Mental health intervention to address climate anxiety in adolescents: a systematic review

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Abstract

Purpose: This study aims to identify and analyze interventions implemented to address the impact of climate change on adolescents' mental health. **Methods:** This systematic review was conducted using PRISMA guidelines. A literature search was conducted across four primary databases — PubMed, ScienceDirect, EBSCO, and Scopus —with keywords related to interventions, climate change, and adolescent mental health. Inclusion criteria include studies involving adolescents aged 10-18 years and featuring an original research design published within the last five years. Of the 1,579 studies identified, 22 articles were assessed for eligibility, and seven underwent quantitative synthesis. **Results:** Suggest that effective environmental education interventions can increase understanding and reduce anxiety among adolescents. **Conclusion:** To address the impacts of mental health on adolescents, interventions such as pro-environmental interventions, education, and augmented reality can be employed.

Keywords: adolescent health; climate change; climate anxiety; interventions; mental health

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INTRODUCTION

Climate change is a phenomenon that refers to long-term alterations in Earth's average temperatures and weather patterns. It occurs at both global and regional levels and may be influenced by both human activities and natural processes [1]. Data indicate that the rate of average warming has increased by approximately 2ºC per decade over the past century. This rate is three times faster than in previous periods, making the years 2014–2023 the warmest on record [2]. According to the World Health Organization (WHO), climate-related diseases such as diarrhea, malaria, heat stroke, and malnutrition are expected to cause over 250,000 deaths annually between 2030 and 2050 [3].

Climate change contributes to emotional distress, anxiety, depression, and stress, either through direct experiences of natural disasters such as floods, wild-fires, and storms, or indirectly through economic uncertainty and loss of livelihood. This is supported by de Bont et al. [4], who found that extreme heat significantly increases mental illness-related morbidity and mortality. A systematic review and meta-analysis by Liu et al. [5] concluded that a 1ºC increase in temperature correlates with higher rates of mental health disorders such as anxiety, mood disorders, organic mental disorders, schizophrenia, and neurotic disorders. Furthermore, extreme weather events are associated with increased trauma-related mental health conditions [6]. Even without direct exposure to climate disasters, many individuals experience anxiety and fear about the future due to climate change, commonly referred to as climate anxiety.

Climate anxiety first gained attention in the early 2000s but only received serious consideration in the medical and psychological communities in the 2010s.

The term gained prominence after the American Psychological Association (APA) and The Lancet published reports on the mental health impacts of climate change (2017–2020). Clayton et al. [7] were among the first to identify climate anxiety as a psychological response to environmental crises in their report, "Mental Health and Our Changing Climate." Since then, a growing body of literature has focused on interventions such as nature-based therapy (eco-therapy) [8], climate education [9], and community-based approaches to enhance mental resilience [10]. Climate anxiety is a rational response to the reality of climate change. While not classified as a medical diagnosis, it warrants serious attention due to its tangible impact on mental health, particularly among younger generations.

Climate change is not only transforming the planet but also reshaping the lives of children and adolescents [11]. Nearly half of the world's children live in countries at extremely high risk of exposure to climate and environmental hazards. UNICEF estimates that 1 billion children worldwide are at very high risk of climate change impacts, with 850 million living in areas facing multiple overlapping climate-related threats. Children and adolescents are particularly vulnerable due to their physical and cognitive immaturity, making them highly susceptible to adverse impacts on brain development, lung function, immune systems, and overall health [12,13].

Adolescents have limited capacity to avoid or adapt to the threats and impacts of climate change [14]. Their adaptation processes differ from those of adults due to increased susceptibility to air pollution, non-communicable diseases, and extreme weather conditions [15]. Maladaptive psychological responses to climate awareness and its impacts may impair an individual's ability to function effectively [13]. Thus, climate change poses a serious threat to younger generations, directly affecting their fundamental rights to health and well-being.

Despite increasing recognition of climate change as a determinant of health, research on its specific impact on adolescent mental health remains relatively scarce and fragmented [16]. Previous studies have predominantly focused on general populations, disaster-related trauma, or physical health outcomes, with limited exploration of targeted interventions for adolescents as a vulnerable group. Moreover, there remains a lack of systematic synthesis that identifies which strategies are most effective in building mental resilience and reducing climate anxiety among young people.

This study aims to fill this gap by systematically reviewing, identifying, and analyzing interventions implemented to mitigate the mental health impacts of climate change on adolescents. By highlighting effective strategies and intervention models, this review aims to provide evidence-based insights that inform the development of tailored health programs and policies, thereby better supporting adolescent mental health in the face of future climate challenges.

METHODS

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [17]. The PICO framework was used to guide the search for relevant literature by defining keywords that facilitated database queries. The format used in this study is presented in Table 1.

Table 1. Literature search strategy using the PICO framework

PICO	Keywords	
P (patient/ population/ problem)	Adolescents	(((((Adolescent) AND (Climate Change)) OR (Global Warming)) AND (intervention)) AND (mental health)
I (intervention/ prognostic factor/ exposure)	Climate change	
C (comparison/ control)	-	
O (outcome)	Mental health intervention	

Searches were conducted across four major databases to identify relevant studies: PubMed, Scopus, ScienceDirect, and EBSCO. All databases were accessed digitally through the University of Indonesia Library portal. Articles retrieved through database searches were screened for eligibility using predefined inclusion and exclusion criteria. The inclusion criteria are participants aged 10–25 years, community-based interventions focused on mental health, and articles published between 2020 and 2025. Exclusion criteria include articles focusing on natural disasters induced by climate change (e.g., earthquakes, landslides), articles on terrorism, literature reviews, systematic reviews, and articles not written in English. Rayyan software was used for screening articles.

Three reviewers (KDC, IPS, and HP) independently screened titles, abstracts, and keywords for inclusion criteria, after removing duplicates. Full-text screening was then conducted. Discrepancies in the selection process were resolved through consultation with a fourth reviewer (SM). Data extraction was performed using a predefined extraction table comprising the following fields: author/year, city/country, design, sample, intervention measures, primary outcome, and outcome.

Study quality was critically assessed using the Joanna Briggs Institute (JBI) critical appraisal tool and its level of analysis (Table 2). Checklists for cross-sectional, mixed-method, quasi-experimental, and randomized controlled trials were used to assess the included studies. There were nine quasi-experimental checklist questions and 13 randomized controlled trial checklist questions, each with answer options: yes, no, unclear, and not applicable. Yes answers were given a score of 1, while no, unclear, and not applicable answers were given a score of 0. Studies were classified as good if the total score was >80%, fair if 50-80%, and poor if <50% [18].

This research review was unable to conduct a meta-analysis of mental health interventions due to heterogeneity in methods and the statistical value of study results. Therefore, a narrative synthesis was performed. The characteristics of the studies, the impact of climate change, and the interventions, measures, and prevention strategies for mental health problems are essential for a thorough understanding and analysis of the results. The narrative analysis step was conducted based on nine items of synthesis reporting without meta-analysis of systematic reviews [19].

Table 2. Data analysis

Author (years)	Research design	Critical appraisal
Benoit et al. (2025)	RCT	Strong
Abrham et al. (2023)	RCT	Strong
Fein et al. (2023)	Quasi-experimental	Strong
Kennes et al. (2024)	Quasi-experimental	Strong
Mittmann et al. (2022)	Mix method	Strong
Trott (2021)	Mix method	Strong
Qin et al.(2024)	Cross Sectional	Strong

RESULTS

A total of 1,576 studies were identified across four databases using the predefined search terms. Additionally, the researcher examined further records obtained from reference lists (Figure 1). In total, the initial screening process yielded 1,579 studies. After duplicates were removed, 21 full-text articles were screened for eligibility. Of these, 13 articles were excluded for non-matching populations, and one was excluded due to an irrelevant title. Ultimately, 22 articles were assessed for eligibility, of which seven studies were included in the quantitative synthesis. The following presents the results of a literature search that analyzes and classifies relevant studies on interventions addressing the impacts of climate change on mental health. A summary of the findings is presented in Figure 1.

The findings summarized in Table 3 reveal that interventions addressing adolescent mental health in the context of climate change are highly diverse. Short-term educational approaches, such as brief video exposure or single-session teaching, were effective in enhancing adolescents' knowledge and hope, but showed limited impact on reducing anxiety or promoting long-term behavioral change [20,21]. These results align with previous literature suggesting that knowledge alone is insufficient to alter behavior without the support of psychological and social mechanisms.

Psychologically based interventions, such as mindfulness and strength-based approaches, yielded more potent effects on emotional well-being and the reduction of negative emotions [22]. The strength of these approaches lies in their capacity to foster adolescents' internal emotion regulation, a crucial skill for managing climate-related anxiety. However, these interventions often require significant resources, trained facilitators, and institutional support, which may pose challenges in low-resource settings.

Community- and technology-based interventions played a crucial role in reducing stigma, promoting peer support, and fostering a sense of belonging. Programs such as Bring Change 2 Mind and the LINA Augmented Reality Game demonstrated effectiveness in facilitating social interaction and providing safe spaces for adolescents to address mental health and climate-related concerns [23,24]. Despite these benefits, sustainability and scalability remain significant challenges, particularly given the high infrastructure requirements and development costs. Family- and community-centered interventions underscore the importance of social dimensions in climate change adaptation. By positioning children as agents of change, such interventions not only improved individual well-being but also had a positive impact on families and communities [25]. This suggests broader potential to strengthen community resilience, though long-term effectiveness depends heavily on multisectoral collaboration and supportive policies.

Highlighted the crucial moderating role of environmental self-efficacy, future interventions should focus not only on knowledge transfer or anxiety reduction, but also on building adolescents' confidence in their ability to address climate challenges [26]. This is essential given that climate anxiety, if unmanaged, may hinder pro-environmental behavior. Multidimensional interventions that integrate educational, psychological, social, and community-based approaches are the most promising strategies for supporting adolescent mental health while simultaneously fostering their active engagement in sustainable climate action.
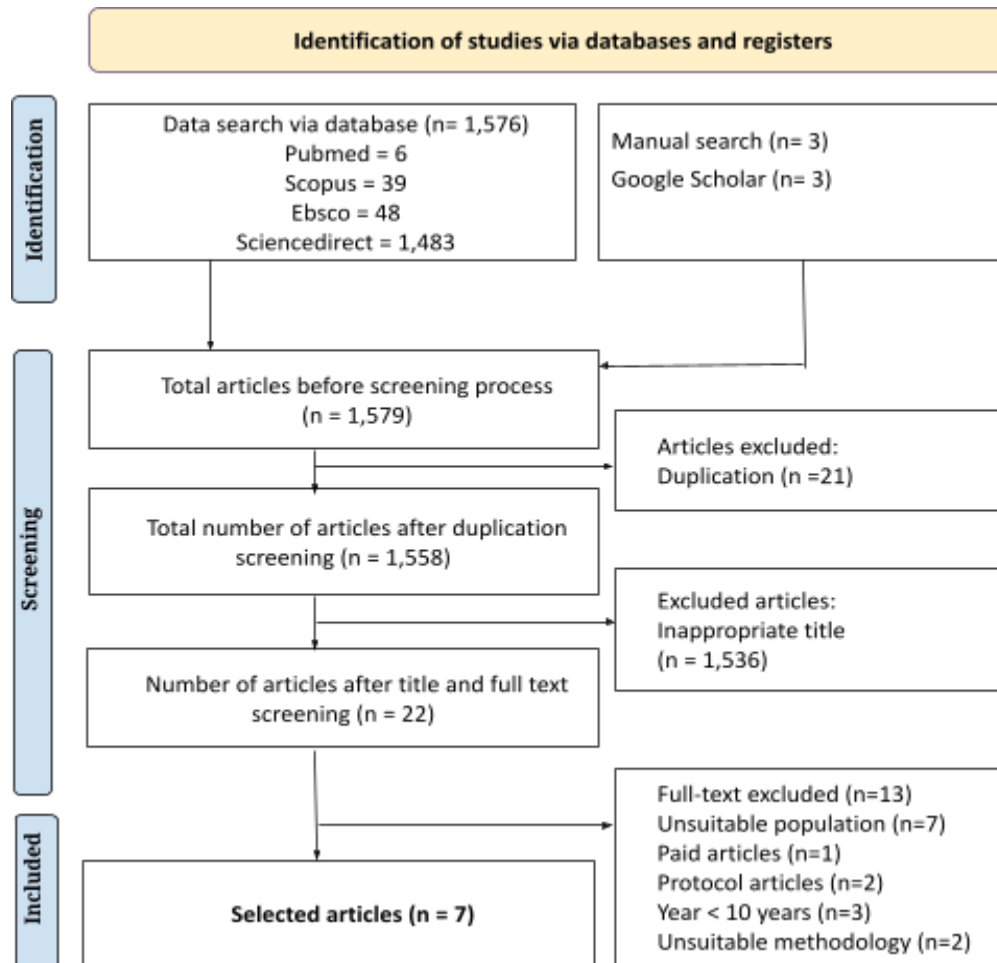
Figure 1. PRISMA literature search results

Table 4. Categorization of articles addressing intervention climate change-related mental health in adolescents

Topic Category	Number of Articles	Authors
Climate change and environmental interventions	3	[20,21,25]
Technology-based mental health	1	[24]
Peer-led school programs	2	[22,23]
Correlational studies on health and the environment	1	[26]

As presented in Table 4, the reviewed articles addressing interventions for climate change-related mental health in adolescents can be categorized into four main themes. The first category, climate change and environmental interventions, comprises three studies that emphasize educational programs and environmental initiatives aimed at enhancing the knowledge, understanding, and engagement of children and adolescents in climate action and adaptation efforts [20,21,25].

The second category comprises a single article on technology-based mental health, highlighting the use of augmented reality to enhance adolescents' mental health by fostering social interaction, a sense of belonging, and psychosocial support [24]. The third category, peer-led school programs, is represented by two studies that focus on school-based and peer-supported initiatives aimed at reducing mental health stigma and promoting prosocial behaviors [23,24].

Lastly, one article belongs to the category of correlational studies on health and the environment, which investigates the relationship between climate anxiety, pro-environmental behavior, and the mediating or moderating roles of psychosocial factors [26]. Overall, this categorization demonstrates that interventions targeting adolescents encompass educational, psychological, technological, and peer-based approaches, while also drawing on correlational evidence to understand the complex link between climate change and mental health.

Table 3. Summary of intervention addressing climate change-related mental health in adolescents

Title, Author (Year), Country	Research design	Population/ participants	Sample size	Research methodology	Outcome measured	Main findings
Climate change hopefulness, anxiety, and behavioral intentions among adolescents: a randomized controlled trial of a brief "selfie" video intervention Benoit et al. (2025) [20] United States	RCT	Adolescents aged 14 to 18 years	Video intervention: 313 Control: 311 Positive: 308	Watching a 110-second video of adolescents with positive, negative, and neutral attitudes toward climate change issues.	Climate change hope, climate change anxiety, and behavioral intentions.	A brief video-based intervention increased hope related to climate change. However, it did not directly affect anxiety and pro-environmental behavior.
Effect of a single one-hour teaching session about environmental pollutants and climate change on the understanding and behavioral choices of adolescents: The BREATHE pilot randomized controlled trial Abrham et al. (2023) [21] California	RCT	Secondary school students aged 13 - 15	504	Intervention by developing short teaching sessions on air pollution and climate change.	Understanding and behavior about air pollution and climate change.	A brief teaching intervention can promote environmentally friendly behavior in adolescents.
Effects of a Mindfulness-Based Strengths Intervention on Adolescent Mental Health are Mediated by Change in Negative Emotions Kennes et al. (2024) [22] Netherlands	Quasi-experimental	Adolescents aged 13 and 15 years	Intervention n= 70 Control = 236	Mindfulness-based positive psychology program utilizing self-strengths.	Measures of well-being, positive and negative emotions.	Positive interventions based on mindfulness and the use of externalities are effective in reducing negative emotions, leading to improved well-being and a reduction in social problems among adolescents.
Encouraging "Positive Views" of Mental Illness in High Schools: An Evaluation of Bring Change 2 Mind Youth Engagement Clubs Fein et al. (2023) [23] United States	Quasi-experimental and qualitative	Adolescents aged 10-18 years	Survey: 2,071 respondents FGDs and interviews: 26 of 65 participating club members. All seven club staff.	Pre-post survey to measure the level of engagement with Bring Change 2 Mind (BC2M), stigma towards mental illness, and help-seeking attitude. FGDs and interviews were conducted to identify the club's mechanisms for reducing stigma.	Percentage of non-member students engaged with BC2M activities—level of stigma towards mental illness among angora and members. Further looking at the relationship between stigma and comfort seeking help, as well as factors identified as ways the club can reduce stigma.	BC2M clubs are effective at reducing mental ill health among members and improving help-seeking attitudes. A combined approach is needed to make BC2M an effective strategy in schools.

Title, Author (Year), Country	Research design	Population/ participants	Sample size	Research methodology	Outcome measured	Main findings
LINA - A Social Augmented Reality Game around Mental Health, Supporting Real-world Connection and Sense of Belonging for Early Adolescents Mittmann et al. (2022) [24] No explicit information on which country the study was conducted in	Mixed-method	Adolescents aged 10-12 years	91	Development of a multidisciplinary collaboration between psychologists, software developers, playwrights, and artists with a co-development process involving adolescents. The intervention takes the form of an augmented reality (AR) game that invites students to solve the mystery of LINA's missing bacteria, utilizing classroom exploration and virtual artifacts.	Usability, usage satisfaction, initial efficacy, acceptance, and user experience.	High satisfaction, positive adolescent acceptance, increased social interaction, strengthened sense of belonging, safe space to discuss mental health, family stress, stigma, and bullying. The use of AR and collaborative immersive narratives in the classroom, alongside teachers and friends, can increase adolescents' interest in digital technology to strengthen real-world social connections.
Youth-Led Climate Change Action: Multi-Level Effects on Children, Families, and Communities Trott (2021) [25] United States	Mix-method	Children aged 10 to 12 years	55	The action-focused climate change education (CCE) program Science, Camera, Action! (SCA) lasts for one hour each week and takes place 15 times. Activities included climate change initiatives, photovoice, participatory action research (PAR) methods, and youth-led climate action projects, aiming to position children as agents of change within the context of their family and community.	Increase children's engagement in climate protection actions to reduce energy waste, and encourage them to become more physically active by spending more time outdoors rather than playing with electronics. Additionally, children model climate change knowledge and actions that inspire their friends and family, and influence the school and community environment.	Climate change education is not only effective for children's mental and physical health, but also has an impact on children's peer and intergenerational relationships.
The relationship between climate change anxiety and pro-environmental behavior in adolescents: the mediating role of future self-continuity and the moderating role of green self-efficacy Qin et al. 2024 [26] China	Crossectional	Middle and high school students (12-17 years old)	1,900	Looking at the relationship between climate anxiety and pro-environmental behavior in adolescents.	Anxiety about climate change can reduce an individual's motivation to engage in pro-environmental behavior.	Environmental self-efficacy plays a vital role in balancing the relationship between future survival and pro-environmental behavior among school students.

DISCUSSION

The relationship between mental health and the environment, particularly in the context of climate anxiety and pro-environmental behavior, appears to be moderated by self-efficacy. Adolescents with high levels of self-efficacy tend to manage climate-related anxiety more effectively and demonstrate greater hope and motivation to engage in environmental action. This finding is consistent with that of Seker et al. [27], who reported that adolescents who believe in the effectiveness of their actions are more likely to experience environmental distress but also show increased engagement in pro-environmental behaviors. Self-efficacy has been identified as a strong predictor of environmentally responsible behaviors, such as recycling and energy conservation [28,29].

However, these findings contrast with those of Hickman et al. [30], who found that even adolescents with high self-efficacy continue to experience elevated levels of climate anxiety, mainly due to perceived lack of governmental and institutional support [31]. Supporting this, studies conducted in Germany and Canada have shown that self-efficacy does not necessarily alleviate climate anxiety, especially among adolescents who perceive climate change as an overwhelming issue that cannot be addressed individually [32]. Thus, high self-efficacy does not always translate into pro-environmental behavior when significant external barriers such as limited access, insufficient family or school support, and inadequate policies are present. Consequently, interventions that integrate self-efficacy enhancement with collective action and institutional support are considered more effective at reducing climate anxiety and promoting sustainable behavior.

Short-term environmental education interventions are effective in enhancing adolescents' awareness and understanding of environmental issues, ultimately encouraging them to adopt more environmentally responsible behaviors. The findings of Zhao et al support this [33], who reported that short-term, nature-based environmental education programs conducted outside the classroom significantly improved students' pro-environmental behaviors, including waste sorting, active participation in environmental protection, advocacy, and engagement in conservation activities.

In addition, direct interaction with nature has been found to reduce stress levels and enhance psychological well-being [34]. Outdoor activities such as gardening or visiting parks can foster a stronger sense of connection to nature and help alleviate anxiety among adolescents. However, such interventions must be culturally adapted, as the emotional and psychological effects of nature-based experiences may vary depending on individuals' cultural and social backgrounds [35].

Short-term environmental education interventions —whether conducted in classroom settings or through outdoor experiential activities—have been found to increase adolescents' awareness and knowledge of environmental issues, thereby encouraging more environmentally responsible behaviors in their daily lives [36]. However, while ecological education can effectively raise awareness and understanding, several studies have noted that single, short-term interventions often fail to produce long-term behavioral change. The effectiveness of such interventions depends primarily on integrating structural policy support, multidisciplinary strategies, and continuous long-term evaluation [28,37]. Thus, a more effective approach would combine environmental education with social engagement, ongoing monitoring, and skill-based training while also taking into account cultural values and addressing local barriers such as limited access to technology.

In parallel, technology-based mental health interventions, including computerized cognitive-behavioral therapy (CCBT) and augmented reality (AR) games, have shown potential to enhance adolescents' psychological well-being and foster positive emotional states. A systematic review by Fernández-Batanero et al. [38] highlights the potential of digital platforms and applications in supporting the mental health of children and adolescents.

Digital programs grounded in cognitive-behavioral therapy, whether game- or web-based, have shown effectiveness in helping adolescents regulate emotions, build resilience, and improve both social and academic functioning [39]. Moreover, CBT-based games have been associated with improvements in mood, quality of life, and user satisfaction, with sustained effects lasting several months after the intervention. AR games, in particular, have demonstrated a multifaceted impact by enhancing emotional well-being, social skills, and cognitive function in adolescents, including those with special needs such as ADHD and autism. Furthermore, AR technologies have proven effective in promoting physical activity, reducing anxiety, and offering more immersive and interactive learning experiences [40].

The integration of gamification, robust monitoring, and peer mentoring has been shown to enhance both user engagement and the overall effectiveness of digital mental health interventions [41]. More substantial and sustained positive outcomes can be achieved when these interventions are grounded in traditional psychological frameworks and supported by parental involvement. Nonetheless, several challenges must be

addressed to ensure successful implementation. These include unequal access to technology, resistance or limited acceptance among mental health professionals, and concerns regarding user privacy and data security. For some adolescents, the effectiveness of digital interventions may be diminished by limited emotional maturity or low intrinsic motivation, leading to sub-optimal outcomes [42]. Additionally, some users have reported adverse effects from prolonged use of augmented reality (AR), including fatigue, cyber-sickness, and boredom [40]. Although technology-based mental health interventions, such as computerized cognitive behavioral therapy (CCBT) and AR games, have shown promise in enhancing psychological well-being and fostering positive emotions among adolescents, their effectiveness is not consistently demonstrated. Variability in design quality, lack of systematic support, and challenges in sustaining long-term engagement highlight the need for cautious implementation and further research to optimize their impact in adolescent populations.

Participatory school-based programs, particularly those led by peers, have demonstrated effectiveness in reducing mental health stigma among adolescents. Peer-led interventions have been shown to significantly reduce stigma and enhance mental health literacy, particularly when delivered intensively over one week and followed by ongoing engagement over a period of three to twelve months [43,44]. Studies conducted in Australia and the United Kingdom further suggest that peer support groups can foster empathy, reduce feelings of shame, and strengthen social networks, thereby contributing to improved psychological well-being in adolescents [45,46].

In addition to general mental health benefits, peer-based programs have also been effective in addressing climate-related psychological challenges. Arnot et al. [47] found that young people in Australia who participated in peer-led climate action groups reported reductions in climate anxiety, attributing these improvements to increased feelings of control, solidarity, and hope. Similarly, peer-led interventions that focus on teaching adaptive coping strategies and building resilience have been shown to alleviate anxiety related to global crises, including climate change, in adolescent populations across various European and Asian contexts [48].

However, the impact of peer-led interventions on reducing stigma tends to vary and often diminishes over time without sustained support from both the school and family environments [43]. Research conducted in Canada and Germany suggests that peer-led programs lacking structured frameworks and specialized training are less effective in addressing climate-related anxiety, particularly when participants perceive themselves as having limited agency or influence over climate issues [49,50]. Therefore, while peer-led programs have shown promise in enhancing adolescent mental health and mitigating anxiety related to climate change, their effectiveness is significantly improved when they are well-structured, supported by comprehensive training, and supervised by professionals [51].

This study highlights several critical social impacts, particularly concerning adolescent mental health in the context of climate change. The findings suggest that environmental education, digital-based interventions, and peer-led programs not only benefit adolescents at the individual level but also strengthen social solidarity, enhance ecological literacy, and foster a more open culture around mental health among young people. By increasing awareness and adolescent engagement in environmental issues, these interventions can cultivate social change agents who can promote pro-environmental behavior within the broader community.

Moreover, the integration of digital mental health interventions expands access to psychological support, particularly for adolescents who face barriers in reaching conventional services. This contributes to greater social inclusion and community preparedness in addressing psychosocial risks associated with climate change. However, disparities in access to technology may exacerbate existing social inequalities, emphasizing the need for inclusive and equitable policies to accompany digital-based strategies.

A key limitation of the current study is its short-term scope and the absence of follow-up assessments, which restricts the ability to conclude long-term outcomes. Nonetheless, these limitations do not diminish the relevance or value of the findings; instead, they underscore the importance of conducting future research employing longitudinal designs and context-specific approaches to validate and expand upon the current results, and to inform more robust policy recommendations.

CONCLUSION

Pro-environmental interventions represent a holistic approach to addressing the challenges of climate change. The integration of education, technology, climate mitigation policies, and psychological support can lead to more effective and sustainable solutions. Long-term evaluations of the impacts of environmental education on pro-environmental behavior are necessary to assess the broader effectiveness of such interventions. This study offers valuable insights into how education can shape long-term sustainable beha-

vior and inform policies that strengthen climate mitigation efforts. Additionally, community-based approaches to adolescent mental health support require further exploration to identify effective strategies for promoting psychological well-being amid a global crisis.

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