also for the emotional rewards of overcoming fear and discovering uncharted realms. According to Maslow's hierarchy of needs, humans possess an innate psychological drive to explore and seek novelty, craving new experiences and challenges in unfamiliar environments. In water-based outdoor settings, these conflicting psychological mechanisms—fear and curiosity—combine to create a profound sense of fearful anticipation.

In summary, this contradictory psychological state highlights the powerful emotional impact of water-based outdoor physical activities, offering valuable insights into how such activities can alleviate fear and stimulate curiosity. By thoughtfully designing environments and activities, it is possible to enhance the exploration-driven motivation while addressing safety concerns, fostering a deeper engagement with water-based outdoor physical activities.

Safe-risking

The majority of participants (91%) emphasized that, during water-based outdoor physical activities, they actively seek stability and security while simultaneously embracing challenges and risks. This reflects a complex physiological and psychological state, highlighting the balance between the fundamental human need for safety and the innate desire for novel and thrilling experiences. As one participant noted during the interview,

"Diving is a process of inward exploration, more precisely, it gives you a sense of freedom within limitations, safety amidst danger, and fun." —(M2).

"I am someone who minimizes risks. Before coming, I also consulted with my classmates for experience. My classmates who used to dive at siming have talked about it and have mastered all situations. They are also very confident in their own bodies, so there is no pressure to dive" —(M2).

"A dive buddy is like a security officer, so you should trust him especially. I have chosen someone familiar with our college as the safety officer. To have a trusted partner, one must also have good technical skills." —(M2).

At the same time, culture influences need such as safety and adventure, with Eastern cultures (e.g., China, Japan, India) emphasizing core values like safety, group harmony, and collective responsibility^{43,44}. In China, particularly, children often prioritize their own safety for the sake of their parents, a cultural dynamic that is especially prominent in the context where "home" holds central importance. As mentioned in our interview,

"I do not have an affinity for extreme diving. The rationale is multifaceted. As the sole child in my family, I possess an inherent inclination towards self-preservation, which is a natural response given my unique familial status. Ensuring personal safety is of paramount importance, especially considering the cultural emphasis on filial piety. I am a child who deeply values and practices filial devotion." —(M2).

Humans also have a need for self-realization or self-transcendence, such as the drive to seek adventure and exploration. This desire to venture into the unknown is evident in behaviors like extreme diving, where some divers reach depths of 200 to 300 m or explore deep caves. This tendency is particularly pronounced in Western cultures, which prioritize self-actualization and personal choice^{43,44}. As highlighted in our interviews, some individuals are even willing to sacrifice their own lives in pursuit of these extraordinary experiences.

“There is a group of people who enjoy pursuing excitement, and many foreigners love cave diving. They are afraid of experiencing it and long for it.” —(M1).

In summary, the contradictory psychological state encapsulated by safe-risking highlights the delicate balance between the need for safety and the craving for adventure. Participants in water-based outdoor physical activities, such as diving, seek stability and security but are also willing to embrace risks and challenges, reflecting both cultural influences and personal tendencies. Eastern cultures tend to prioritize safety, familial responsibility, and collective well-being, which may lead to a more cautious approach toward risky activities. In contrast, Western cultures often emphasize self-actualization and personal exploration, sometimes fostering a greater acceptance of risk. This dual desire for safety and thrill underscores the powerful emotional dynamics at play during water-based outdoor physical activities, where individuals navigate their fundamental needs for security and self-transcendence. Understanding these dynamics can inform the design of environments and activities that reduce fear while simultaneously stimulating the inherent human desire to explore and take risks.

Intermediate cognitive and behavioral responses

As participants' diving skills, cognitive abilities, and experiences deepen, they begin to exhibit intermediate cognitive and behavioral responses. These responses are characterized by two key themes: Freedom with Constraints and Solitude Integration. These themes reflect the evolving psychological and emotional states that emerge as individuals progress through water-based outdoor physical activities.

Freedom with Constraints captures the dynamic tension between autonomy and limitation. It encompasses the sense of freedom participants experience within the boundaries imposed by the activity, while also acknowledging the inherent constraints. This theme highlights the paradoxical nature of water-based outdoor physical activities, where a structured environment simultaneously facilitates liberation and restriction. Participants find themselves enjoying a sense of autonomy yet remain aware of the limitations imposed by the underwater environment and the need for safety protocols.

In parallel, Solitude Integration embodies the delicate balance between individual solitude and social cohesion. Participants report a profound enjoyment of the solitary aspects of diving, appreciating the introspective moments it offers. At the same time, they recognize the importance of team integration for safety and shared experience. This theme underscores the ability to derive pleasure from both solitude and social connection, reflecting the complexity of human interaction in a unique setting.

The rationality of these themes lies in their ability to capture the nuanced cognitive and emotional shifts that occur as individuals engage more deeply with water-based outdoor physical activities. These intermediate responses mark a transition from initial fear-driven behaviors to more complex and balanced states of psychological adaptation. They offer valuable insights into the participants' evolving engagement with the activity, highlighting the multifaceted nature of their experience.

Freedom with constraints

The psychological state of 'Freedom with Constraints' captures the delicate equilibrium between an individual's desire for autonomy and the inherent limitations they encounter. This dual experience is defined by the intricate interplay between a profound sense of freedom and an equally palpable sense of constraint. It reflects how participants (81%) navigate the boundaries of their environment, finding liberation within the very structures that impose restrictions.

The primary reasons are twofold: (1) the experience of water-based outdoor settings is characterized by a unique auditory isolation—one hears only the sound of one's own heartbeat. This sensory phenomenon engenders a profound sense of tranquility and serenity, effectively distancing individuals from the hustle and bustle of urban life and the stresses of daily existence. As a result, participants often experience a deep sense of freedom³⁰. The main appeal of water sports lies in the sensory immersion in nature, which brings about a sense of mental exhilaration. Participants have noted that,

"This sense of novelty is unparalleled. Underwater, there is a sense of freedom, unencumbered by the pressures of the surface. By simply hovering in place underwater, one can observe the underwater world without constraints and with minimal stress." —(M1).

"During dragon boat and kayak training, I often feel the power of water and the caress of the wind; this direct interaction with nature provides a sense of mental release." —(M4).

(2) The buoyancy of water, while offering a unique sense of weightlessness, also imposes limitations on the freedom of movement for participants in water-based outdoor physical activities, restricting their autonomy to some extent. Additionally, the tight-fitting attire commonly worn in water can induce a sensation of constriction. As an interviewee stated,

"The attire is extremely tight, and underwater, one can only breathe through the mouth, with the risk of water entering the diving mask. This is unlike any experience on land." —(M1).

This dichotomy between the liberating and constraining aspects of water sports contributes to the complex psychological experience of fearful anticipation. On one hand, the immersive and tranquil nature of water-based

outdoor settings evokes a profound sense of freedom and mental release. On the other hand, the very same environment, with its inherent limitations on movement and the sensation of constriction from tight-fitting attire, can trigger feelings of vulnerability and apprehension. This interplay of liberation and restriction creates a nuanced psychological landscape where excitement and trepidation coexist, shaping the unique emotional journey of participants in water sports.

Sociable solitary

Sociable Solitude is a psychological state that encompasses the ability to enjoy solitude while also deriving pleasure from team integration. This term captures the individual's capacity to balance the need for personal space and introspection with the desire to engage and integrate within a group setting. It reflects a dynamic equilibrium between the autonomy of solitude and the interconnectedness of social participation.

The primary reasons for this state are twofold: (1) water-based outdoor physical activities provides a unique sensory experience by immersing participants deeply through visual, auditory, and tactile stimuli. As one interviewee noted,

"It's a quiet space with only the sound of bubbles; one can hardly hear anything else. It's akin to meditation, which strengthens and liberates the inner self."—(F1).

(2) The challenges inherent in water-based outdoor physical activities demand a high degree of team integration among participants. They must complement each other's knowledge and abilities to achieve a common goal and share responsibility. This collaborative dynamic enhances their sense of unity and cohesion, enabling them to face the difficulties and potential dangers of the water-based outdoor settings with calmness and confidence. One interviewee highlighted this aspect, saying, "Diving necessitates interaction with others, which I truly enjoy. It's a team effort that requires constant communication with a dive buddy, analyzing and sharing new experiences. Trust in one's dive partner is crucial. At ten meters deep, I felt uneasy—doubting myself, my instructor, and the vast unknown of the deep sea. Of course, if I knew my dive buddy well, my sense of trust would be much stronger. The underwater world is very dark, almost like returning to the womb. The so-called anxiety stems from the discomfort of being in that enclosed space."

Another interviewee stated, "On a dragon boat, we are all 'bound together like fleas on a rope,' a sense of unity that few other sports can provide. It's a feeling of being tightly knit together in spirit. When exhausted, the echoing cheers from teammates can push us to exert just a little more. We never fight alone. We move forward together, drenched in sweat and splashing water, yet our minds, eyes, and ears are only focused on the drumbeat and the finish line. There are moments on the boat when we approach our physical limits; our hands feel as if they are filled with lead, and the waist that once turned out with strength gradually weakens, leaving only what seems like muscle memory propelling us forward. The finish line holds our honor, and around us are our comrades in arms."—(F3).

"Now, I am not just an athlete but a better person. I have become more confident, more aware of the importance of teamwork, and more capable of facing various challenges in life with equanimity. Water-based outdoor physical activities have given me a new perspective on the world and myself."—(F5).

In summary, these intermediate cognitive and behavioral responses capture the intricate emotional dynamics experienced by participants in water-based outdoor physical activities. They suggest that while individuals seek freedom and solitude, they are also keenly aware of the importance of safety and teamwork. This dynamic balance is essential for understanding how to alleviate fear and stimulate the desire to explore through thoughtful environmental and activity design. By creating an environment that balances freedom with safety, and by fostering opportunities for teamwork, the psychological needs of participants can be more effectively met, thereby enhancing their engagement and overall satisfaction.

Advanced cognitive and existential responses

As participants continue to advance their diving skills, cognitive abilities, and emotional experiences, they begin to exhibit advanced cognitive and existential responses. These responses are characterized by three key themes: Awe and Confrontation with Nature (including awe for nature and confrontation with nature), Sense of Meaning in Life (comprising belonging to nature, contemplation of existential questions about life and the world, and self-efficacy), and Sense of Identity (including professionalism, certification, and risk management skills).

These advanced responses reflect a deeper, more profound engagement with water-based outdoor physical activities, transcending basic psychological needs to encompass existential and self-reflective dimensions. The theme of Awe and Confrontation with Nature emerges as participants confront the vastness and power of the natural environment. This theme encapsulates a profound sense of reverence and awe towards nature, often accompanied by the challenge of physically and mentally engaging with the environment's inherent challenges. Participants report deep emotional reactions, such as feeling humbled or deeply connected to the natural world, which in turn fosters personal growth and self-awareness.

The Sense of Meaning in Life develops as participants experience a heightened sense of connection to nature, prompting introspective contemplation about life's deeper meanings. This includes reflections on existential questions related to existence, the world, and the individual's role within it. Simultaneously, self-efficacy emerges as a key aspect, as participants gain a sense of accomplishment and mastery, reinforcing their belief in their own capabilities.

Finally, the Sense of Identity is shaped by the acquisition of professional skills, certifications, and risk management abilities. As participants achieve proficiency and certifications, they establish a clear sense of self as skilled divers. This theme reflects the development of a professional identity, where individuals gain confidence

in their abilities to manage risks and handle complex challenges, further reinforcing their sense of purpose and self-competence.

Awe and confrontation with nature

Awe and confrontation with nature refers to a psychological mechanism that encompasses both a profound reverence for nature and an attempt to engage in confrontation or interaction with it, reflecting a dual attitude of deep respect and challenge towards the natural world.

The awe for nature is encoded in the human genome. From the perspective of ancient times, when productivity was low, nature was mysterious to humans, capable of nurturing humanity as well as destroying it. This engendered a profound sense of awe, and even led to responses such as witchcraft, totem worship, and sacrificial rituals to reciprocate and appease the gifts of nature. Similarly, human capacity for exploring the ocean is vastly insufficient, a fact well acknowledged by mankind.

Therefore, water-based outdoor physical activities participants (91%) who experience nature with an attitude of uncertainty and exploration will inevitably develop a sense of awe, as one interviewee stated:

"Diving is often referred to as a form of "blue opium," indicating its addictive and captivating nature. When one truly immerses themselves in the marine environment, the experience of encountering orcas or specific schools of fish is no longer confined to television screens or aquariums; instead, it becomes a direct encounter with nature. The clownfish, or amphiprions, swimming amidst the coralline structures, or corals, is not a spectacle viewed from afar but a personal experience in the natural world. The impact on individuals is profound, and after experiencing such sensations, one feels a sense of beauty and the presence of numerous wonders to behold. There is an abundance of sights to explore beneath the waves, with a vast array of marine life swimming about, offering endless opportunities for discovery. However, it is imperative to ensure that one's diving skills are proficient, as below may lie delicate coralline structures, sea urchins, or even sharks feeding. If one's technique is not up to par, the consequences could be dire: damaging the coralline structures or being harmed by a sea urchin's spines. The term "blue opium" encapsulates the dual nature of the diving experience, where the allure of the underwater world is balanced with the respect and caution required to navigate it safely and responsibly." —(M3).

While satisfying their exploratory desires and enjoying the pleasures of diving, divers are also deeply moved by the beauty and splendor of the underwater world. This experience fosters a profound respect and protective consciousness towards the natural environment. Numerous empirical studies, grounded in the theory of embodiment, have substantiated this connection. In addition, the interviewees in this study also mentioned that,

"water-based outdoor physical activities, particularly dragon boat racing, have exerted a unique and profound influence on my personal development and psychological well-being. Firstly, water serves as a distinct medium for physical activity, offering an experience radically different from that of terrestrial sports. Within this aqueous environment, we engage in direct confrontation with natural forces, a struggle that not only hones our physical strength but also tempers our resolve. With each paddle stroke, we contend with the water's flow, and this relentless challenge instills in us the virtues of perseverance and courage." —(F5).

In summary, we propose that "awe and confrontation with nature" is a significant psychological characteristic that emerges as participants in blue sports interact with the natural environment. This concept encapsulates the dual sentiments of deep respect and the urge to challenge the natural world.

Sense of meaning in life

The Sense of Meaning in Life encompasses several psychological dimensions, including participants' sense of belonging to nature, contemplation of existential questions about life and the world, and the development of self-efficacy.

At its core, water-based outdoor physical activities leverages water-based outdoor settings to enhance mental health more effectively than traditional approaches. Participants in water-based outdoor physical activities experience a profound sense of belonging to nature, which generates a feeling of pleasure and helps distance them from the stress and anxiety often associated with urban life³⁰. In this study, one interviewee highlighted this experience by stating:

"Furthermore, water sports provide a unique sense of psychological balance. When we paddle vigorously on the water, it feels as if the entire world is reduced to just us and the water. This intimate connection with nature allows us to temporarily forget the troubles and pressures of life, achieving a sense of inner peace and tranquility. After each training session, I feel as though my soul has been cleansed, becoming stronger and more open-minded." —(F5).

"Choosing dragon boat racing as a water sport was an important decision in my university life. It not only allowed me to experience the joy of teamwork but also enabled me to grow by challenging myself. Moreover, it helped me find inner peace through harmonious coexistence with nature." —(M6).

In the presence of nature, individuals often re-evaluate their contemplation of existential questions about life and the world. This is because human beings inherently revere nature, and such reverence can weaken the self-centered perspective, triggering deeper philosophical reflections on the existence and connection between life and humanity¹⁹. Water-based outdoor physical activities, with its endless uncertainty, insecurity, and continuous sense of novelty and mystery, prompts participants to reconsider the meaning of human life. This is distinct from

trivial matters such as minor losses of immediate benefits or academic failures. In this study, one interviewee stated:

"The insignificance of humans is often reflected in extreme sports, prompting reflection on what one truly desires. Why do humans cling to the present, and why do many people fight over trivial gains? Why, with such a vast world, do they never venture out to explore? Reading thousands of books and traveling thousands of miles allows one to see and experience the natural state of things, leading to new personal missions. When facing the Earth, each person is but a speck of dust."—(F2).

"Each time I stand by the shore, gazing at the calm water, a surge of excitement wells up inside me. It is the anticipation of the unknown, the desire for challenge, and the aspiration for self-transcendence. Water sports have taught me how to maintain passion in tranquility and how to stay calm in turbulent currents. This psychological training is unparalleled by other forms of exercise."—(F5).

Water-based outdoor physical activities demands the overcoming of fears and insecurities that are often unimaginable in campus-based outdoor sports such as basketball and soccer. Participants may continuously confront and challenge their own fears, while simultaneously strengthening their self-efficacy.

"Dragon boat racing demands intense paddling on the shimmering water surface, which is undoubtedly a severe test of physical strength and endurance. Choosing dragon boat racing means that I must continuously challenge myself and break through my limits. Each stroke is an exploration of physical limits, and each training session is a refinement of mental fortitude. In this ongoing process of self-challenge, I have learned how to face difficulties bravely, how to overcome inner fears resolutely, and how to persistently pursue my goals."—(M6).

"Through repeated capsizings, I have gradually grown, both technically and mentally. My paddling skills have improved, and I have become more confident. I am no longer as afraid of failure. Just like paddling, when I capsize, I get back up and continue!"—(M5).

Sense of identity

In Max Weber's sociological theory, occupation and professional certification are emphasized as significant factors in shaping social identity. Certification not only provides social recognition of an individual's skills but also signifies their sense of belonging within a particular professional field⁴⁵. For participants in water-based outdoor physical activities, particularly diving (36%), the sense of identity is largely derived from the high level of professionalism required, which often necessitates formal certification for independent practice. Moreover, compared to green exercise activities such as marathon running and cycling, water-based outdoor physical activities demands more advanced risk management skills. In this study, one interviewee highlighted this distinction by stating:

"Diving is a skill with strong professionalism, which is available in our school but rare in other schools. In addition, things learned, such as wilderness survival, do not necessarily require skills. There is no need to be taught, it can be learned at a glance"—(M1).

"We need this certificate to do it, there must be a hidden companion nearby. Today is most of the textual research. We all have certificates."—(F2).

"Loong Boat is a technical activity!"—(M5).

"Although diving is safe, the prerequisite is to check your belongings. The sense of insecurity needs to be overcome through the improvement of technology"—(M2).

In summary, these advanced cognitive and existential responses are logically grounded in the progression from basic emotional reactions to deeper, reflective engagements with both the environment and the self. They reflect the complex and transformative nature of water-based outdoor physical activities, offering participants a multifaceted sense of meaning, identity, and connection to the world.

Advanced experiences

As participants' engagement with water-based outdoor physical activities deepens, they begin to experience advanced levels of psychological immersion, which can be characterized as a Flow experience. This theme encompasses several key components, including temporal transformation, spatial transformation, the merging of action and awareness, task-oriented focus, and a heightened sense of control.

These elements of flow represent an optimal state of experience, where participants become fully absorbed in the activity, and their cognitive and emotional resources are intensely directed toward the task at hand. This immersive state allows individuals to transcend ordinary awareness and achieve a sense of effortless concentration and enjoyment.

The emergence of flow is logically consistent with the progression of participants' engagement in water-based outdoor physical activities. As individuals gain more skill and experience, they are increasingly likely to enter a flow state, characterized by full immersion, optimal performance, and a deep sense of satisfaction. The flow experience is a critical aspect of the advanced cognitive and emotional responses that emerge as participants deepen their involvement in water-based outdoor physical activities, offering a rich and transformative experience that enhances both personal growth and overall well-being.

Flow experience

The Flow experience refers to "the state in which people are so involved in an activity that nothing else seems to matter"⁴⁶. In our study, this state encompasses several key elements: temporal transformation, spatial transformation, the merging of action and awareness, task orientation, and a sense of control.

Temporal and spatial transformation. Water-based outdoor physical activities is particularly well-recognized for inducing a profound sense of temporal and spatial transformation among participants. Wilkie et al. aptly described this experience as being "lost in the world," where individuals transcend their ordinary awareness of time and space³⁰. This sentiment is vividly reflected in the following interviewees (36%),

"While participating in dragon boat racing on water, I can sense the flow of the water and the caress of the wind. This experience of harmonious coexistence with nature brings tranquility to my mind. On the dragon boat, I am able to temporarily forget the hustle and bustle of the city and the troubles of life, fully immersing myself in the interaction with nature. This interaction provides a sense of peace and satisfaction to my soul."—(M4).

"Each stroke on the water seems to temporarily free me from the pressures of life, allowing me to enter a state of focused tranquility."—(M4).

Olive et al. (2020) emphasized the unique visual dimension of water-based outdoor physical activities, highlighting that it provides perspectives that are rarely accessible to others, extending from coast to coast⁴⁷. Psychologically, these distinctive viewpoints may have positive social implications, as posited by Tajfel and Turner (1979)⁴⁸. Specifically, they can strengthen a sense of group membership among those who share similar perspectives, while differentiating them from others with divergent views. This group affiliation, in turn, reinforces the positive aspects of an individual's social identity, thereby enhancing self-esteem. The unique visual perspective also illustrates a complete detachment between the individual and the land, creating a sense of magnitude or "the richness that constitutes another world," a key characteristic of restorative environments⁴⁹.

In this way, water-based outdoor physical activities may reinforce the belief that it serves as an escape from everyday life. Participants reported that water-based outdoor physical activities enhances its restorative potential by providing a "breakaway" feeling from daily responsibilities—a key characteristic of restorative environments^{4,25}. In this regard, the perspectives of participants align closely with those of open-water swimmers who use the sport to disconnect from daily life⁵⁰. This sense of detachment was further contrasted with other outdoor sports activities. Overall, these findings underscore and augment the broader restorative potential of outdoor sports activities⁵¹.

Action-Awareness Merging. Action-awareness merging refers to the seamless unity of body and mind during water-based outdoor physical activities. This concept is grounded in the theory of embodied cognition, which posits that cognitive processes are fundamentally rooted in physical states and experiences. Unlike the traditional view of cognition as a disembodied process, embodied cognition emphasizes the deep interconnection between bodily states and cognitive functions^{29,52}. Within this theoretical framework, researchers have proposed that the sensory-motor representations activated during physical actions are similarly engaged during the processes of action representation, observation, and imitation^{29,53}. This suggests that the neural mechanisms underlying movement are not isolated to physical activity but extend to the mental processes associated with it. Furthermore, studies have demonstrated a high degree of similarity between psychological imagery and action perception, highlighting how the mind and body are intricately linked in both thought and movement⁵⁴.

So, in the context of water-based outdoor physical activities, the concept of action-awareness merging takes on particular significance. It refers to the seamless integration of action and awareness, where an individual's focus is entirely absorbed in the task at hand, leading to an optimal state of experience known as flow. During these exercises, the activation of sensory-motor representations not only facilitates the execution of the physical activity but also enhances cognitive engagement and awareness. This exemplifies the principles of embodied cognition in action, where the mind and body work in harmony to achieve a heightened state of performance and immersion. As stated by the interviewees in this study, "Choosing water sports over other activities is primarily because they offer a unique experience of merging the mind with nature."—(M4).

Task oriented. Task-oriented design in water-based outdoor physical activities means that activities are structured around specific goals or tasks, aiming to enhance participants' physical capabilities and cognitive functions through the completion of these tasks. This approach emphasizes active individual participation and goal achievement by breaking down complex movements into concrete, actionable steps. This method helps participants gradually acquire skills and ultimately achieve functional recovery or improvement. For example, in rehabilitation training, task-oriented training is often integrated with real-life activities. Using the patient's functional deficits as a starting point, repetitive and focused task-oriented exercises are designed to maximize functional recovery.

In water-based outdoor physical activities, this could manifest as designing a series of tasks specifically related to the marine environment or water-based activities, such as rowing or diving. These tasks are crafted to enhance participants' physical coordination, strength, and endurance, while simultaneously boosting their cognitive engagement and concentration. As stated by the interviewee in our study, "My deepest dive is 30 m, and I descend quickly without experiencing motion sickness. My only concern is the reliability of the equipment. My fear stems from confidence in my technical skills, as I am aware that the depth here is only seven meters. Therefore, I am not afraid. At 30 m, I feel no fear."—(M2).

Sense of Control. The sense of control refers to participants' ability to manage their own movements and adapt to the environment during water-based outdoor physical activities. This encompasses both the precise regulation of bodily movements and the psychological modulation required to navigate the exercise setting.

Regulation of bodily movements: In water-based outdoor physical activities such as rowing and diving, participants must exert precise control over various body parts to execute complex movements. For example, during rowing, participants need to coordinate the movements of their arms, legs, and torso to maintain the stability and direction of the boat. This precise control over bodily movements not only enhances their physical mastery but also reinforces their sense of control.

Adaptation to the exercise environment: water-based outdoor physical activities are often conducted near or on water, where environmental factors such as water currents, wind direction, and underwater pressure can significantly impact the activity. Participants must adapt to these dynamic conditions and employ corresponding strategies to cope effectively. For example, when diving, divers must adjust their breathing and movements in response to changes in water currents and pressure to maintain balance and ensure safety. This ability to adapt to and manage the environment is a crucial component of the sense of control, reflecting participants' capacity to navigate and respond to the challenges posed by the water-based outdoor settings.

The modulation of psychological states: The sense of control also encompasses the regulation of psychological states. In water-based outdoor physical activities, participants often need to maintain calmness and focus to effectively cope with potential challenges. For example, in surfing, surfers must maintain balance on the waves, which requires not only physical coordination but also psychological stability. By enhancing their sense of control, participants can better regulate their psychological states, reducing anxiety and tension, and thereby improving their overall exercise performance. As one interviewee in our study mentioned,

"Learning to dive is a gradual process. As I mentioned earlier, during my first attempt, I didn't know anything, and I wasn't familiar with the equipment. Naturally, I felt anxious at that time. However, through systematic training, there is a process of expanding awareness. Initially, when you enter the water, you need to focus on yourself: Is my breathing smooth? Is my ear pressure balanced? Is my equipment in the correct position? Am I safe? The second level involves confirming the connection with your dive buddy, such as knowing where your partner is. The third level expands to the external environment, assessing whether the coral is beautiful, what I should do next, and what my task is."——(F2).

In summary, these advanced psychological experiences are integral to the transformative nature of water-based outdoor physical activities. By fostering deep engagement, emotional restoration, and a strong sense of self-efficacy and control, water-based outdoor physical activities enables participants to achieve not only physical fitness but also profound psychological well-being. As such, it emerges as a holistic and profoundly rewarding activity.

Discussion

This research addresses both practical and theoretical aspects. On the practical side, to the best of our knowledge, this study is the first to explore the psychological experiences of university students engaging in water-based outdoor physical activities, with a particular focus on how their interaction with water-based outdoor settings uniquely influences these experiences. Building on this, the study examines the psychological benefits of water-based outdoor physical activities, highlighting its potential to enhance the psychological abilities and qualities of university students.

On the theoretical side, the psychological benefits gained from participating in water-based outdoor physical activities appear to stimulate participants' psychological needs. Drawing on Maslow's hierarchy of needs theory, this study delves into the contradictory themes of fearful anticipation, safe-risking, freedom within constraints, solitude integration, awe, and confrontation with nature. It re-examines Maslow's framework and proposes an innovative concept: the nested structure of human needs and its applicable boundaries.

The unique psychological experiences of university students in the water-based outdoor physical activities, as well as the psychological abilities or qualities gained through these experiences

The research findings suggest 8 key themes and 21 sub themes, which collectively capture the unique psychological experiences of university students engaging in water-based outdoor physical activities. These themes include: Fearful anticipation (fear, novelty seeking/desire for exploration); Safe-risking (safety needs, The impulse to take risks); Freedom with constraints (sense of freedom, sense of constraint); Solitude integration (enjoying solitude, team integration); Awe and confrontation with nature (awe for nature, confrontation with nature); Sense of meaning in life (belonging to nature, contemplation of ontological questions about life/world, self-efficacy); Sense of identity (professionalism, certification, risk management skills); Flow experience (temporal transformation, spatial transformation, action-awareness merging, task oriented, sense of control).

These psychological experiences can foster the development of various psychological abilities and qualities in university students. These include:

The ability to cope with fear and anxiety

Water-based outdoor physical activities, as a form of physical activity, stands apart from other sports in that it achieves its benefits not solely by enhancing psychological resilience or self-efficacy, but through other unique mechanisms. For example, as an aerobic exercise performed in natural or artificial water environments, water-based outdoor physical activities has been shown to significantly improve mental health, with positive effects on mood and anxiety symptoms^{55,56}.

For participants engaging in water-based outdoor physical activities in natural water environments, the unpredictable elements and potential dangers of the water-based outdoor settings force individuals to develop strategies for managing fear and anxiety, thus enhancing their self-control and emotional regulation abilities. In

particular, underwater activities, with their stark contrasts to terrestrial environments—such as weightlessness, confinement, and monotony—induce a range of unique psychological and physiological responses. Prolonged engagement in these activities can lead to conditions like decompression sickness (DCS), Inert Gas Narcosis (IGN), and High Pressure Nervous Syndrome^{57,58}. To adapt to these challenges, individuals must learn to manage the fear and anxiety triggered by environmental shifts in order to maintain both psychological stability and physiological health, ultimately improving their performance in underwater tasks⁵⁹. Psychology often draws on these inherent psychological characteristics to provide cognitive therapy for anxiety patients⁶⁰, and even exposure therapy to enhance individuals' ability to reduce or eliminate fear and anxiety⁶¹.

Adventurous spirit and risk assessment ability

In water-based outdoor physical activities, the balance between the primal desire for adventure and the need for safety can enhance participants' risk assessment and decision-making skills. Similarly, other activities such as wilderness survival, high-altitude mountaineering, and orienteering also contribute to the development of these abilities. However, the underlying mechanisms vary across these sports. One possible explanation for this difference lies in the distinct environmental characteristics of each activity.

Unlike land-based sports, blue sports typically occur in water-based outdoor settings like oceans, where the fluidity, fluctuations, and unpredictability of water bodies—such as waves, undercurrents, and tides—expose participants to more significant risks. Research has particularly highlighted that the darkness and unknown aspects of the ocean can trigger deep-seated fears, often linked to the subconscious¹⁷. This fear is so fundamental that it has given rise to the term thalassophobia, describing the instinctive fear humans have of the ocean. As a result, participants in water-based outdoor physical activities must cultivate both an adventurous spirit and a strong ability to assess and manage risks.

Respect and challenge nature

As previously discussed, water-based outdoor physical activities introduces greater uncertainty and fear compared to terrestrial sports. Humans often harbor thalassophobia (fear of the ocean)¹⁷ and biophobia (fear or aversion to living organisms)⁶², leading to apprehension toward marine life and underwater environments. Additionally, as air-breathing mammals highly reliant on vision for survival, humans may experience nyctophobia (fear of darkness) and heightened thalassophobia⁶³. However, with increased understanding and exposure to blue spaces, this fear typically diminishes, fostering a greater appreciation and affinity for such environments⁶². The continuous improvement of water-based outdoor physical activities skills also boosts self-esteem and self-efficacy³⁰, which, as noted by Deci (2004), can cultivate a mindset oriented toward challenging and coexisting with nature⁶⁴. This aligns with Maslow's hierarchy of needs, wherein the pursuit of new experiences through water-based outdoor physical activities contributes to self-actualization and self-transcendence. In summary, water-based outdoor physical activities instills in participants both a profound respect for nature and a spirited drive to challenge it.

Teamwork and Social Skills. Extensive research supports the idea that physical exercise can enhance social skills and reduce social anxiety disorder (SAD). Both access to blue spaces and participation in water-based outdoor physical activities promote social interaction^{12,50}. However, studies have found that compared to solitary exercise or static relaxation in blue spaces, water-based outdoor physical activities further enhances attention and executive function while mitigating negative emotions and job burnout, highlighting a synergistic effect⁶⁵. In China, research identifies four types of social anxiety among young people: avoidant, exhausted, utilitarian, and wandering, all of which describe increasing alienation from their immediate surroundings⁶⁶. Water-based outdoor physical activities provides adolescents with a real, challenging social environment that can effectively alleviate social anxiety and enhance social skills. As such, it holds promise as both an intervention for SAD and a means to improve interpersonal abilities.

Self-reflection and self-growth. This study suggests that water-based outdoor physical activities offers participants an environment conducive to attentional focus, triggering a sense of temporal and spatial transformation. In the presence of natural surroundings and the application of motor skills, participants experience the merging of action and awareness, task engagement, and an enhanced sense of control—all of which contribute to achieving a flow state. In this state, participants engage in continuous self-reflection, exploring a sense of meaning in life through feelings of belonging to nature, contemplation of ontological questions about life and the world, and a deep sense of self-efficacy. These experiences foster personal growth and heightened self-awareness.

The inherent feelings of fear and insecurity, coupled with exposure to complex natural environments, encourage participants to grow through the mastery of motor skills and cognitive enhancement. This process often results in the development of a strong sense of identity, encompassing attributes like professionalism, certification, and risk management skills. However, these outcomes are not unique to water-based outdoor physical activities and can also be observed in other activities, particularly green exercise. As this study does not aim to compare water-based outdoor physical activities with other contexts, further exploration of these outcomes is beyond its scope.

In all, the psychological abilities and qualities developed through water-based outdoor physical activities represent valuable goals for future physical education curricula. By fostering skills that promote self-growth, social interaction, and resilience, water-based outdoor physical activities can help cultivate well-rounded individuals capable of effectively navigating both personal and social challenges.

The nested structure and dynamics of human needs in water-based outdoor physical activities contexts: an analysis based on maslow's hierarchy of needs

The findings of this study offer a fresh perspective on Maslow's hierarchy of needs⁶⁷. While they align with existing research in some aspects, (1) the structure of Maslow's hierarchy of needs is not strictly hierarchical and

unidirectional. For instance, the themes distilled from the results of this study, such as "Awe and confrontation with nature," illustrate that individuals' lower-level needs, such as safety needs, can coexist with higher-level needs, such as self-actualization needs. This conclusion is also supported by existing research⁶⁸. Even, Rojas, M., based on empirical data, has confirmed this point. Low-income groups may simultaneously pursue social needs, while high-income groups may neglect self-actualization due to social pressures and focus more on esteem needs (such as social status). Multiple needs can be satisfied concurrently or even leapfrog hierarchical levels, challenging Maslow's linear model. For example, individuals who have experienced long-term hunger (such as refugees) may not be able to shift to higher-level needs due to early psychological trauma. Similarly, those whose basic needs are met may revert to lower-level needs due to sudden environmental changes (such as emergencies). Moreover, the emergence of higher-level needs after the satisfaction of lower-level needs does not necessarily follow a fixed order. For example, adolescents may prioritize social needs over physiological needs (such as eating)⁶⁹. In addition, existing studies have begun to reconceptualize humans as complex entities with interwoven needs, rather than as mere layered mechanical structures. This shift in perspective aims to propose new alternatives to Maslow's hierarchical model by simultaneously addressing multiple individual needs⁶⁹.

(2) Maslow's hierarchy of needs is influenced by culture. In this study, participants are situated within China's collectivist culture, where the order of needs may differ from what Maslow's theory emphasizes. For example, self-actualization needs in water-based activities (such as exploring and challenging nature) may not be the most important. Instead, safety needs are prioritized. As one interviewee mentioned, "I do not have an affinity for extreme diving. The rationale is multifaceted. As the sole child in my family, I possess an inherent inclination towards self-preservation, which is a natural response given my unique familial status. Ensuring personal safety is of paramount importance, especially considering the cultural emphasis on filial piety. I am a child who deeply values and practices filial devotion" (M2).

In contrast, in Western cultures that emphasize freedom and self-expression, self-actualization and personal choice are highlighted. As our interviews with participants in Western water sports revealed, some individuals are even willing to sacrifice their lives to pursue these extraordinary experiences: "Some people are even willing to sacrifice their lives to pursue these extraordinary experiences" (M1).

In fact, although Maslow acknowledged early on that culture affects the manifestation of needs, his theoretical framework remains inclined towards universalism and does not fully integrate cultural diversity. Maslow's hierarchical structure, with self-actualization as the pinnacle, has been criticized for having a Western-centric bias. In his later years, Maslow reflected that "the path to self-actualization is Western, even American"⁶⁸.

In exploring Maslow's hierarchy of needs, our study diverges from existing research, which has not clearly defined the specific structural types of human needs, particularly within the realm of sports. By focusing on water-based outdoor physical activities, our study offers a unique perspective on the complexity of needs. Integrating the Attention Restoration Theory and the Biophilia Hypothesis, we propose that the coexistence and conflict of multiple needs among participants create a complex, nested structure. Within this structure, lower-order safety needs and higher-order self-actualization needs are not mutually exclusive but rather interwoven and overlapping. In water-based outdoor physical activities, this is particularly evident in the tension between the drive for self-actualization through water-based outdoor exploration and the fundamental need for safety via risk mitigation. In addition, the present study suggests that culture is a moderating variable for this nested structure.

Specifically, on the one hand, according to Attention Restoration Theory, natural environments allow individuals to interact with them in various ways, thereby satisfying different psychological needs⁷⁰. Based on this, the current study found that in water-based outdoor sports activities, individuals' needs are more strongly elicited and are characterized by complexity and contradictions. For example, as found in this study, in water-based outdoor settings, expectations of fear, risky safety behaviors, constrained freedom, loneliness and integration, awe, and confrontation with nature all emerge simultaneously. As a result, individuals may feel both fear and desire, being strongly attracted by the unknown marine domain while also feeling uneasy about the deep and mysterious underwater world. This duality is reflected in the delicate balance between the instinctive desire for adventure and the need for safety, often leading participants to avoid darker and deeper areas. In addition, water-based outdoor sports activities can not only enhance team cohesion and improve social skills but also provide solitude and tranquility, allowing individuals to enjoy the quiet and peaceful underwater environment. This duality is also reflected in participants' interactions with nature, where they experience both awe and resistance to the natural order. This complex emotional demand is consistent with the Biophilia Hypothesis, which posits that contact with nature can simultaneously elicit positive emotions such as awe, tranquility, and a sense of belonging⁷¹.

On the other hand, culture emerges as a significant influencing variable, capable of either solidifying or adjusting this nested structure. Hofstede's cultural dimensions theory posits that the priority of needs varies across different cultural backgrounds. For instance, in collectivist cultures, the need for belongingness may be more significant compared to individualist cultures. In cultures with high uncertainty avoidance, the need for safety becomes more pronounced, while in individualistic Western cultures, there is a greater emphasis on personal adventure and the need for self-actualization⁷². Consequently, in China, where collectivist culture is predominant, participants place a high value on a sense of security, as interviewees emphasize: "I do not have an affinity for extreme diving. The rationale is multifaceted. As the sole child in my family, I possess an inherent inclination towards self-preservation, which is a natural response given my unique familial status. Ensuring personal safety is of paramount importance, especially considering the cultural emphasis on filial piety. I am a child who deeply values and practices filial devotion".

In addition, Chinese *Zhongyong* refers specifically to a mode of orientation in social action that bears some resemblances to Aristotle's "doctrine of the mean"⁷³. It demands locating an optimal midpoint between extremes. Adhering to the midpoint entails avoiding excess in any direction. In Confucianism, all things and phenomena

have corresponding limits that define their appropriate optimal states or conditions. This principle applies to social behavior as well, which should remain within reasonable bounds. However, it is crucial to emphasize that “adhering to the middle” means identifying the most appropriate position, rather than a mechanically equidistant point between poles.

Building on this philosophy, the Chinese relationship with water—one element of nature—is characterized by both dependence and active conquest. On one hand, water is a source of life, and the Chinese have an innate reliance on it, considering it fundamental for survival and development. This is exemplified in early folk beliefs through the worship of “water deities” and “dragon kings,” reflecting reverence for and appeals to water⁷⁴. On the other hand, based on this dependence, the Chinese have actively sought to conquer and transform water. Mythological stories such as that of Yu the Great controlling the floods illustrate the ancient people’s brave resistance to water disasters, attempting to harness water for the betterment of human society. The story of “*Kua Fu Chasing the Sun*” recorded in the <*Shan Hai Ching*> shows the immense sacrifices made by the ancients in their quest for water amidst scarcity. Kua Fu, a chieftain of a giant tribe, observed the sun’s daily rise and set, which brought light and warmth but also heat and drought. In an effort to bring eternal light to humanity, Kua Fu decided to chase the sun and make it stand still. He ran extremely fast, but the intense heat made him terribly thirsty. He drank up the waters of the Yellow and Wei rivers but was still not satisfied. Heading north to drink from a great marsh, he died of thirst along the way. After his death, his staff turned into a peach grove⁷⁵.

The story of “*Hou Yi Shooting the Suns*,” documented in the <*Huai nan zi*>, fully demonstrates the ancients’ struggle against drought. According to legend, in ancient times, ten suns appeared in the sky simultaneously, causing unbearable heat, withering crops, and great suffering among the people. Hou Yi, a heroic archer, seeing the people’s plight, decided to save humanity. Climbing to the top of Mount Kunlun, he drew his bow and shot down nine of the suns, leaving only one to provide light and warmth. Thereafter, the earth regained its vitality, and the people lived happily. Although these mythological stories are not uniformly recorded in ancient texts, the spirit of conquering nature they embody is consistent⁷⁶.

The Chinese cultural reverence and affinity for water profoundly shape individuals’ experiences in water-based activities. This cultural attitude is evident not only in traditional festivals but also in contemporary water-based leisure pursuits, cultivating a unique experiential relationship with nature among participants. This experience encompasses both awe and intimacy with nature, reflecting the Chinese philosophical concept of “unity of heaven and humanity.” For instance, during traditional festivals such as the Dragon Boat Festival, dragon boat races are held. These events are not only commemorations of tradition but also expressions of reverence and closeness to water. In modern water-based leisure activities, this cultural backdrop leads participants to prioritize harmonious coexistence with nature, striving for a balance of mind and body. This also implies a nested structure of needs, where safety needs coexist with the need for belonging⁷⁷.

Strengths and limitations

This study has 3 strengths and 3 limitations. The strengths are as follows:

Systematic Exploration of Psychological Effects. The study systematically explores the unique psychological effects of water-based outdoor physical activities on university student participants, along with the underlying causes of these effects. This research provides a solid theoretical foundation for future experimental and quantitative studies in this field and offers a novel approach for psychological intervention in university physical education.

Expansion of Maslow’s Hierarchy of Needs Theory. This study suggests that human needs may be structured as nested rather than hierarchical, as originally proposed by Maslow. Furthermore, Maslow’s hierarchy of needs is context-dependent, and its application boundaries can be expanded in the future based on cultural and sports scenario differences. It is also worth considering whether there are differences in needs based on gender.

Unique Sample and Methodological Contribution. The unique sample utilized in this study demonstrates a significant methodological strength. To our knowledge, this is the first time that the unique psychology of university students participating in water-based outdoor physical activities has been explored. This pioneering approach allows for a deeper understanding of the specific psychological dynamics at play in this context, providing a novel perspective on the interplay between water-based outdoor settings and mental health.

The limitations are as follows:

Limited Applicability Across Contexts. The applicability of the research findings to other individual or group activities, particularly in different sports or cultural contexts, remains uncertain and requires further investigation.

Exclusion of Certain Physiological Effects. The study did not identify certain psychological issues that may arise from physiological effects during diving, such as decompression sickness, inert gas narcosis, and high-pressure neurological syndrome (HPNS), which can negatively impact cognitive functions⁵⁹. This absence of findings may be attributed to the fact that the diving depths of the interview subjects did not exceed thirty meters.

Influence of Individual Personality Traits. Individual personality traits and psychological resilience, among other factors, can influence the structure of needs. Due to limitations in scope and research focus, these factors were not included in the current discussion. However, they represent potential areas for future investigation.

The research results need further validation through high-level evidence-based research methods. Given the exploratory nature of this study, the robustness of our current findings is not on par with those derived from more rigorous methodologies, such as randomized controlled trials (RCTs).

Conclusion

This study explored the potential psychological effects of water-based outdoor physical activities through a qualitative study. The study found that there are seven themes and twenty-one subthemes. These themes include: fearful anticipation, characterized by fear and a desire for exploration; safe-risking, which involves balancing safety needs with the impulse to take risks; freedom with constraints, encompassing a sense of freedom alongside feelings of constraint; solitude integration, highlighting the balance between enjoying solitude and team integration; awe and confrontation with nature, reflecting both reverence for and challenges posed by the natural environment; sense of meaning in life, involving belonging to nature, contemplation of existential questions, and self-efficacy; sense of identity, marked by professionalism, certification, and risk management skills; and flow experience, which includes temporal and spatial transformation, action-awareness merging, task orientation, and a sense of control. These experiences contribute to the development of four key psychological abilities and qualities in university students: (1) the ability to cope with fear and anxiety, (2) an adventurous spirit and risk assessment skills, (3) teamwork and social skills, and (4) self-reflection and personal growth. These findings offer a novel approach to psychological intervention within university physical education.

The study systematically examines the underlying causes of these effects and suggests that human needs may be structured as nested rather than strictly hierarchical, emphasizing the context-dependent nature of Maslow's hierarchy of needs. Furthermore, the exploration of the sample provides valuable insights into the psychological effects of water-based outdoor settings.

However, the generalizability of these findings to other activities, cultural contexts, or sports backgrounds remains uncertain. This uncertainty underscores the necessity for further research to validate and expand upon these results. Additionally, given that the psychological impact of water-based outdoor physical activities may also be influenced by factors such as water quality, hydrostatic pressure, seasons, temperature and the impact of the physiological effects of water immersion, the robustness and stability of this research topic will need to be quantitatively validated through mixed-methods research in the future.

Data availability

The datasets used during the current study remain available from the corresponding author.

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Xiuxia Liu; Ran Wang; Huahui Qin: Writing-original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Hangyu Zhang; Xinghe Weng; Shunying Lin; Fengmin Ge: Writing- original draft, Validation, Methodology, Formal analysis.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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