Environment and Social Psychology (2026) Volume 11 Issue 2 ISSN: 2424-8975 (O)
doi: 10.59429/esp.v11i2.4575 2424-7979 (P)

Research Article

Green spaces, mental well-being and the digital service age: Evidence and policy recommendations

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ABSTRACT

In the digital age, opportunities for direct contact with nature are increasingly limited, while scientific evidence shows that green and blue spaces offer numerous mental health benefits, such as reducing stress, anxiety, and depression, and enhancing social connectedness. This paper reviews studies on the relationship between nature, technology, and mental health, analyzing the dual role of technology as both a supportive tool and a barrier when overused. Findings indicate that exposure to nature, whether direct or indirect has positive effects, yet a balanced strategy is needed to optimize these benefits. Initiatives from the WHO and the Blue Health project provide evidence and practical tools for integrating health considerations into urban planning and community interventions. The paper recommends developing urban green infrastructure, reducing inequalities in access, and leveraging digital technology as a a complementary rather than substitutive pathway for nature experiences.

Keywords: Green spaces; Blue spaces; Digital technology; Mental health; Public policy

1. Introduction

In the digital age, rapid technological advancement has transformed patterns of work, consumption, and social interaction, generating new challenges for mental well-being and sustainable urban development [1,2]. While existing studies primarily examine the relationship between digitalization, green spaces, and mental health from public health and environmental perspectives, limited attention has been paid to their economic and service-oriented implications [3,4]. This paper conceptualizes green and blue spaces not only as environmental amenities but also as integral components of urban service infrastructure that contribute to labor productivity, service quality, and the performance of the digital service age [5].

Drawing on interdisciplinary evidence from psychology, urban studies, and economics, the study synthesizes empirical findings on the effects of green and blue spaces on mental well-being in digitally intensive environments [6,7]. The analysis highlights how improved mental health outcomes are linked to broader socio-economic benefits, including enhanced workforce engagement, increased demand for urban

ARTICLE INFO
Received: 21 January 2026 | Accepted: 12 February 2026 | Available online: 25 February 2026

CITATION
Thi Le L, Le Thi TN, Xuan Tran B,etc.. Green Spaces, Mental Well-being and the Digital Service Age: Evidence and Policy Recommendations. *Environment and Social Psychology* 2026; 11(2): 4575. doi:10.59429/esp.v11i2.4575

recreational and tourism services, and reduced social and healthcare costs [8,9]. The paper further examines the role of digital technologies, such as data platforms, geographic information systems, and smart urban services, in planning, managing, and delivering green-space-related services [10,11].

Based on this integrated perspective, the paper advances policy recommendations that frame investment in green and blue spaces as strategic public service investments rather than purely environmental expenditures; emphasizing service-oriented urban governance, data driven decision making, and public–private partnership mechanisms to enhance the efficiency, inclusiveness, and sustainability of green-space provision [12,13]. The findings contribute to the literature by bridging mental health, digital transformation, and service economics, offering policy-relevant insights for cities seeking to strengthen their competitiveness and resilience in the digital age.

2. Theoretical and conceptual background

Research on the relationship between green spaces and mental well-being has been grounded in multiple theoretical traditions, particularly within environmental psychology, public health, and social ecology. Among the most influential frameworks are Attention Restoration Theory (ART), Stress Reduction Theory (SRT), the Socio-Ecological Model, Nature Connectedness Theory, and the Positive Health Model. While each theory offers distinct explanatory mechanisms, together they provide a comprehensive foundation for understanding how green spaces contribute to mental well-being, especially within the context of increasing digitalization of services. Attention Restoration Theory (ART) posits that exposure to natural environments facilitates recovery from directed attention fatigue by engaging involuntary attention processes, thereby improving cognitive functioning and emotional regulation [14]. Empirical studies have consistently demonstrated that access to green spaces is associated with enhanced concentration, reduced mental fatigue, and improved psychological well-being across different age groups [15]. Complementing ART, Stress Reduction Theory (SRT) emphasizes the affective and physiological responses elicited by natural environments. According to SRT, exposure to green spaces can rapidly reduce stress by lowering physiological arousal and negative emotional states [16]. A growing body of evidence supports the role of natural settings in mitigating stress, anxiety, and depressive symptoms, particularly in urban populations facing high environmental and psychosocial stressors [15]. Beyond individual-level mechanisms, the Socio-Ecological Model provides a broader perspective by situating mental well-being within interacting layers of influence, including individual, interpersonal, community, and policy environments [17]. From this perspective, green spaces are not merely physical environments but social infrastructures shaped by urban planning, governance, and service delivery systems. This model is particularly relevant for understanding inequities in access to green spaces and their implications for population mental health. Nature Connectedness Theory further deepens this understanding by highlighting the psychological and emotional bond between individuals and the natural world. Higher levels of nature connectedness have been associated with greater life satisfaction, emotional well-being, and pro-environmental behaviors (Mayer & Frantz, 2004) [18]. Digital technologies, when appropriately designed, may enhance rather than diminish nature connectedness by facilitating access to information, engagement, and community-based environmental initiatives. Finally, the Positive Health Model reframes mental well-being as a dynamic capacity to adapt and self-manage in the face of social, physical, and emotional challenges [19]. This model aligns well with contemporary public health and social policy approaches that emphasize resilience, empowerment, and supportive environments. In the digital service age, integrating green space initiatives with digital mental health services may strengthen adaptive capacities at both individual and community levels. Taken together, these theoretical perspectives underscore the need for an integrated conceptual framework that links green spaces, mental well-being, and digital services. Rather than treating these elements as separate domains, this

study synthesizes them into a unified model to inform evidence-based policy and practice in urban mental health promotion.

This integrated theoretical synthesis provides the foundation for the conceptual framework presented in **Figure 1** and directly informs the formulation of the study's research questions.

Based on the integrated theoretical synthesis, this study advances the following guiding propositions: Proposition 1: Exposure to green and blue spaces influences mental well-being through cognitive restoration, emotional regulation, and enhanced nature connectedness.

Proposition 2: Digital technologies mediate and moderate the relationship between nature exposure and mental well-being by shaping access, experience intensity, and continuity of engagement.

Proposition 3: The impact of green and blue spaces on mental well-being is conditioned by socio-ecological factors operating at individual, community, and policy levels.

Proposition 4: Integrated investments in green infrastructure and digital services contribute not only to mental well-being but also to adaptive capacity within the digital service economy.

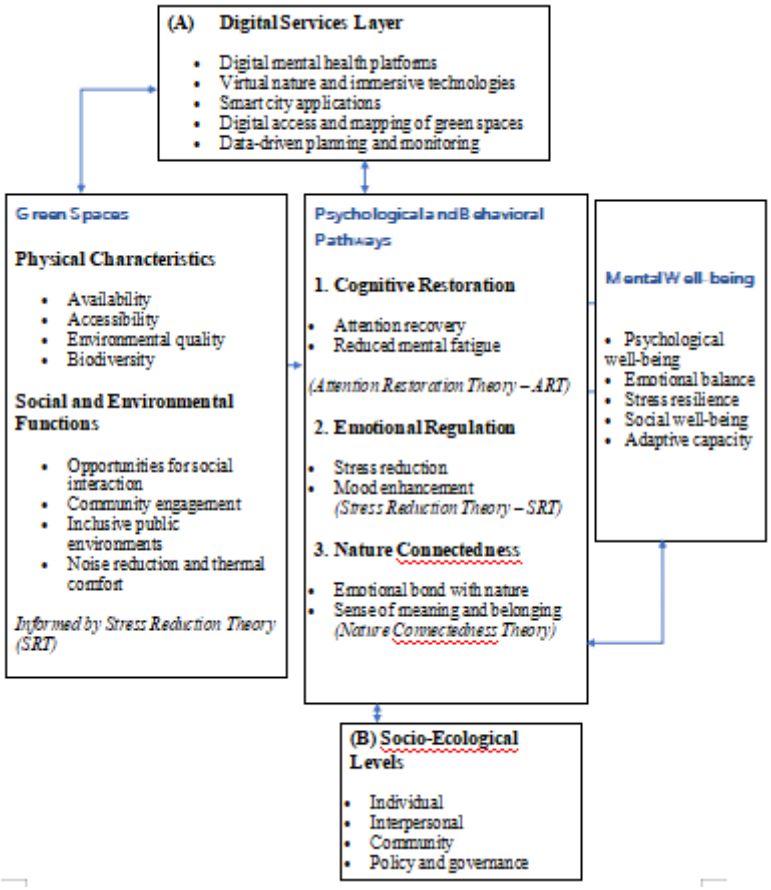

Figure 1. An Integrated Conceptual Framework Linking Green Spaces, Mental Well-being, and Digital Services

Figure 1 illustrates an integrated conceptual framework in which green spaces influence mental well-being through cognitive, emotional, and relational pathways. These relationships are embedded within a socio-

ecological context and are shaped by the enabling and moderating role of digital services in the contemporary service age.

Research Questions

This study is guided by the following research questions, derived from the integrated conceptual framework linking green and blue spaces, mental well-being, and digital services in the contemporary service age.

RQ1. How do green and blue spaces influence mental well-being through key psychological and behavioral pathways, including cognitive restoration, emotional regulation, and nature connectedness?

RQ2. How do digital services and digital technologies mediate or moderate the relationship between green and blue spaces and mental well-being in the digital service age?

RQ3. How do socio-ecological factors at the individual, community, and policy levels shape access to green and blue spaces and their mental well-being outcomes?

RQ4. What evidence-based policy and service design implications can be derived from integrating green and blue spaces with digital services to promote mental well-being in urban and service-oriented societies?

3. Research methods

To address the above research questions, this study adopts a systematic narrative review approach to synthesize existing evidence on the relationships between green and blue spaces, digital services, and mental well-being. Following the PRISMA 2020 framework, the review ensures transparency in literature identification, screening, and selection. Narrative synthesis and content analysis are employed to examine underlying mechanisms, socio-ecological contexts, and policy implications in line with the proposed conceptual framework. Each research question guided the literature selection, thematic coding, and narrative synthesis process.

3.1. Research design

This study employs a systematic narrative review approach to synthesize and analyze scientific evidence on the relationships between green spaces, blue spaces, digital technology, and mental health. The research design follows the PRISMA 2020 framework, ensuring transparency in data collection, selection, and analysis processes. It also integrates narrative synthesis to provide deeper interpretation of meanings, mechanisms of influence, and policy implications.

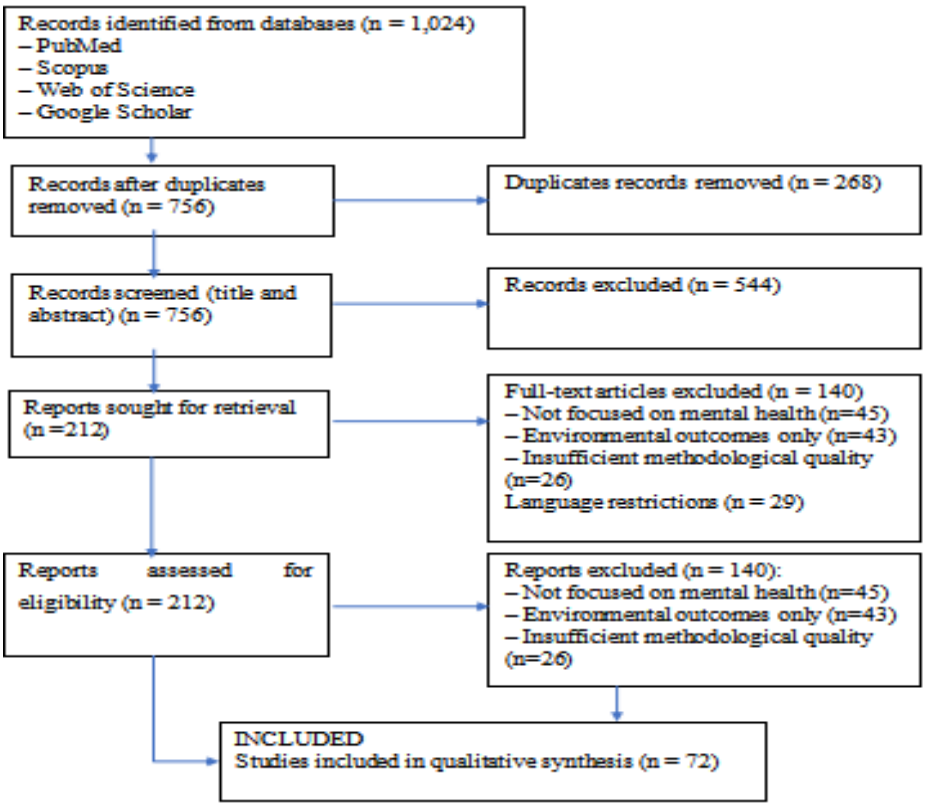

Figure 2. PRISMA 2020 flow diagram of the study selection process

3.2. Literature search strategy

Data were collected from multiple reputable academic and international sources, including PubMed, Scopus, Web of Science, Google Scholar, and reports from the World Health Organization (WHO), UN-Habitat, the European Environment Agency (EEA), and OECD. The search strategy combined keywords using Boolean operators: ("green space" OR "blue space" OR "urban nature") AND ("mental health" OR "well-being" OR "psychological health") AND ("digital technology" OR "virtual reality" OR "VR" OR "COVID-19" OR "social media").

The time frame for the review spans 2010–2024, reflecting the period of rapid digital technology development and major mental health fluctuations during the COVID-19 pandemic. This range ensures that the evidence is up to date and relevant, while capturing new trends in the human–nature–technology interaction.

3.3. Inclusion and exclusion criteria

The selection of literature was guided by clear criteria to ensure the relevance and quality of data sources. Studies included in this review met at least one of the following conditions: (1) quantitative, qualitative, or review studies that assess the impact of green or blue spaces on mental health; (2) studies related to digital technology, such as the use of virtual reality (VR), mobile applications, or digital platforms to enhance access to or experience of nature; and (3) policy reports published by reputable international organizations such as WHO, the European Union (EU), or the United Nations (UN). Conversely, sources were excluded if they lacked original data, were not peer-reviewed, or focused solely on ecological or environmental aspects without addressing mental health. Publications not available in English or Vietnamese were also excluded to ensure consistency in citation and data interpretation.

3.4. Screening procedure

The literature screening process was conducted in four systematic and transparent steps. (i) The research team initially identified 1,024 records from selected scientific databases. (ii) After removing duplicates, 756 unique studies remained. (iii) Screening based on titles and abstracts excluded irrelevant studies, leaving 212 with high relevance. (iv) Finally, 72 studies that met all criteria regarding topic, quality, and language were included for detailed analysis. The screening process was conducted systematically by the research team to ensure transparency and minimize bias. Two researchers independently conducted the screening process at the title/abstract and full-text stages. Discrepancies were resolved through discussion until consensus was reached. Given the conceptual and interdisciplinary nature of the topic, a narrative synthesis approach was adopted rather than a quantitative meta-analysis to accommodate methodological heterogeneity across studies.

3.5. Data analysis and coding

Data were analyzed using Content Analysis (CA) based on the guidelines by Luo (2023)[20]. The coding process was implemented in three stages: (i) In the open coding stage, key concepts were extracted directly from the studies, such as *stress reduction*, *anxiety alleviation*, *VR nature*, and *digital access to green spaces*. (ii) In the axial coding stage, related concepts were grouped into major themes, including: positive impacts, negative impacts, the role of technology, and policy recommendations. (iii) In the selective coding stage, these themes were synthesized into a theoretical model reflecting the "Technology–Nature–Mental Health" relationship. Although the coding stages resemble grounded theory procedures, they were applied within a qualitative content analysis framework to organize and synthesize themes rather than to inductively generate theory. The analysis of 72 studies revealed four major thematic groups:

1. Mental health benefits from nature exposure: Most studies reported positive outcomes such as reductions in stress, anxiety, and depression, along with improvements in happiness, social connectedness, and psychological restoration.
2. Challenges in the digital and urbanized context: Many studies identified reduced opportunities for nature contact, leading to "Nature Deficit Disorder (NDD)" and increasing mental health problems.
3. Digital technology as a substitute or complement: VR applications, mobile devices, and online platforms were viewed as tools enabling people to access or experience green spaces when direct exposure was limited.
4. Policy implications: Research emphasized the importance of integrating mental health perspectives into urban planning and leveraging digital technology to design, manage, and promote the values of green and blue spaces to enhance community well-being.

Table 1. Summary of Selected Recent Studies

Study	Method / Design	Participants	Key Findings
Green spaces exposure and the risk of common psychiatric disorders: A meta-analysis (2024) PubMed	Meta-analysis of cohort and cross-sectional studies	Participants of various age groups; NDVI index used to measure green coverage via GIS satellite data	Exposure to green spaces reduces the prevalence of common psychiatric disorders such as depression, anxiety, dementia, schizophrenia, and ADHD.
Green space exposure on depression and anxiety outcomes: A meta-analysis (2023) PubMed	Meta-analysis of observational studies	Diverse locations; measured by green area ratio and NDVI PubMed	A 10% increase in green space is associated with lower risk of depression; higher NDVI correlates with reduced depression. Results for anxiety

Study	Method / Design	Participants	Key Findings
			show a similar but weaker trend.
Effects of immersive virtual reality IVR in cardiac rehabilitation (Systematic review + meta-analysis) PubMed	Meta-analysis of randomized controlled trials (RCTs) combining IVR with cardiac rehabilitation programs	Older adults with cardiovascular conditions; IVR nature or relaxation environments; psychological state and stress measured pre- and post-intervention PubMed	IVR significantly reduces depression, anxiety, and stress; strongest effects when combined with traditional rehabilitation programs.
Virtual reality natural experiences for mental health: comparing the effects between different immersion levels (2024) SpringerLink	Experimental cluster trial comparing high vs. low immersion levels in nature-based VR	Healthy adults; compared VR headset immersion vs. smartphone 360° nature video SpringerLink	Both groups improved in mood and stress reduction, but the high-immersion VR group showed stronger effects.
Effects of School-led Greenspace Interventions on Mental, Physical and Social Wellbeing in Children and Adolescents: A Systematic Review (2024) SpringerLink	Systematic review following PRISMA guidelines; school-based interventions (nature walks, green playgrounds, outdoor learning)	Children and adolescents (ages 5–19); pre-post or quasi-experimental comparisons SpringerLink	Improvements in positive emotions, physical activity, and social interaction; some differences observed by gender.
Spatiotemporal variability of the association between greenspace exposure and depression in older adults in South Korea (2024) BioMed Central	Observational study with spatiotemporal analysis using multiple green metrics and time points	Adults aged 60+; data on green area, proximity, and various indicators over time and geography BioMed Central	The association between green space exposure and reduced depressive symptoms varies across space and time; not all measures are equally strong; frequency and quality of exposure matter.
Nature-based interventions for enhancing resilience in children: a systematic review and meta-analysis (2025) SpringerLink	Systematic review and meta-analysis of nature-based interventions promoting psychological resilience	Children; diverse nature-based interventions including outdoor nature experiences and environmental education SpringerLink	Nature-based interventions positively enhance resilience (psychological coping capacity); effects depend on frequency and intervention type.

Table 1. (*Continued*)

4. Research findings

4.1. Mental health benefits from exposure to green and blue spaces

Most studies synthesized in this review indicate significant positive effects of exposure to nature on mental health. Being in or near green and blue spaces such as trees, parks, rivers, or coastal areas is associated with lower levels of stress, anxiety, and depression, while enhancing positive emotions and psychological relaxation [21,22]. Notably, Shanahan et al. (2016) found that as little as 30 minutes of weekly exposure to nature could substantially reduce the risk of depression and improve life satisfaction. [23]. Beyond emotional well-being, green spaces also play a crucial role in fostering social connectedness and a sense of community belonging, thereby strengthening the social and psychological resources of urban residents [24].

> "Urban green spaces, such as parks, playgrounds, and residential greenery, can promote mental and physical health by providing psychological relaxation and stress alleviation, stimulating social cohesion" (World Health Organization, Regional Office for Europe, 2016, p. 12) [25].

> "Green and blue spaces such as parks and sports fields … form a refuge from noise. Green and blue spaces also are important to mental health. Having access to green and blue spaces can reduce health inequalities, improve well-being, and aid in treatment of mental illness." (World Health Organization, n.d., para. 4) [26].

Overall, these findings suggest that nature can serve as a "natural preventive medicine" that provides sustainable, low-cost, and powerful support for long-term community mental health.

4.2. Challenges in the context of urbanization and digital technology

Alongside these well-established benefits, many studies also point out that rapid urbanization and increasing dependence on digital technology are widening the gap between humans and nature. Accelerated urban growth has significantly reduced green space coverage, especially in rapidly developing Asian cities [27]. Meanwhile, excessive technology use including social media, online work, and digital entertainment has markedly diminished time spent outdoors, leading to what Louv (2008) described as "nature-deficit disorder"[28]. During the COVID-19 pandemic, social distancing and quarantine measures further limited opportunities for direct contact with nature, contributing to heightened feelings of loneliness, anxiety, and emotional exhaustion [29,30].Without proper urban planning and green space protection policies, humans risk becoming increasingly detached from the natural environment, resulting in a long-term decline in mental well-being in the digital age.

> "Exposure to green spaces is associated with various health benefits, especially for mental health, such as reduced stress and a lower risk of depression and anxiety"
>
> (Geary RS, Thompson DA, Garrett JK, et al) [31].

4.3. Digital technology as a complementary tool for nature connection

Although technology can reduce direct nature exposure, recent studies show that it can also serve as an effective means of reconnecting with the natural environment. For example, virtual reality (VR) nature exposure applications have been proven to reduce stress and improve mood, particularly benefiting older adults or individuals with limited mobility [32]. Supporting evidence from recent VR studies includes:

> "While direct contact with real-world nature remains optimal, digitally simulated and virtual nature experiences can serve as a meaningful alternative when in vivo exposure is not feasible" (White et al., 2021, p. 3002) [33].

> "All studies used a range of nature-based virtual environments, such as forests, islands, mountains, lakes, waterfalls, and most commonly, beaches to promote relaxation." (Browning et al., 2021, p. 8) [34].

> "Exposure to virtual natural environments effectively reduces anxiety levels stress levels and depression levels in healthy adults." (Bratman et al., 2019) [15].

Mobile applications and smart health sensors can monitor time spent in nature, encourage outdoor physical activity, and track changes in emotional well-being [35]. Social media platforms also indirectly promote nature engagement by enabling users to share images, experiences, and inspiration for outdoor exploration [36]. Hence, technology should not be viewed solely as a barrier but also as a "bridge" that broadens access to nature provided it is applied appropriately within public mental health strategies.

4.4. Policy and practical implications

International organizations such as WHO, along with large-scale projects like *BlueHealth* and *GreenUr*, have developed tools to integrate mental health considerations into urban planning and design [37,38]. Policy recommendations primarily emphasize three directions:

1. Integrated planning of green and blue spaces, ensuring equitable access for all populations while avoiding "green gentrification" (a process in which urban greening initiatives such as new parks, lakes, and eco-walkways raise property values and living costs, forcing low-income residents to relocate, thereby transforming "green" areas into spaces primarily for wealthier groups).
2. Enhanced monitoring and evaluation using quantitative tools such as *i-Tree* and *GreenUr*, enabling simultaneous assessment of environmental, social, and health impacts and extending these metrics to include mental health indicators.
3. Combining digital technology with smart urban planning, leveraging big data and digital platforms to monitor health behaviors, simulate green exposure, and promote healthy city models.

Overall, urban planning in the digital era should view green and blue spaces as a form of "health infrastructure," equal in importance to transportation, education, and healthcare systems. Equitable access is crucial, as emphasized. *"Equitable access to green and blue spaces is crucial for people whose access to nature has been restricted "* (World Health Organization, n.d., para. 5) [39].

Case Studies about International and Local Examples of Integrating Digital Technology and Green Spaces

(i) Singapore: Smart Park Model and User Experience Assessment

Singapore is one of the pioneering cities experimenting with "smart park" solutions by integrating environmental sensors, open-data platforms, and mobile applications to enhance park experiences and collect public-space usage data. Reports on Smart Parks highlight the potential of sensor networks to monitor air quality, noise levels, and visitor density, while also delivering health prompts or outdoor activity recommendations to users [40]. A recent pilot study also demonstrated techniques for assessing user perceptions of urban environmental quality using mixed methods supported by digital tools [41]. These digitally enabled interventions, when intentionally designed, can strengthen nature connectedness and foster healthier outdoor behaviors.

(ii) Japan: Virtual Reality (VR) Nature for Attention Restoration Among Urban Youth

Experiments examining the impact of "virtual nature" show that VR can serve as a bridge for attention restoration in urban environments with limited green space. Using ERP and behavioral tests, studies have demonstrated that short exposure to 360° natural scenes through mobile or VR devices reduces fatigued attention indicators (e.g., reduced P3a amplitude) and enhances perceived restorativeness [42]. Systematic reviews also indicate that VR-based restorative environments reduce stress and improve emotional states in adults and adolescents, particularly when designed to simulate meaningful natural experiences [43,44].

(iii) Copenhagen (Denmark): Participatory Digital Mapping for Green-Space Equity

In Copenhagen, research and practice have applied participatory digital mapping platforms (PPGIS) to document "meaningful places" identified by community members from small vegetation patches to micro-parks and used these inputs for planning decisions. This approach links spatial data (remote sensing/GIS) with

lived experiences, enabling community-driven nature-based solutions and improving equity in the distribution of investments for small urban parks [45].

Findings show that such methods promote resident engagement, leading to the revitalization of pocket parks and improved access for vulnerable populations.

(iv) Vietnam: Representative Local Initiatives (Da Nang and Related Studies). In Vietnam, several initiatives illustrate how green-space planning and digital tools can support public-health outcomes: Da Nang Green-Space System Planning: Landscape-ecological analyses of Da Nang propose a green-space network (green wedges, greenways) to mitigate urban heat-island effects and improve community health. These recommendations provide a technical foundation for linking central and peri-urban green corridors [46].

Intersectoral Collaboration and Participatory Systems Mapping: A recent project in Da Nang applied participatory systems mapping to connect sectors such as planning, health, and education. The findings clarified how "smart city" development interacts with public health, helping identify opportunities to expand green-space access for vulnerable groups [47]. Remote-Sensing Green-Space Assessment: Local studies using remote sensing have quantified green-space distribution across Da Nang, helping identify areas with critical green deficits and guiding investment priorities [48].

These Vietnamese cases demonstrate the potential of integrating spatial data (remote sensing), online/participatory tools, and cross-sector collaboration to position green spaces as health infrastructure serving local populations [46,48].

A synthesis of the case studies reveals a shared perspective on how technology, community engagement, and spatial data are shaping the future of urban green spaces. First, technology emerges as a factor that can either bridge or widen the gap between people and nature. When designed to be intuitive and aligned with natural user experiences, mobile applications, sensor systems, and virtual reality platforms have demonstrated their potential to strengthen human–nature connections and enhance psychological well-being [49,50]. In addition, the cases underscore the central role of community participation in ensuring equity within urban interventions. Participatory mapping platforms in Copenhagen and the participatory systems mapping approach used in Da Nang not only amplify residents' voices but also help clarify local priorities. As a result, decision-making processes become more transparent and lead to more equitable allocation of resources, particularly in areas that are often overlooked [51],[46].

Finally, spatial data plays a crucial role in enabling evidence-based decision-making. Remote sensing and environmental sensor systems applied in Singapore and Vietnam demonstrate how quantitative data can identify areas lacking green space, thereby guiding targeted improvements with greater precision and effectiveness [46],[40].

Box 1. Summary of Findings

Synthesized evidence from 72 studies demonstrates that nature has pronounced positive effects on mental health, reducing stress, anxiety, and depression. While urbanization and digital technology limit opportunities for nature contact, they also present new pathways through digital-assisted nature exposure. Integrating mental health into urban planning and digital innovation is key to promoting equity and sustainability in access to nature.

5. Discussion

5.1. The significance of green space exposure in the digital era

The findings reinforce evidence that green and blue spaces play a critical role in reducing stress and improving mental health. This is consistent with Attention Restoration Theory and Stress Reduction Theory, which propose that exposure to environments facilitates psychological restoration and emotional balance. [14],[16]. However, in the digital age, this relationship has become more complex as prolonged use of electronic devices limits opportunities for direct contact with nature.

5.2. Technology as an enhancer or a hindrance

Technology can serve as both an enabler and a barrier. On one hand, solutions such as VR simulations, outdoor mental health apps, and gamified well-being platforms have proven effective in replicating or even amplifying nature-based experiences. On the other hand, technological overuse fosters sedentary behavior and nature deprivation increasing risks of anxiety and depression [52]. This duality highlights the relevance of the Ecological Systems Theory, which emphasizes that individuals are influenced not only by their natural environment but also by technological and social contexts [17].

5.3. Interdisciplinary nature of interventions

Evidence underscores that integrating technology with green spaces can open new pathways for mental health care. The intersection between environmental psychology, digital health technology, and urban planning suggests a promising interdisciplinary intervention mode - applicable to both individual therapy (e.g., mindfulness-in-nature applications) and community-level strategies (e.g., "healing city" design frameworks).

5.4. Inequality and practical challenges

A striking finding is the persistence of inequalities in access to both green spaces and technology. Disadvantaged populations often reside in urban areas with limited greenery and also have reduced access to advanced technologies, resulting in a "double deficit" in mental health. Thus, policy responses must address both the green gap and the digital divide simultaneously to ensure health equity.

5.5. Directions for future research

Despite encouraging evidence, current studies lack long-term experimental designs that compare the effects of direct versus digitally mediated nature exposure. Further research is needed in Asian contexts where urbanization and technological pressures are intense to generate culturally and contextually relevant policy insights.

5.6. Limitations

This review has several limitations. First, the included studies vary considerably in design, measurement, and population, limiting causal inference. Second, heterogeneity across socio-cultural contexts may affect generalizability. Third, as a narrative synthesis, this study does not quantify pooled effect sizes. Therefore, policy implications should be interpreted as informed guidance rather than definitive causal conclusions.

6. Conclusion and recommendations

6.1. Conclusion

This study highlights the crucial role of green and blue spaces in maintaining and enhancing mental health, particularly in the digital era. Synthesized evidence consistently demonstrates that exposure to natural environments, whether direct or digitally mediated, reduces stress, anxiety, and depressive symptoms while strengthening emotional regulation and social connectedness. Yet technology introduces a paradox: it

simultaneously enables and undermines contact with nature. Rather than viewing this relationship as contradictory, the findings suggest the need for an integrated eco-social framework that balances digital innovation with sustained real-world engagement with natural environments.

6.2. Recommendations

6.2.1. Policy and Urban Planning Level

Position green and blue spaces as health infrastructure: Cities should treat parks, lakes, and community gardens as *health infrastructure* rather than mere landscape elements, thereby reducing inequalities in nature access, especially for vulnerable groups [53,54]. Ensure equitable access: Establish minimum distance criteria from residential areas to green spaces (e.g., 300 meters, as recommended by WHO) to guarantee universal access to the benefits of natural environments [55].

Leverage digital technologies for environmental governance: GIS, satellite imagery, and AI can support the assessment of green density, air quality, and health impacts to inform effective policy decisions [56].

6.2.2. Community and School Level

Encourage outdoor activities: Educational programs should increase physical and experiential outdoor learning to balance digital screen time [57].

Develop "green community" models: Support initiatives such as community gardens and shared green spaces to enhance social cohesion and prevent mental health problems [58].

Promote awareness campaigns: Implement public health communication about the mental health benefits of nature, while integrating guidance on responsible digital use, including periodic digital breaks to reduce psychological strain.

6.2.3. Individual Level

Practice digital detox with nature: Individuals can schedule device-free periods to walk, exercise, or simply relax under trees or near water. Interventions combining reduced digital engagement with outdoor activity have been shown to reduce stress and anxiety and improve psychological well-being [59,60].

Structured digital detox strategies, when combined with nature exposure, appear to produce more sustained mental health benefits [61], and exposure to natural environments further contributes to anxiety alleviation and mood improvements [62]. Use technology positively: Utilize health-tracking apps to monitor outdoor activity or VR/AR experiences when direct contact with nature is not possible [63]. Adopt proactive mental self-care: Combine deep breathing, meditation, and walking in green environments to strengthen psychological balance in a digitalized lifestyle [64].

In the digital age, green and blue spaces should be understood not merely as environmental amenities but as strategic public health assets. Integrating ecological planning, community engagement, and individual behavioral change offers a balanced pathway to align technological advancement with long-term psychological resilience.

Author Contributions

Conceptualization, Lam Thi Le; Methodology and Data analysis, Thuy Nga Le Thi; Writing original draft, Dieu Thi Thanh Bui and Lam Thi Le; Writing review & editing, Bach Xuan Tran. All authors have read and approved the final manuscript.

Funding

This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 504.05-2023.19

Conflict of interest

The authors declare no conflict of interest

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