International Journal of Research in Medical Sciences
Joseph A et al. Int J Res Med Sci. 2026 Apr;14(4):1750-1758
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20260998

Review Article

The nexus of mental health, climate change and artificial intelligence: a narrative review of emerging evidence and clinical implications

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Received: 08 February 2026
Revised: 11 March 2026
Accepted: 23 March 2026

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ABSTRACT

Climate change has emerged as a major global determinant of mental health, contributing to a growing burden of psychological distress. Concurrently, artificial intelligence (AI) offers novel approaches to enhance mental health assessment, monitoring, and intervention, particularly in contexts where access to care is limited. This narrative review synthesizes current evidence on the mental health impacts of climate change and critically examines the potential role of AI-driven technologies in addressing climate-related psychological disorders. A comprehensive narrative review of peer-reviewed literature published between 2015 and 2025 was conducted using major academic databases. Relevant studies addressing climate-related mental health outcomes and AI applications in mental healthcare were analysed thematically. Four key themes were identified: direct and indirect mental health consequences of climate change, including eco-anxiety, depression, and climate-related post-traumatic stress disorder; emerging AI applications in mental health, such as machine learning–based neuroimaging, digital phenotyping using wearable biosensors, and conversational AI platforms; implementation challenges, including algorithmic bias, data privacy and ethical concerns, and digital inequities; and pathways for integrating climate-sensitive, AI-supported mental health interventions into healthcare systems, particularly in vulnerable populations within low- and middle-income countries such as India. Interdisciplinary collaboration among climate scientists, mental health professionals, and digital health innovators is essential to develop equitable, culturally sensitive, and evidence-based interventions. Future research should prioritize longitudinal studies, bias-mitigation strategies in AI systems, and policy frameworks linking climate adaptation with mental health resilience.

Keywords: Climate change, Mental health, Artificial intelligence, Eco-anxiety, Digital health, Psychoterratic syndromes, Machine learning, Wearable sensors

INTRODUCTION

Mental health constitutes a critical pillar of global health security, yet remains profoundly under addressed in climate change discourse and policy frameworks.[1] Climate change operates as a potent psychological stressor through multiple direct and indirect pathways, including acute traumatic exposure from extreme weather events, chronic environmental degradation, climate-induced migration and economic displacement, and anticipatory anxiety regarding future climate impacts.[2-4] The World Health Organization has identified climate change as one of the most pressing threats to mental health in the twenty-first century.[1] Simultaneously, artificial intelligence (AI) technologies are revolutionizing mental health assessment and treatment by enabling scalable, objective, and real-time monitoring of psychological states through digital phenotyping and machine learning approaches.[5,6] This convergence of escalating climate-related psychological burden and rapid AI innovation presents both unprecedented opportunities and significant ethical, clinical, and equity-related risks requiring urgent

interdisciplinary attention. India represents a context of heightened vulnerability to climate-related mental health impacts due to rapid urbanization, high population density, reliance on climate-sensitive agricultural sectors, and limited mental health infrastructure.[7-9] The frequency and intensity of extreme weather events—including heatwaves, floods, cyclones, and droughts—have increased substantially, disproportionately affecting rural populations, women, children, older adults, and socioeconomically marginalized communities.[7,10-12] Concurrently, India's expanding digital health ecosystem and adoption of tele-mental health platforms offer potential pathways to extend mental health services to underserved regions, though significant challenges related to equity, access, and ethical governance persist.[13,14] This review synthesizes contemporary evidence on the mental health consequences of climate change and critically examines the potential and limitations of AI-enabled mental health applications, with particular emphasis on implementation in low-resource and climate-vulnerable settings. Conceptual framework flowchart is shown in Figure 1.

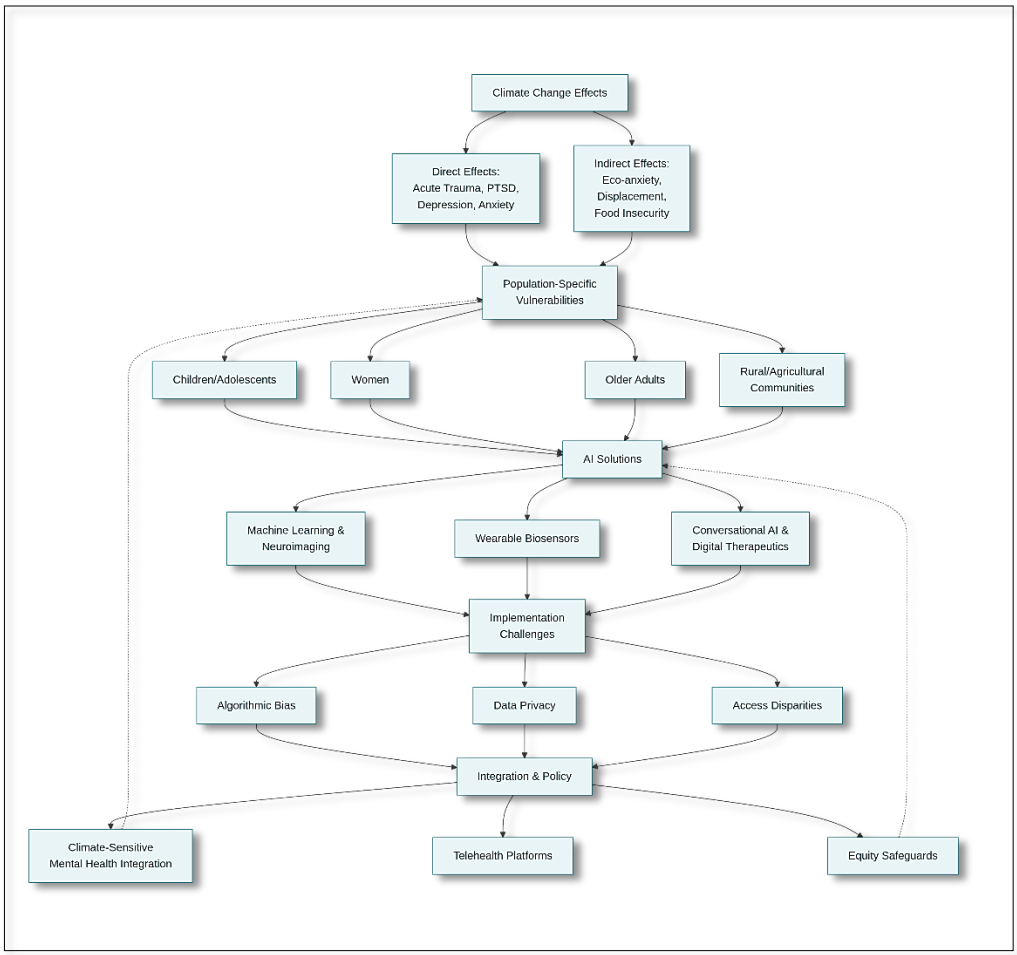

Figure 1: Conceptual framework: integrating climate change, mental health, and artificial intelligence.

METHODS

Study design and search strategy

This narrative review followed established guidelines for narrative review methodology, including transparent description of literature search and study selection processes. A comprehensive search of peer-reviewed literature was conducted using PubMed, Google Scholar, PsycINFO, and Web of Science databases covering the period January 2015 to December 2025. Search terms combined keywords related to climate change ("climate change," "environmental stressor," "extreme weather," "climate disaster"), mental health ("mental health," "psychological distress," "eco-anxiety," "climate anxiety," "PTSD," "depression"), and artificial intelligence ("artificial intelligence," "machine learning," "digital health," "digital phenotyping," "wearable sensors," "conversational AI").

Inclusion and exclusion criteria

Studies were included if they: presented empirical data or evidence-based frameworks; addressed climate-related mental health impacts, AI applications in psychiatric care, or both; were published in English in peer-reviewed

journals, book chapters, or institutional reports; and focused on populations in low- and middle-income countries or were relevant to South Asian contexts. Studies were excluded if they were opinion pieces lacking empirical evidence, editorials, or duplicate publications.

Thematic analysis framework

Included studies were analysed using thematic synthesis. Four major themes were identified iteratively through multiple readings: direct and indirect mechanisms linking climate change to mental health; current and emerging AI applications in mental health assessment and treatment; implementation challenges and barriers; and policy and clinical integration pathways. This approach aligns with scale for assessment of narrative review articles (SANRA) reporting standards for transparent narrative review methodology.

MENTAL HEALTH CONSEQUENCES OF CLIMATE CHANGE: EPIDEMIOLOGY AND MECHANISMS

Direct effects: acute traumatic exposure

Extreme weather events constitute the most extensively documented pathway linking climate change and mental health morbidity.[3,15] Floods, cyclones, droughts, and heatwaves precipitate acute psychological trauma manifested as post-traumatic stress disorder (PTSD), depressive disorders, anxiety disorders, substance use disorders, and complicated grief.[15-17] A systematic mapping review of flood-related mental health outcomes demonstrated consistently elevated prevalence of anxiety, PTSD, and depressive symptoms, with reported rates ranging from 30–40% among directly exposed populations in the immediate post-disaster period.[17] Heat exposure has additionally been linked to increased psychiatric morbidity and mortality, with rising ambient temperatures correlating with higher rates of mental health–related emergency department visits, suicide attempts, and violent behaviour.[18,19] Neurobiologically, trauma responses following climate-related disasters involve sensitization of the amygdala and anterior cingulate cortex, dysregulation of the hypothalamic–pituitary–adrenal axis, and impaired prefrontal–limbic connectivity, resulting in hyperarousal, emotional dysregulation, and compromised executive functioning.[20] These neurobiological alterations may persist beyond the initial exposure, increasing vulnerability to chronic psychiatric disorders and long-term functional impairment.[21]

Indirect effects: chronic stressors and eco-anxiety

Beyond acute trauma, climate change generates chronic psychosocial stressors that contribute to sustained mental health burden.[3,4] Eco-anxiety—defined as chronic fear, worry, and distress related to environmental degradation and anticipated climate impacts—has emerged as a significant psychological phenomenon, particularly among younger populations and individuals with heightened environmental awareness.[22] A systematic scoping review encompassing 35 studies and 45,667 participants demonstrated small-to-large positive correlations between eco-anxiety and psychological distress, depressive symptoms, anxiety symptoms, and stress, with stronger associations when eco-anxiety was operationalized explicitly as anxiety rather than generalized concern.[22] Cross-national surveys indicate that more than two-thirds of adults in high-income countries report at least some degree of climate-related anxiety, with particularly high prevalence in parts of Europe and North America.[23] Climate-induced migration, displacement, food insecurity, and livelihood disruption further exacerbate mental health risk.[24,25] Forced displacement and environmental migration are associated with increased rates of anxiety disorders, affective disorders, substance use disorders, reduced self-esteem, and depressive symptomatology.[24,26] These socioeconomic stressors activate chronic psychological stress pathways independent of direct traumatic exposure, contributing to cumulative mental health burden.[25]

TERMINOLOGY AND NOSOLOGY OF CLIMATE-RELATED PSYCHOLOGICAL DISTRESS

The emerging climate psychology literature employs multiple overlapping terms requiring nosologically clarification: eco-anxiety, climate anxiety, climate grief, solastalgia, and climate-related PTSD. These are distinct but related constructs with different clinical and research implications.

Eco-anxiety and climate anxiety

These terms are often used interchangeably, describing persistent worry, fear, and rumination about climate change futures and environmental degradation. Eco-anxiety is distinguished from generalized anxiety disorder by its specific focus (climate futures) and potential adaptive value-climate concern may motivate pro-environmental behaviour and community engagement. Importantly, not all climate-related worry represents pathological anxiety; perspectives in climate psychology argue that climate concern is a normative, even adaptive response to genuine existential threat. The clinical threshold at which climate worry becomes impairing (meeting DSM-5 criteria for anxiety disorder) remains poorly defined and may vary by cultural context.[22] A scoping review of eco-anxiety measures identified 16 distinct assessment tools, with limited convergent validity, suggesting that eco-anxiety may represent distinct constructs across populations.[22]

Solastalgia

This neologism (combining "solace," "nostalgia," and the Greek root "algia," meaning pain) describes psychological distress caused by environmental change in one's homeland or place of belonging. Unlike "nostalgia" (which

involves loss of place through movement/displacement), solastalgia describes distress when one remains in place but the environment itself is degraded or transformed. Examples include farmers grieving desertification of previously fertile land, or indigenous communities experiencing disruption of traditional ecosystems. Solastalgia may better capture the experience of climate-exposed populations remaining in place than standard psychiatric nosology.

Climate grief

This construct describes profound sadness and grief (distinct from clinical depression) in response to losses caused by climate change: loss of ecosystems, species extinction, displacement of communities, loss of traditional ways of life. While grief is a normative response to loss, climate grief may be chronic and cumulative as losses accelerate. Some researchers conceptualize climate grief as a form of collective grief requiring community-level acknowledgment and processing rather than individual psychiatric treatment.

Climate-related PTSD

This specific diagnosis describes post-traumatic stress symptoms following direct traumatic exposure to climate-related disasters (floods, cyclones, heatwaves, droughts causing acute trauma). Climate-PTSD is phenomenologically identical to PTSD from other traumatic causes but has specific environmental stressor and may involve ongoing threat (repeated floods, chronic heat) rather than singular traumatic events.

Clinical and research implications

The field currently lacks consensus on whether eco-anxiety, solastalgia, and climate grief warrant distinct DSM-5/ICD-11 diagnoses or should be understood as adaptive responses to genuine existential threat. Future nosologically work must distinguish: adaptive climate concern from maladaptive anxiety; normative grief from clinical depression; and culturally contextualized distress responses from universalized psychiatric categories. This is critical for equitable clinical practice, particularly in non-Western populations where direct Western psychiatric terminology may mischaracterize adaptive coping.

POPULATION-SPECIFIC VULNERABILITIES IN INDIA

Epidemiological and intersectional analysis India's susceptibility to climate-related mental health impacts reflects intersecting environmental, demographic, and socioeconomic vulnerabilities. The National Climate Risk Assessment estimates that approximately 600 million individuals (approximately 42% of India's population) face high to very high exposure to climate hazards.[7,27]

Children and adolescents

Children and adolescents demonstrate heightened sensitivity to climate anxiety and eco-anxiety, frequently perceiving climate change as an existential threat and reporting functional impairment, hopelessness, and disengagement from developmental activities.[28,29] A global survey of 10,000 youth found that 75% of respondents in India reported "very worried" or "extremely worried" about the future due to climate change, with 45% reporting that climate anxiety interferes with daily functioning.[28] Climate-related disruption of schooling, displacement from disaster, and witnessing environmental losses contribute to intergenerational transmission of trauma. The developmental timing of exposure is critical: disruptions during sensitive periods (ages 6-18) may impair emotional regulation, social development, and academic trajectory through adulthood.

Women and gendered vulnerabilities

Women experience amplified psychological burden due to intersecting gendered vulnerabilities: economic dependence and limited asset ownership, increasing livelihood vulnerability to climate shocks; social marginalization and limited decision-making power in household and community responses; disproportionate caregiving responsibilities (childcare, eldercare) during climate-induced household disruption, creating dual burdens and caregiver burnout; and increased sexual violence and trafficking risk during displacement and chaos following disasters.[30] Gender-disaggregated data from flood-affected populations in India found that women reported 2.3-fold higher rates of post-flood depression (42% versus 18% in men) and 1.9-fold higher anxiety rates.[30] Women's reproductive health may also be compromised through nutritional insecurity, healthcare access disruption, and pregnancy complications during and after climate disasters.

Older adults

Older adults (aged ≥60 years) face compounded mental health risks: heat vulnerability due to physiological thermal dysregulation and reduced thermoregulatory capacity; epidemiological data link heat waves to increased psychiatric emergency visits (+5% per °C rise above seasonal threshold) and completed suicide (+2-3% per °C) in older adults; limited adaptive capacity and reduced mobility during climate disasters, increasing dependency on others; loss of autonomy, identity, and social integration following climate-induced displacement, contributing to depression and existential distress; and complex medical comorbidities and polypharmacy, complicating mental health treatment and increasing medication interactions during climate stress.[31] Older widows and single older adults are particularly vulnerable, lacking social support networks and household economic security.

Rural and agricultural communities

Rural and agricultural populations experience the most direct and sustained climate impacts. Droughts, floods, and crop failures contribute to sustained psychological distress among farmers, with rigorous epidemiological studies consistently reporting elevated rates of depression, anxiety, and suicidal ideation.[32,33] A prospective cohort study of farmers across 6 Indian states found that repeated climate-induced crop loss was associated with 3.2-fold increased risk of major depressive disorder and 1.8-fold increased risk of suicide attempts over 24 months.[32] The mechanisms are multifaceted: loss of livelihood, debt accumulation, food insecurity, loss of inherited land and identity, and limited access to mental health care. Agricultural suicide rates in India approximate 48 per 100,000 farmers annually, with climate variability and drought identified as significant contributing factors [33]. Young farmers and those with largest debt burdens face highest suicide risk.

Intersectionality and compounded vulnerability

The above vulnerabilities compound inter-sectionally. A low-caste woman agricultural worker facing drought experiences: climate-related livelihood loss (agricultural vulnerability), gendered marginalization (social vulnerability), caste-based discrimination (structural vulnerability), and multiple intersecting discrimination. She may lack land rights, face violence without institutional recourse, and have minimal voice in climate adaptation planning. Future research must explicitly examine intersectional vulnerabilities rather than treating vulnerability categories as independent.

ARTIFICIAL INTELLIGENCE IN MENTAL HEALTH: DIAGNOSTIC AND MONITORING APPLICATIONS

Machine learning and neuroimaging-based approaches

Machine learning and deep learning techniques have advanced psychiatric research through analysis of neuroimaging data, particularly functional and structural magnetic resonance imaging.[34-36] Supervised machine learning models using functional connectivity, cortical thickness, and multimodal imaging features have achieved classification accuracies exceeding 80% in differentiating schizophrenia, major depressive disorder, bipolar disorder, and autism spectrum disorder from healthy controls.[35-38] Convolutional neural networks, support vector machines, random forests, and deep neural networks have demonstrated utility, with convolutional neural networks showing strong performance in bipolar disorder classification.[36]

Despite these advances, substantial methodological limitations constrain clinical translation. Most neuroimaging-based AI studies are characterized by modest sample sizes, limited external validation, and inconsistent reporting of generalizability to independent datasets.[39,40] Psychiatric heterogeneity further complicates individual-level prediction, as overlapping symptom profiles and diverse neurobiological substrates reduce the reliability of group-trained models when applied to individual patients.[41] Additionally, the limited interpretability of deep learning models impedes clinical adoption and biological insight.[42]

Wearable biosensors and digital phenotyping

Wearable biosensors integrated with AI enable continuous, passive, and objective monitoring of mental health through physiological and behavioural data streams.[43,44] Metrics including heart rate variability, electrodermal activity, sleep parameters, physical activity, and social interaction patterns demonstrate robust associations with depression, anxiety disorders, bipolar disorder, and substance use disorders.[44-46] A recent scoping review identified 42 peer-reviewed studies employing wearable and smartphone-based sensing for mental health monitoring, with depression and anxiety being the most frequently studied conditions.[45] Machine learning models analysing wearable data have demonstrated promising diagnostic performance. Deep learning architectures, including convolutional neural networks and long short-term memory networks, have achieved accuracy exceeding 90% in anxiety detection, while traditional algorithms such as random forests remain widely used due to greater interpretability.[45,47] Wearables facilitate real-time detection of deterioration, enabling just-in-time adaptive interventions that deliver personalized coping strategies during periods of heightened vulnerability.[48]

Conversational artificial intelligence and digital therapeutics

Conversational AI platforms deliver evidence-based psychological interventions using natural language processing and adaptive dialogue systems.[49,50] Digital mental health chatbots such as Woebot, Wysa, and Limbic Access collectively engaged over one million users by 2022, offering scalable, multilingual, and cost-effective access to cognitive-behavioural therapy–based support.[49] Limbic Access demonstrated 93% accuracy in screening for depression and anxiety disorders in primary care settings, significantly reducing clinician assessment burden.[51] AI-driven platforms also analyze speech, facial expressions, and vocal biomarkers to enhance diagnostic accuracy.[52-54] Technologies such as emotion recognition and voice-based depression detection address diagnostic gaps in time-limited clinical encounters and hold promise for extending services in low-resource and high-stigma contexts.[53,54]

Evidence maturity of AI applications in mental health

Current literature on AI in mental health reflects heterogeneous evidence maturity, with most applications remaining at experimental to early implementation stages.

Neuroimaging-based machine learning and voice biomarkers are largely confined to proof-of-concept studies, characterized by small samples, limited external validation, and challenges related to psychiatric heterogeneity and generalizability. Wearable biosensors demonstrate a growing empirical base, yet evidence supporting real-world clinical utility, cost-effectiveness, and data privacy remains insufficient. Conversational AI and chatbots show the most advanced translational potential, with feasibility studies and preliminary efficacy data in mild to moderate conditions; however, robust randomized controlled trials (RCTs), accountability frameworks, and integration with clinical care systems are notably lacking, particularly for severe mental illness.

Critical evidence gap

Importantly, there is a complete absence of empirical evidence evaluating AI applications for climate-related mental health distress. Existing studies focus exclusively on conventional psychiatric conditions such as depression, anxiety, and bipolar disorder within non-climate contexts. Consequently, current assertions regarding the role of AI in addressing climate-associated mental health outcomes remain speculative, underscoring an urgent need for targeted, methodologically rigorous research in this emerging domain.

INTEGRATION OF CLIMATE-SENSITIVE MENTAL HEALTH APPROACHES WITH ARTIFICIAL INTELLIGENCE

Real-time monitoring of climate-related psychological distress

AI-enabled systems facilitate the development of climate-sensitive mental health monitoring frameworks capable of detecting acute and chronic psychological responses to environmental stressors.[3,55] Wearables and smartphones may identify physiological and behavioural signatures of eco-anxiety and climate-related distress before progression to clinical disorders.[22,45] Conversational AI platforms adapted with climate-informed psychoeducation can normalize climate anxiety, provide evidence-based coping strategies, and deliver scalable support to climate-vulnerable populations.[22,49]

Telehealth and digital therapeutics in climate disasters

Tele-mental health interventions have demonstrated effectiveness in delivering psychological care following climate-related disasters.[56,57] Videoconference-based cognitive-behavioural therapy achieves outcomes comparable to in-person treatment while reducing logistical barriers and carbon emissions associated with travel.[56] In India, the Tele MANAS platform provides nationwide, 24/7 tele-mental health services, offering a foundation for climate-resilient mental healthcare delivery.[58,59]

CRITICAL CHALLENGES: ALGORITHMIC BIAS, DATA PRIVACY, AND EQUITY

Algorithmic bias and health equity

AI models trained on non-representative datasets risk perpetuating health inequities through systematic underperformance in marginalized populations. Empirical studies have demonstrated ranking bias in depression prediction algorithms, particularly affecting older adults, racial-ethnic minorities, and individuals of lower socioeconomic status. Addressing bias requires diverse training datasets, bias mitigation techniques, and rigorous external validation across heterogeneous populations.[60]

Future directions and research priorities

Critical gaps in current knowledge demand urgent research attention. Longitudinal studies with extended follow-up periods (≥12 months) and large diverse samples are needed to establish causal relationships between climate exposure and mental health outcomes and to identify predictive biomarkers of individuals at highest risk for clinically significant psychological distress. Multimodal integration of neuroimaging, wearable sensor data, genetic information, and environmental exposure data may enhance prediction accuracy and provide insights into neurobiological mechanisms linking climate stressors to psychiatric outcomes. External validation of artificial intelligence mental health models across diverse populations, geographic contexts, and healthcare systems is essential before clinical deployment, with particular emphasis on assessment of model generalizability in low-resource and climate-vulnerable settings. Development of bias-mitigation and fairness-enhancement strategies for psychiatric artificial intelligence applications represents a critical research priority. Implementation research examining the adoption and sustainment of climate-informed mental health interventions and artificial intelligence tools in real-world healthcare settings is needed to identify effective implementation strategies, organizational factors promoting sustained integration, and cost-effectiveness. Qualitative research investigating patient and clinician perspectives on acceptability, trust, and perceived utility of artificial intelligence mental health tools is essential to complement quantitative efficacy studies and to understand how implementation experiences diverge across diverse populations and contexts.[41]

CONCLUSION

Climate change represents an unprecedented challenge to global mental health, operating through multiple direct and indirect psychological pathways and disproportionately affecting vulnerable populations, including children, women, older adults, and economically marginalized communities. Simultaneously, artificial intelligence technologies offer transformative potential for advancing mental health assessment, monitoring, and treatment through neuroimaging-based prediction, wearable

biosensor integration, and conversational platforms providing accessible, scalable support. However, realizing this potential whilst mitigating substantial risks of algorithmic bias, privacy violations, and inequitable access demands urgent interdisciplinary collaboration between climate scientists, psychiatrists, digital health engineers, ethicists, and affected communities. For India specifically, climate-resilient mental health systems require integration of mental health considerations into climate adaptation and disaster response policies, development of artificial intelligence tools specifically adapted for diverse linguistic and cultural contexts, strengthening of mental health workforce capacity, particularly in rural and tribal areas, and establishment of robust data governance and ethical oversight mechanisms. Future research must prioritize longitudinal and implementation studies, external validation of artificial intelligence models in diverse populations, development of bias-mitigation strategies, and participatory design approaches, ensuring that technology solutions reflect the priorities and contexts of affected communities rather than imposing externally derived technological solutions. The convergent crises of climate-driven mental health burden and limited mental healthcare access in vulnerable populations represent a defining public health challenge of our era. Harnessing artificial intelligence innovation responsibly—with explicit attention to equity, cultural adaptation, ethical governance, and integration with human professional expertise—offers promise for substantially advancing mental health care in climate-vulnerable contexts whilst simultaneously building psychological resilience in the face of ongoing environmental change.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Joseph A, Abraham J. The nexus of mental health, climate change and artificial intelligence: a narrative review of emerging evidence and clinical implications. Int J Res Med Sci 2026;14:1750-8.