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Impact of Climate Change on Adolescents' Health Outcomes: An Evidence Gap Map Review

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ABSTRACT

Background: The evolving impact of climate change on adolescents' health is a pressing global concern. Climate change's effects on their physical, mental, and social well-being worsen unique developmental challenges for adolescents. This study aims to map existing evidence, identify gaps, and highlight research and intervention needs.

Methods: Following Campbell standards, an evidence gap map (EGM) review was conducted. We searched for global studies on adverse climate events and adolescents aged 10–19 using five databases such as Medline, EMBASE, Global Health, CINAHL, and Scopus from September 1946 to June 01, 2023. Two independent reviewers completed the screening using Covidence software, and a critical appraisal of all included studies. EGM was developed using EPPI Mapper software, which presents a comprehensive overview of climate events and their impact on adolescents' health outcomes. This study protocol was registered in the International Platform of Registered Systematic Review and Meta-Analysis (INPLASY) (# INPLASY202410119).

Findings: We included 44 studies that explored the impact of climate change on adolescents' health. Most included studies were from Asia (35), with limited evidence from Africa, Australia, and South America (one study each). Earthquakes, hurricanes, and tornadoes were the major climate events impacting adolescents' health and well-being globally (37 studies). However, wildfires, droughts, and extreme heat got less attention. Most studies reported climate change's impact on adolescents' mental health (44), with few studies reporting the effect on physiological and psychosocial aspects of adolescents' health and well-being (10).

This research delves into the effects of climate change on adolescents' health outcomes. Through an evidence gap map review, we have aimed to provide a comprehensive overview of the current research landscape and highlight areas where further investigation is needed.

Conclusion: The systematic examination reveals significant evidence gaps, particularly in Africa, Australia, and South America, and in climate events like wildfires, droughts, and extreme heat. Most studies focus on mental health, with limited research on physiological and psychosocial aspects. These gaps highlight key areas for future research and targeted interventions at the intersection of adolescent health and climate change.

1 | Introduction

Extreme weather and climate events, including heat waves, cyclones, floods, and wildfires, are indicators of climate variability. These occurrences, exacerbated by climate change, contribute to substantial human health impacts, causing morbidity and mortality (Heys et al. 2021). Adolescents (10–19 years) undergoing significant biological, psychological, and social changes are particularly susceptible to the health effects of a changing climate (Heys et al. 2021; McGushin et al. 2022). The impact of climate change on the physical health of adolescents includes increased risks of heat-related illnesses, injuries, respiratory conditions like asthma, allergies, and waterborne diseases due to changes in precipitation patterns (McGushin et al. 2022; Sanson, Van Hoorn, and Burke 2019). Additionally, ecosystem disruptions and biodiversity loss may impact access to clean water, food sources, and natural spaces for physical activity and recreation (McGushin et al. 2022; Bennouna, Stark, and Wessells 2020). This, in turn, can lead to poor nutrition and exacerbate health challenges among adolescents. Besides the physical impact of climate change on adolescents' health, it can also significantly affect their mental well-being. Adolescents undergo anxiety, depression, trauma, and posttraumatic stress disorder (PTSD) due to the uncertainty and stress linked with climate change impacts (Bennouna, Stark, and Wessells 2020; Watts et al. 2021; Ross et al. 2020). These impacts include displacement and forced migration from natural disasters or apprehension about future catastrophes (Sanson, Van Hoorn, and Burke 2019; Evans 2019). Anxiety and depression resulting from these impacts can lead to long-term mental health challenges if interventions are inadequate (Clemens, von Hirschhausen, and Fegert 2022; Guihenneuc et al. 2023). Moreover, climate change also amplifies gender-based violence, exacerbating existing vulnerabilities among adolescents, particularly girls (Watts et al. 2021). In the aftermath of disasters like hurricanes and floods, there is often a documented rise in domestic violence, sexual exploitation, and trafficking. For instance, GBV reports increased after Hurricane Katrina due to unstable living conditions. Similarly, in low- and middle-income countries, adolescent girls face heightened risks of child marriage and sexual violence during climate crises. Including figures that show the rise in GBV incidents following climate disasters could further illustrate this urgent issue, underscoring the need for gender-sensitive climate adaptation strategies (5,6.9). Furthermore, increased environmental stressors can heighten tensions within households and communities, leading to higher incidences of intimate partner violence, early marriage, and exploitation consequently (Lewis et al. 2023).

Adverse climate events have notably increased worldwide in the past 5 years. The Fifth National Climate Assessment reported 25 significant disasters in 2023 alone (Bhola et al. 2023). A global map of 504 extreme weather events revealed that 71% were recently intensified by human-caused climate change, emphasizing the urgency for climate action and resilience measures (Climate change fueled extreme weather in 2023—expect more records in 2023—expect more records in 2024). In 2023, the United States witnessed 28 extreme weather and climate disasters, including hurricanes, floods, earthquakes, wildfires, and heatwaves, exceeding the previous evidence of 22 events in 2020, costing at least $92.9 billion to the economy and healthcare (Lewis et al. 2023). Canada witnessed its most extreme wildfire season in 2023, scorching over 18 million hectares of land, exacerbated by hot, dry, and windy conditions intensified by climate change (Climate change fueled extreme weather in 2023—expect more records in, 2023—expect more records in 2024). Similarly, southern Europe, including Greece, Italy, and Spain, experienced unprecedented wildfires, with temperatures soaring above 50°C, posing fatal risks. A drought in the Horn of Africa culminated in catastrophic floods in Libya, claiming hundreds of lives, with climate change amplifying rainfall intensity by up to 50%. A blistering heatwave in April 2023 in Asia shattered temperature records across multiple countries (Climate change fueled extreme weather in 2023—expect more records in, 2023—expect more records in 2024). Meanwhile, South Sudan faced its fourth consecutive year of historic flooding, affecting millions and signaling a prolonged absence of dry seasons, indicative of the global reach and severity of climate-related disasters (Lewis et al. 2023; Bhola et al. 2023; Climate change fueled extreme weather in 2023—expect more records in 2023—expect more records in 2024; Park 2023).

The literature indicates that adolescents are particularly vulnerable to the potential adverse effects of climate change due to shifting environmental conditions. It's imperative to address the impact of climate change on adolescents' health and well-being, given that they will ultimately bear the consequences of these environmental shifts as future decision-makers. There needs to be a significant gap in understanding and addressing the impact of climate change on adolescents' health and well-being, necessitating focused attention and research (Bennouna, Stark, and Wessells 2020; Clemens, von Hirschhausen, and Fegert 2022; Bakrania and Ghimire 2018). This evidence gap map (EGM) aims to identify, map, and highlight gaps in existing empirical evidence on climate change and its impact on adolescents' health. By pinpointing these gaps, we can better understand adolescents' specific health risks due to climate change, develop targeted interventions, and inform policies and practices to promote better health outcomes.

2 | Methods

We conducted an EGM review to identify the impact of climate change on adolescents' health and the gaps in existing evidence following Campbell Standards (White et al. 2020). This research is registered with the International Platform of

Registered Systematic Review and Meta-Analysis (INPLASY) (#INPLASY202370086).

2.1 | Scope and Conceptual Framework

We followed *the Risk and Resilience Model* (Tamene 2016; Abramson et al. 2015) and Climate Change Adaptation Strategies (Begum et al. 2014; Karki et al. 2022) to present a conceptual overview of how climate change impacts adolescents' health and well-being (Figure 1). This structured approach aligns closely with the objectives of the EGM, allowing us to systematically map existing evidence within each category and identify areas where research is lacking or insufficient.

Our conceptual framework provides a comprehensive overview of how exposure to climate change events affects adolescents' physical, mental, and psychosocial well-being, as reported in the included studies. It categorizes climate events into geological, atmospheric, and environmental categories, including earthquakes, wildfires, droughts, floods, extreme heat, hurricanes, and tornadoes. The framework also presents climate-related adverse health outcomes among adolescents, such as PTSD, anxiety, depression, and respiratory diseases. Through this framework, we presented the adaptation strategies to address these challenges through collaborative efforts, policy implementation, evaluation, and future interdisciplinary research spanning environmental sciences, public health, psychology, sociology, and related fields (Figure 1).

2.2 | Search Strategy

The search strategy for this EGM is reported by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for Searching (Parums 2021) (Figure 2). The search strategy was developed by an experienced health sciences librarian (MK) at the University of Alberta in consultation with the research team. The following databases were searched individually from inception to present (from September 1946 to June 01, 2023): Medline, EMBASE, and Global Health via OVID; Cumulative Index to Nursing and Allied Health Literature (CINAHL) via EBSCOhost; Scopus and organizational websites for grey literature (commentary brief reports, discussion papers, etc.). The search strategy focuses on adolescent physical and mental health, reproductive rights, and sexual health topics, with an extensive list of specific keywords related to climate change, environmental factors, and various health-related issues. It combines terms associated with climate change impacts, such as "carbon cycle," "carbon sequestration," and "global warming," with keywords related to adolescent health and reproductive rights (Supporting Information S1: File 1—detailed search strategy).

2.3 | Eligibility Criteria

Our eligibility criteria included primary studies (qualitative and quantitative), reviews (scoping, systematic, and meta-analysis), and grey literature that specifically examined the impact of any climate change on adolescents' health aged 10–19, including both male and female individuals. The EGM considered studies conducted globally, regardless of setting or context, and studies published in English only.

2.4 | Screening and Data Extraction

All studies identified from the databases were imported into Covidence, an online screening software for title, abstract

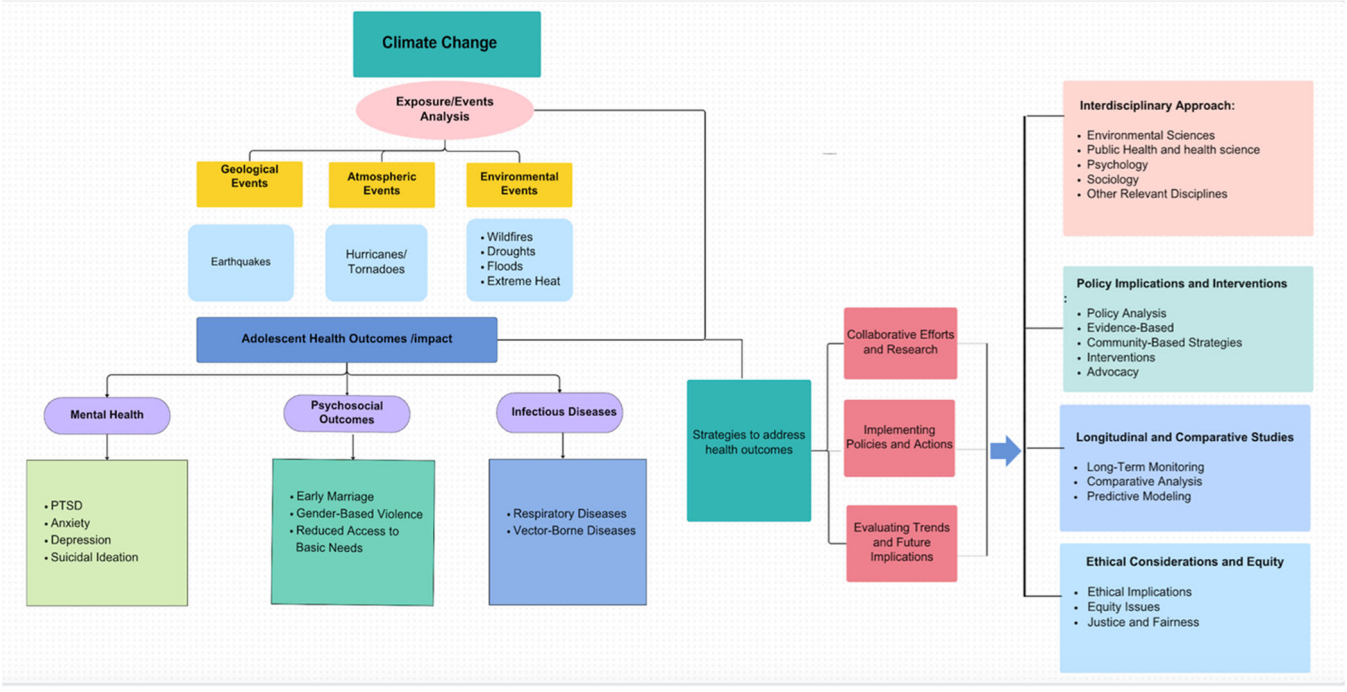

FIGURE 1 | Conceptual Framework of Climate Change Impacting Adolescents' Health. [Color figure can be viewed at wileyonlinelibrary.com]

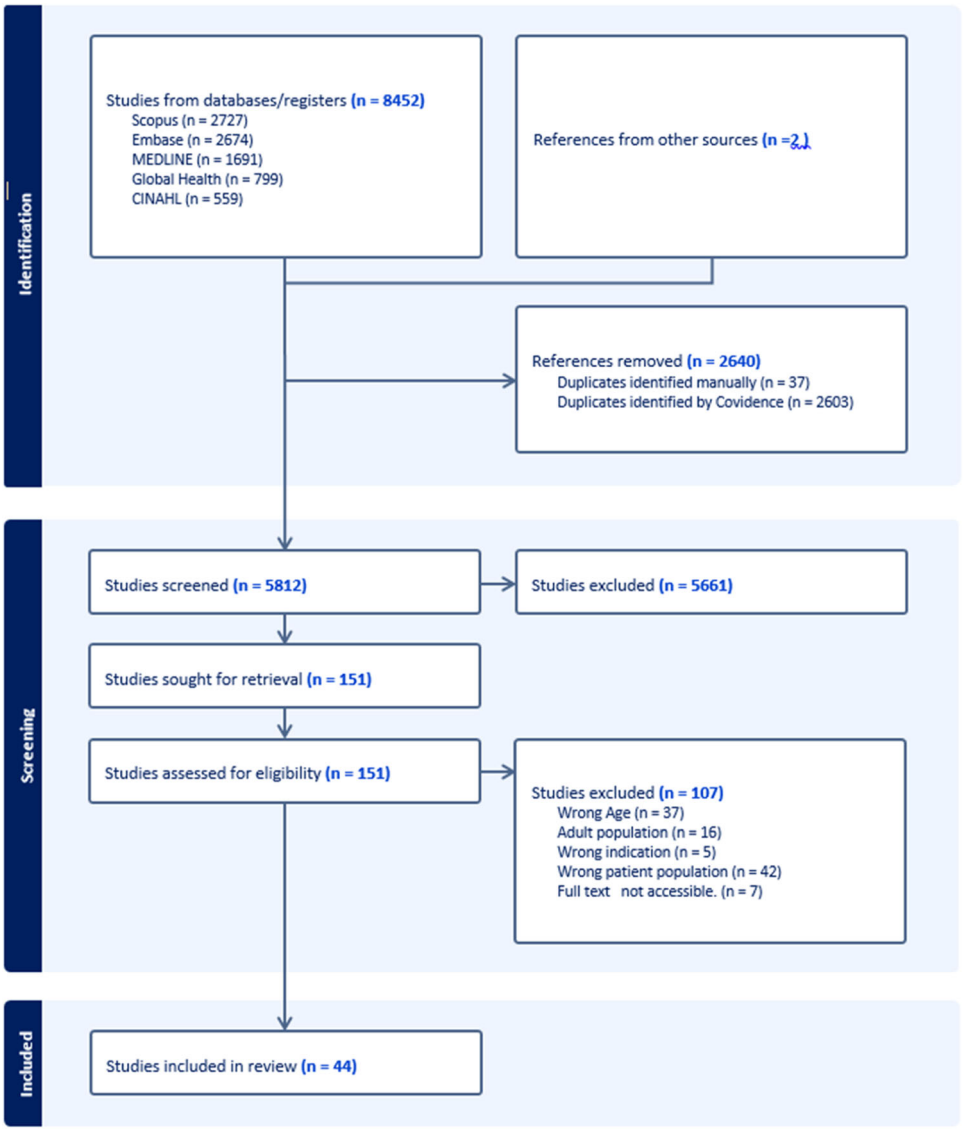

FIGURE 2 | PRISMA flow chart. [Color figure can be viewed at wileyonlinelibrary.com]

screening and full-text screening (Kellermeyer, Harnke, and Knight 2018). Two reviewers (SN and YA) independently completed the screening phase, with any conflicts resolved by a third reviewer (SM). Articles meeting the final inclusion criteria were exported to EndNote as RIS files (Hupe 2019). These studies were then transferred to *Evidence for Policy and Practice Information* (EPPI) Reviewer software (version 6.15.0.2) for coding, data extraction, and developing an EGM (White et al. 2020). Data extraction was also done in a Word document to minimize errors, reduce biases, and ensure transparency (Supporting Information S1: File 2). Finally, 44 studies were included in our study.

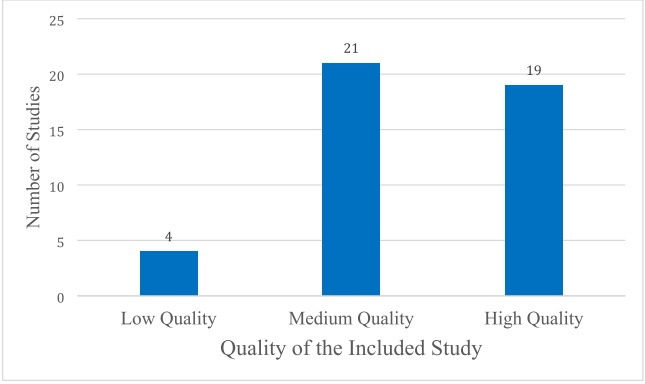

FIGURE 3 | A quality appraisal of the included studies. [Color figure can be viewed at wileyonlinelibrary.com]

2.5 | Quality Appraisal

A critical appraisal of all the included studies (Figure 3) was done using specific tools.

Assessment of Multiple Systematic Reviews (AMSTAR) for systematic reviews, Meta-Reviews and Narrative Reviews (Hong et al. 2018), and Mixed Methods Appraisal Tool (MMAT) for primary studies (qualitative and quantitative) (Lu et al. 2020). AMSTAR evaluates aspects such as the thoroughness of the literature search, clear inclusion/exclusion criteria, assessment

of publication bias, and the handling of conflicts of interest, ensuring systematic reviews follow rigorous standards. MMAT assesses the clarity of research questions, appropriateness of study design, reliability of data collection methods, adequacy of data analysis, and integration of qualitative and quantitative findings in mixed-method studies. Two reviewers independently evaluated each study, and any discrepancies were resolved through discussion to reach a consensus, ensuring consistent and objective quality assessment.

3 | Findings

3.1 | Evidence Gaps in Research Methodology

The study of climate change's impact on "adolescents" health has gained significant traction and a notable increase in existing evidence (Figure 4). The peak of research on climate change (eight studies) for assessing its impact on adolescents in 2018 reflects a growing recognition of the urgency surrounding the intersection of environmental changes and adolescent health. However, there was a slight dip in 2020 and 2021, a resurgence with six publications.

Characteristics of studies are detailed (Table 1). Quantitative research is the most prevalent, with 38 studies, including 28 cross-sectional studies, six cohort studies, two RCTs, one case-crossover study, and one census study (Adams et al. 2015, 2014; An et al. 2013; Shi et al. 2018; Brown et al. 2019; Dass-Brailsford et al. 2022a; Forresi et al. 2020a; Fransen et al. 2016; Geng et al. 2018a, 2018b; Jia et al. 2013; Lian et al. 2018; Marthoenis, Nirwana, and Fathiariani 2019; Tian et al. 2014; Niu et al. 2023; Varghese et al. 2021a; Xu et al. 2018a, 2017; Fan et al. 2017; Kadak et al. 2013; Kinoshita et al. 2016; Bountress et al. 2017; Mathew et al. 2021; Wahab et al. 2021; Shi, Zhou, and Fan 2016; Xu, Wang, and Tang 2018b; Chen et al. 2021; Sloand et al. 2017a; Yang et al. 2014; Tang et al. 2018; Seddighi et al. 2021; Tanaka et al. 2016; Zheng, Huang, and Wong 2019). Other research types are less common, with one qualitative study, one systematic review, one narrative review, one mixed methods study, and two studies categorized as grey literature commentary that is, a brief report and discussion paper. However, geographically, 35 studies was mainly conducted in Asia (An et al. 2013; Shi et al. 2018; Geng et al. 2018a, 2018b; Jia et al. 2013; Lian et al. 2018; Tian et al. 2014; Xu et al. 2018a, 2017; Fan et al. 2017; Kadak et al. 2013; Kinoshita et al. 2016; Mathew et al. 2021; Wahab et al. 2021; Shi, Zhou, and Fan 2016; Xu, Wang, and Tang 2018b; Chen et al. 2021; Yang et al. 2014; Tang et al. 2018; Tanaka et al. 2016; Tang et al. 2015; Wang, Xu, and Lu 2020; Qi et al. 2020; Varghese et al. 2021b; Patel and Rajak 2022; Sharma and Kar 2019), reflecting an acknowledgment of the diverse challenges faced by adolescents in this region. Additionally, North America with eight studies (Adams et al. 2015, 2014; Brown et al. 2019; Niu et al. 2023; Bountress et al. 2017; Tanaka et al. 2016; van Nieuwenhuizen et al. 2021; Zacher et al. 2022), Europe three (Fransen et al. 2016; Uttervall et al. 2014; Forresi et al. 2020b), Central America/Caribbean two (Sloand et al. 2017a; Dass-Brailsford et al. 2022b), South America one

TABLE 1 | Study characteristics.

Types of study design	Frequency
Quantitative Studies	38
Cohort	6
RCT/Experimental	2
Cross-sectional	28
Case-crossover	1
Census	1
Qualitative Studies	1
Systematic Review	1
Narrative Review	1
Mixed methods study	1
Other (Viewpoints/Commentary brief reports and discussion paper)	2
Total	44

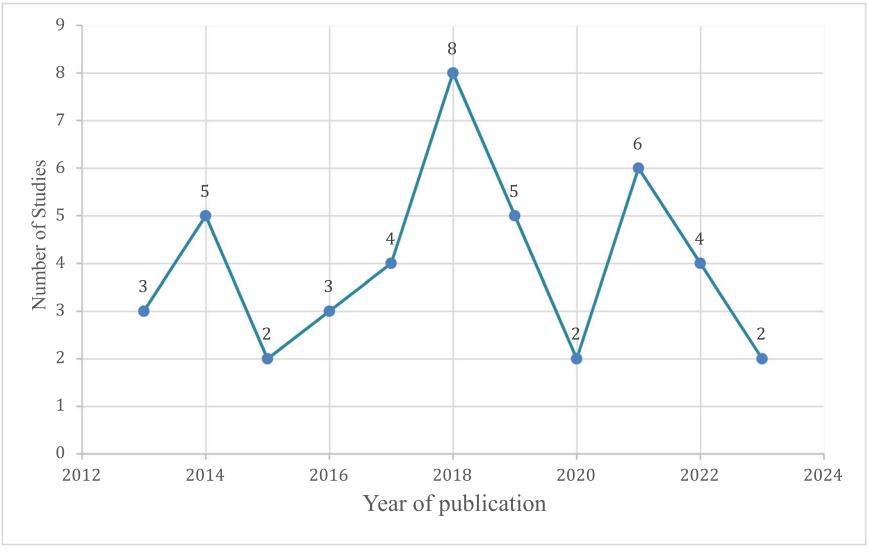

FIGURE 4 | Publication trends of the included studies. [Color figure can be viewed at wileyonlinelibrary.com]

(Sloand et al. 2017b), and Africa one (Rother et al. 2020) contributed to global understanding. In these studies, out of the total 44 studies, 19 were classified as high quality, indicating a robust methodology and reliability of results. Additionally, 21 studies were deemed moderate quality, suggesting satisfactory methodological rigor. On the other hand, four studies were categorized as low quality, implying potential limitations in study design or execution. We intensively assessed to minimize double counting a study from a review to primary studies. Primary research will only be counted once if included in any review. This comprehensive global analysis underscores the evolving landscape of research on climate change and adolescents' health, emphasizing the urgency and importance of further exploration to inform effective interventions and policies.

3.2 | Climate Change Exposure/Events

This EGM (Figure 5) represents various climate change events responsible for adolescents' adverse physical health, mental health, and psychosocial outcomes. Using our conceptual framework (Figure 1), we categorized climate change events into three distinct groups: geological, atmospheric, and environmental events. Geological events include the earth's structure and processes, including earthquakes and volcanic eruptions (Keller and DeVecchio 2019). Within the geological events, we found earthquakes have been extensively studied in 26 research papers, highlighting their profound effects on adolescents, encompassing both physical and psychological consequences (An et al. 2013; Fransen et al. 2016; Geng et al. 2018a, 2018b; Jia et al. 2013; Lian et al. 2018; Marthoenis, Nirwana, and Fathiariani 2019; Tian et al. 2014; Xu et al. 2018a; Fan et al. 2017; Kadak et al. 2013; Wahab et al. 2021; Shi, Zhou, and Fan 2016; Xu, Wang, and Tang 2018b; Chen et al. 2021; Tang et al. 2018; Tanaka et al. 2016; Zheng, Huang, and Wong 2019; Sharma and Kar 2019; Sloand et al. 2017b; Zhou, Zhen, and Wu 2019). Transitioning to Atmospheric Events, these events included natural occurrences like wildfires, floods, droughts, and other ecological disruptions (Forresi et al. 2020a). Hurricanes and Tornadoes have been the focus of 13 studies (Adams et al. 2015, 2014; Dass-Brailsford et al. 2022a; Fransen et al. 2016; Xu et al. 2017; Yang et al. 2014; Qi et al. 2020; van Nieuwenhuizen et al. 2021; Zacher et al. 2022; An et al. 2018; Majumder et al. 2023; Patel and Rajak 2023; Sumner et al. 2014), emphasizing the extensive repercussions of these extreme weather events. Furthermore, environmental events

FIGURE 5 | Link to Map: Climate change and adolescents' health-EGM OR Scan. [Color figure can be viewed at wileyonlinelibrary.com]

such as wildfires (Brown et al. 2019; van Nieuwenhuizen et al. 2021; Majumder et al. 2023; Patel and Rajak 2023), droughts (Fransen et al. 2016; Patel and Rajak 2023), floods (Brown et al. 2019; Varghese et al. 2021a; Mathew et al. 2021; van Nieuwenhuizen et al. 2021; Rother et al. 2020; Majumder et al. 2023; Patel and Rajak 2023), and extreme heat (Niu et al. 2023; Bountress et al. 2017) have been investigated in various studies, shedding light on the diverse challenges posed by these climate-related exposures. However, more literature is needed to understand wildfires, drought, and extreme heat.

3.3 | Climate-Related Adolescent Health Outcomes

Our EGM found that 44 included studies reported climate change's impact on adolescents' mental health (Adams et al. 2015, 2014; An et al. 2013; Brown et al. 2019; Fransen et al. 2016; Geng et al. 2018a, 2018b; Jia et al. 2013; Marthoenis, Nirwana, and Fathiariani 2019; Tian et al. 2014; Niu et al. 2023; Xu et al. 2018a, 2017; Fan et al. 2017; Kadak et al. 2013; Bountress et al. 2017; Mathew et al. 2021; Wahab et al. 2021; Shi, Zhou, and Fan 2016; Xu, Wang, and Tang 2018b; Chen et al. 2021; Yang et al. 2014; Tang et al. 2018; Tanaka et al. 2016; Zheng, Huang, and Wong 2019; Qi et al. 2020; Sharma and Kar 2019; Zacher et al. 2022; Sloand et al. 2017b; Rother et al. 2020; Zhou, Zhen, and Wu 2019; An et al. 2018; Sumner et al. 2014). The mental health outcomes presented in the conceptual framework and EGM included PTSD, anxiety, depression, and suicidal ideation. However, the physiological impact on the health of adolescents due to climate change was found to be less noted (Brown et al. 2019; Fransen et al. 2016; Varghese et al. 2021a; Xu et al. 2017; Bountress et al. 2017; van Nieuwenhuizen et al. 2021; Rother et al. 2020; Majumder et al. 2023) (eight studies). Diseases such as vector-borne, infectious, and respiratory diseases were common among adolescents affected by climate change. Moreover, we found that climate change impacts the psychosocial aspects of adolescents, such as disasters and floods leading to early/teenage marriage, gender-based violence, and reduced access to basic needs, which were explored in 10 studies (Dass-Brailsford et al. 2022a; Fransen et al. 2016; Geng et al. 2018b; Lian et al. 2018; Varghese et al. 2021a; Xu et al. 2017; Sharma and Kar 2019; van Nieuwenhuizen et al. 2021; Majumder et al. 2023; Patel and Rajak 2023). There is a gap in the literature in understanding or paying more attention to the neglected aspects of adolescents wellbeing, such as sexual and reproductive health needs.

4 | Discussion

The findings of our EGM reveal a significant disparity in the geographical distribution of studies over the past years. We found a steady increase in research conducted on adolescents' health related to climate change from 2012 to 2023, with a pronounced surge in research output in 2018. Nevertheless, we found that after 2018, there was a noticeable decrease in the volume of publications, with only five studies in 2019 and two in 2020. This trend raises concerns about the diminishing research output on adolescence and climate change's impact on adolescents, considering these years as a COVID-19 pandemic period. The apparent decline in research during the pandemic may be attributed to the overwhelming demands of the immediate health crisis or the lack of resources to conduct research (Gao et al. 2021; Evgeny Soloviov and Alexander Danilov 2020; Gupta et al. 2023; Citaristi 2022). However, it is essential to understand and address the long-term impacts of climate change on adolescent health, which is equally urgent. Reallocating resources and reinstating a focused effort on this critical intersection is necessary to ensure a comprehensive and resilient response to the multifaceted health challenges faced by adolescents in the evolving global landscape (Maja and Ayano 2021; Barbier and Hochard 2018).

While a considerable body of research focusing on climate change's impact on adolescent health is conducted in Asia (35 studies), less attention is paid to the regions of Africa and South America, with the contribution of one study in each region. The geographic distribution of available research, particularly in Asia (35 studies), highlights the region's recognized vulnerability to environmental changes. This is consistent with other research conducted in Asia, which underscores the continent's large and diverse population, rapid urbanization, and industrialization, positioning it at the forefront of climate-related challenges (Patel and Rajak 2023; Citaristi 2022; Burke et al. 2018; Heys et al. 2021). Asian adolescents face unique circumstances, including exposure to air pollution, water scarcity, extreme weather events, and the disruption of traditional livelihoods (Sumner et al. 2014; Evgeny Soloviov and Alexander Danilov 2020; Barbier and Hochard 2018). A key contribution of this study is identifying significant research gaps in regions like Africa and South America. Despite facing considerable exposure to climate change, these regions have not received adequate research attention. Factors contributing to this gap may include limited research capacity building, inadequate research financing, and competing regional government priorities, which often prioritize immediate development and public health concerns over climate research (Bennouna, Stark, and Wessells 2020; Heys et al. 2021). In contrast to Asia, where evidence exists but is underutilized by policymakers, Africa and South America require more comprehensive investigations to build a robust evidence base that can inform policy and interventions to protect adolescents from climate-related health risks. Addressing these gaps is critical for a more global understanding of how climate change impacts adolescent health. Understanding of the unique challenges and consequences faced by adolescents in these regions.

Our EGM's identification of earthquakes as a significant contributor to adverse health effects among adolescents aligns with previous research highlighting the profound impact of seismic events on the adolescent population. Earthquakes can lead to physical injuries, displacement, and mental health challenges (Patel and Rajak 2022; Zacher et al. 2022; Evgeny Soloviov and Alexander Danilov 2020), which can have long-lasting consequences for adolescent well-being. Moreover, the potential links between seismic activity and climate-related factors suggest a need for interdisciplinary research to understand better the complex interactions shaping health outcomes. Furthermore, we found the least research focusing on drought; therefore, more studies need to address the impacts of drought on

adolescent health. Adolescents are particularly vulnerable to heat-related illnesses and dehydration during extreme heat events (Patel and Rajak 2023; Gupta et al. 2023; Burke et al. 2018), while prolonged droughts exacerbate food insecurity and water scarcity, further jeopardizing their health. These findings underscore the necessity for expanded research efforts to comprehensively examine drought's health ramifications on adolescents.

Our EGM findings present significant climate change outcomes 'for adolescents' mental health (44 studies). The mental health impact of climate change, such as PTSD, anxiety, depression, and suicidal ideation, also aligns with existing literature (Dass-Brailsford et al. 2022b; Barbier and Hochard 2018; Burke et al. 2018). This strengthens the understanding that climate change is a multifaceted challenge with profound implications for adolescents' psychological health, emphasizing the urgency of targeted interventions and support strategies in this critical intersection. The primary focus of existing studies on mental health outcomes in adolescents highlights the urgency of integrating psychological considerations into disaster management and recovery strategies. This aligns with broader societal concerns regarding the well-being of this age group and emphasizes the need for targeted interventions to address their specific needs (Gao et al. 2021; Heys et al. 2021). Moreover, we found that adolescents experience significant psychosocial impacts because of climate change, including factors such as early marriage and gender-based violence (Keller and DeVecchio 2019; Zhou, Zhen, and Wu 2019; An et al. 2018; Majumder et al. 2023; Patel and Rajak 2023; Sumner et al. 2014; Gao et al. 2021; Evgeny Soloviov and Alexander Danilov 2020; Gupta et al. 2023; Citaristi 2022; Maja and Ayano 2021; Barbier and Hochard 2018; Burke et al. 2018). The uncertainty and unpredictability of climate change can exacerbate fear, helplessness, and hopelessness, impacting adolescents' sense of control and security about their future (Keller and DeVecchio 2019; Bograd et al. 2023). Additionally, socioeconomic disparities exacerbated by climate change can further exacerbate psychosocial stressors, particularly among vulnerable populations.

5 | Conclusion

Our EGM highlights the substantial impact of climate change on adolescents' health and well-being, but more predominantly on mental health. However, a concerning lack of research during the pandemic, coupled with our observation of limited studies focusing on adolescents in the context of climate change, underscores the need for increased attention. Asia's specific vulnerability to these challenges further emphasizes the urgency for enhanced research efforts and targeted interventions to address the distinct mental health challenges faced by adolescents at the intersection of climate change and the ongoing pandemic.

6 | Implications

Our findings suggest that Asia is the most vulnerable region in the context of climate change's impact on adolescent health, which carries profound implications for both further research and policymaking. The absence of studies during the pandemic and the scarcity of research on climate change and adolescents' physical and psychosocial well-being highlights a critical gap that demands immediate attention. Allocating funds for research addressing these challenges is crucial to driving evidence-based interventions. Integrating climate considerations into mental health policies is equally vital, enabling the development of climate-resilient mental health programs tailored for adolescents. Moreover, by incorporating qualitative methodologies, future studies can capture the complexity and contextuality of adolescents' health responses to climate change. In addition, recommendations for future studies include longitudinal research designs to track the long-term trajectories of health outcomes among adolescents exposed to climate change. Furthermore, interdisciplinary approaches integrating insights from medicine, psychology, sociology, public health, and environmental science are essential for developing comprehensive understandings of climate change's physical, mental, and psychosocial impacts and informing evidence-based interventions and policies to support adolescent wellbeing.

Regarding adolescent health outcomes amidst climate change, several interventions and adaptation strategies can be implemented to mitigate the impact. For instance, increasing education and awareness among adolescents about the health impacts of climate change is crucial. This can involve integrating climate change education into school curricula and community outreach programs. Additionally, mental health support programs tailored to adolescents can help address the psychological effects of climate change-induced disasters, such as anxiety and depression.

Author Contributions

All listed authors contributed substantially to the manuscript and agreed to the final submitted version.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data are freely available in the manuscript itself and uploaded supplementary files.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.