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Exploring the Health Impacts of Climate Change on Children: A Scoping Review

Endah Widyastuty[1], Dhiana Ayu Novitasari[1], Wa Ode Saridewi Mulyainuningsih[1], Lely Lusmilasari[2], Wiwin Lismidiati [2]

[1]*Master of Nursing, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia*
[2]*Department of Pediatric and Maternity Nursing, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia*

Climate change is a global phenomenon characterized by alterations in temperature, rainfall patterns, sea level rise, and an increase in extreme weather events, all of which can significantly impact human health, particularly in children. Children are considered a vulnerable population due to their developing physiology and dependence on caregivers. This study aims to identify the effects of climate change on child health. This study employed a scoping review design with a systematic search method using the databases ScienceDirect, SpringerLink, and ProQuest. Keywords were developed based on the PCC framework and combined using Boolean operators: "climate change AND pediatric AND health impact." Inclusion criteria included articles published within the last five years, focusing on children and climate change-related health impact, available in full text English. The article screening process followed the PRISMA 2020 guidelines. The findings indicate that climate change adversely affects children's health, including: 1) Extreme heat contributing to malnutrition; skin, respiratory, food, and general allergies; mental health issues; and respiratory diseases. 2) Drought associated with diarrhea and malnutrition. 3) Temperature changes, humidity, and air pollution linked to respiratory diseases. Climate change significantly increases children's risk of adverse health outcomes, including malnutrition, diarrhea, respiratory diseases, allergies, and mental health problems. Strengthening preventive strategies, early monitoring, and health system capacity is essential to mitigate these impacts. Further research is needed to support evidance-based interventions and policies to protect children's health.

Keywords: climate change, health impact, pediatric

Introduction

Climate change is a global phenomenon contributing to long-term alterations, including shifts in temperature, precipitation patterns, sea level rise, and increased occurrences of extreme weather events such as heatwaves, floods, and wildfires.[1] The impacts of climate change are not only detrimental to the environment but also pose significant threats to human health, particularly in children.[2] Children are considered a vulnerable population due to their physical and cognitive immaturity, as well as their dependency on their environment and caregivers.[3,4] The effects of climate change on children can be both direct and indirect. Direct impacts include injuries resulting from natural disasters, while indirect impacts encompass reduced quality and security of food and water, as well as changes in disease patterns.[5] These changes contribute to an increased risk of various health issues in children,

Corresponding Author:
Lely lusmilasari
Department of Pediatric and Maternity Nursing, , Faculty of Medicine, Public Health, and Nursing
Universitas Gadjah Mada
Jl. Farmako Sekip Utara, Yogyakarta, 55281, Indonesia
e-mail: lely_psik@ugm.ac.id

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such as respiratory diseases, asthma, allergies, vector-borne illnesses, malnutrition, low birth weight, and mental health disorders.[3,5,6,7,8] The World Health Organization (WHO) estimates that between 2030 and 2050, climate change could cause approximately 250,000 deaths annually due to malnutrition, malaria, diarrhea, and heat stress.[9] Furthermore, children's health and well-being are exacerbated by inadequate caregiving and elevated parental stress levels.[3,4,7] The United Nations International Children's Emergency Fund (UNICEF) reports that half of the world's children are at extremely high risk of the impacts of climate change. This vulnerability is driven by the combined effects of climate change and limited access to healthcare for children, families, and communities to prevent and treat climate-related issues. One of the main challenges is that climate change is still often not regarded as a critical issue.[10]

Based on the issues, this study aims to identify the impacts of climate change on children's health. This review seeks to provide a comprehensive synthesis of climate related exposure, associated health outcome, and factors contributing to children's vulnerability, as well as to identify existing research gaps. The findings of this review are expected to inform future research and contribute to the development of evidence-based interventions and policies aimed at mitigating the adverse effects of climate change on children's health.

Methods

The method used in this paper is a scoping review. A scoping review is a method for mapping the literature on a specific topic and identifying knowledge gaps. This method is useful when research on a particular topic is limited or heterogeneous.[11] The stages in the article search process refer to Arksey and O'Malley, who outline a five-stage process, including identifying research questions, searching the literature, selecting studies, extracting data, and presenting descriptive results.[12]

Search Strategy and Selection Criteria

The literature search process was conducted systematically using the PCC framework as the basis for determining the search focus. The PCC framework formulation includes: Population (P): children; Concept (C): the impact of climate change on children's health; and Context (C): the global context, not geographically limited. Therefore, the research question in this literature review is "What are the impacts of climate change on children's health?"

The literature search was conducted using secondary databases obtained from databases including ScienceDirect, SpringerLink, and ProQuest. The article search used keywords designed to ensure the relevance of the literature, using Boolean operators to broaden or narrow the search for appropriate articles. The following keywords were used "climate change AND pediatric AND health impact." This study applied predefined inclusion and exclusion criteria for article selection. The inclusion criteria consisted of studies focusing on children, examining the effects of climate change on children's health, published between 2020 and 2025, available as full-text open access articles, and written in English. The exclusion criteria included studies employing review-based designs, such as literature reviews, systematic reviews, and meta-analyses, as well as study protocols.

Data Collection Process

Articles obtained from the database were downloaded and then uploaded to the RAYYAN software for selection by the researcher. The screening process using RAYYAN software is conducted through several sequential steps. It begins with identifying and removing duplicate articles, followed by an independent review of titles and abstracts to assess their relevance to the research questions as well as the predefined inclusion and exclusion criteria. After this, validation is performed and any disagreements in article selection are resolved. Articles that meet the eligibility criteria are then selected, and their full texts are retrieved for comprehensive evaluation. Upon completing the full-text review, the researcher proceeds with data extraction to facilitate synthesis. Finally, the results of the screening process are presented in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 guidelines.

Data Extraction

Data extraction was conducted systematically using a pre-designed extraction sheet to ensure consistency in the information collection process. This process included data collection related to bibliographic information (author, year of publication, title, and country), research objectives, research design, population characteristics, causes, and impacts of climate change on children's

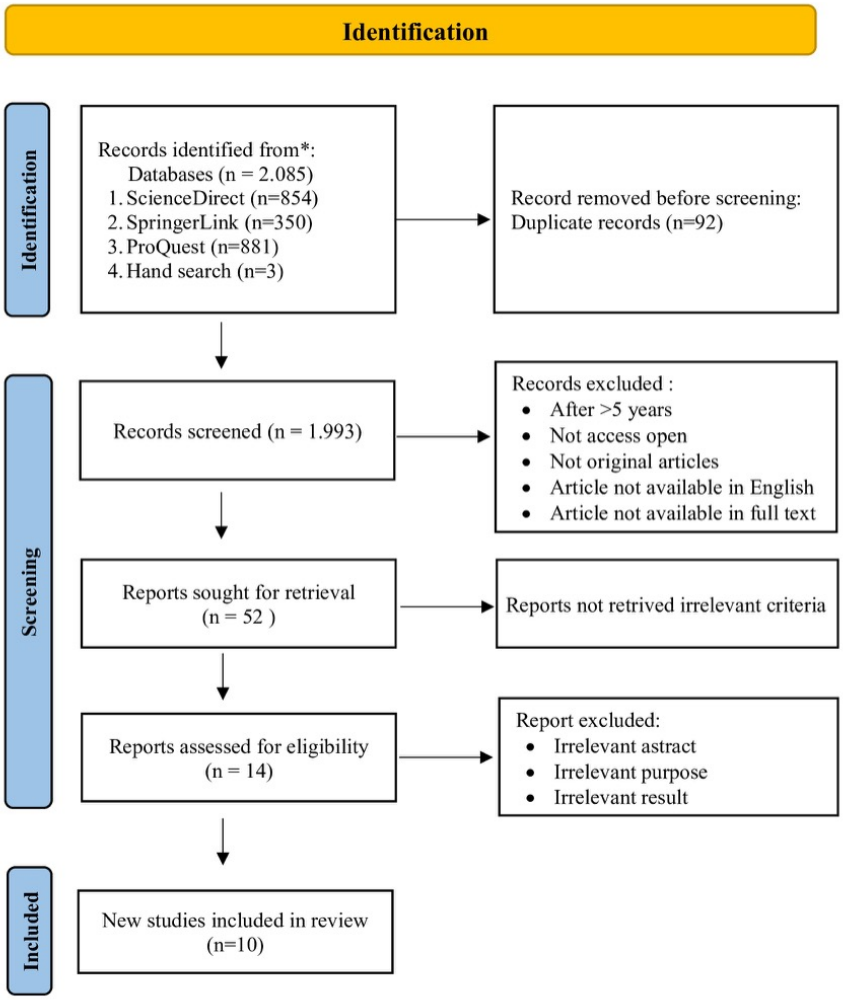

Figure 1. PRISMA flowchart.

health, and research findings. After all data was extracted, thematic analysis was conducted. The collected data were analyzed descriptively and compared to identify patterns, similarities, and differences between studies. Each finding was then grouped based on the PCC components and the research focus, namely the type of climate change exposure and the health impacts that arise in children.

Results and Discussion

In this literature review, a total of 2,085 articles were initially identified from the selected databases, and an additional 3 articles were obtained through handsearching. Following the application of inclusion and exclusion criteria, 10 articles were deemed eligible for further review as shown in **Figure 1.** The findings of this review indicate that climate change significantly affects children's. As presented in **Table 1**, indicating that the studies were conducted in settings vulnerable to climate change, examining climate-related exposures such as heatwaves, floods, droughts, and air pollution in relation to child health. A total of 10 articles were included for data extraction. These studies originated from both developed and developing countries, including China, Germany, Indonesia, India, various African nations, South and Southeast Asian countries, Latin America, and the Caribbean. The research designs used across these studies included cross-sectional, cohort, case-control, time-series studies, longitudinal panel studies, and log-binomial mixed-effects models.

The literature review identified several categories of contributing factors and the health impacts of climate change on children. First, extreme heat can lead to health problems such as malnutrition,[20,21] skin, respiratory, food, and overall allergies,[14] mental health issues,[19] and respiratory tract diseases.[13] Second, drought conditions increase the risk of diarrheal diseases,[22] and prolonged droughts may result in malnutrition.[20] Third,

Table 1. Study characteristics and findings on the impact of climate change on children's health.

Country	Aim	Research Design	Respondents	Exposure/Cause	Health Impact	Main Findings	Ref.
China	To explore the relationship between extreme temperatures and outpatient visits for pediatric respiratory diseases and the modifying effects of seasonality in Harbin, China	Distributed Lag Non-Linear Model (DLNM)	Outpatient children with respiratory diseases at Harbin Children's Hospital	Very high temperatures (>26°C)	Respiratory diseases	Very high temperatures significantly increased the risk of outpatient visits for respiratory diseases among children	[13]
	To assess the impact of temperature variability and relative humidity on allergic diseases in children and identify critical exposure windows	Case-control	Outpatient children (case group: allergic diseases; control group: no allergy history)	Extreme temperature and humidity variability	Skin allergy, food allergy, respiratory allergy, overall allergies	Extreme and moderately cold temperatures were associated with increased allergic diseases in children	[14]
	To investigate the relationship between air pollutant concentrations and hospital admissions for acute respiratory infections (ARI) in children in Lanzhou City	Time-series study	Hospitalized children aged 0–14 years from seven hospitals in Lanzhou	PM2.5, PM10, SO_2, and NO_2 exposure	ARI, pneumonia, bronchiolitis	Short-term exposure to PM2.5, PM10, SO_2, and NO_2 was associated with increased hospital admissions for ARI, pneumonia, and bronchiolitis	[15]
	To explore the effects of short- and long-term cold air exposure and environmental driving factors on asthma symptoms	Panel longitudinal study	37 children with asthma aged 5–11 years	Temperature and humidity exposure	Asthma	Personal temperature exposure appeared to have a stronger influence on asthma symptom variability than environmental temperature exposure	[16]
	To examine asthma prevalence among adolescents in Chongqing and its association with environmental exposure	Cohort study	4,146 children aged 10–13 years	PM2.5, temperature, and humidity exposure	Asthma	Chronic exposure to PM2.5, temperature, and humidity was associated with asthma in adolescents	[17]
India	To determine the risk of short-term PM2.5 exposure on pediatric respiratory inpatients under 6 years old in Ahmedabad	Cross-sectional study	Pediatric respiratory inpatients aged 0–6 years	PM2.5 exposure	Respiratory diseases	PM2.5 exposure significantly increased respiratory disorder cases among children, particularly during winter and post-rainfall periods	[18]
Germany	To identify and manage mental health disorders associated with extreme weather events among children and adolescents	Cross-sectional study	Professionals in pediatrics, psychiatry, pedagogy, health sciences, and sociology	Extreme weather events	Mental health disorders	Climate change-related extreme weather events negatively affected the mental health of children and adolescents	[19]
Indonesia	To study the impact of temperature and rainfall exposure on child growth indicators in Indonesia	Cross-sectional study	Children under five years old from the Indonesian Family Life Survey (1993–2015)	Extreme heat and drought	Malnutrition	Delayed rainy season onset was consistently associated with poorer child health outcomes	[20]
West Africa (Benin, Burkina Faso, Côte d'Ivoire, Ghana, and Togo)	To explore the impact of extreme temperature exposure on nutritional status among children	Cross-sectional study	32,000 children aged 3–36 months from DHS datasets	Extreme heat exposure	Macro- and micronutrient malnutrition	Extreme heat contributed to both chronic and acute malnutrition among children	[21]
Sub-Saharan Africa, South Asia, Southeast Asia, Latin America, and the Caribbean	To examine the relationship between drought exposure and diarrhea risk among children under five in LMICs	Log-binomial mixed-effects model	1,379,566 children under five from 141 surveys in 51 LMICs	Drought exposure	Diarrhea	Mild and severe drought exposure for six months increased diarrhea risk by 5% and 8%, respectively	[22]

Table 2. Classification of contributing factors and health impacts of climate change on children.

Causes	Impact	Ref
Extreme high temperatures	Malnutrition	[20,21]
	Allergies (skin, respiratory, food, general)	[14]
	Mental health	[19]
	Respiratory disease	[13]
Drought	Diarrhea	[22]
	Malnutrition	[20]
Temperature and humidity	Respiratory disease	[16,17]
Air pollution	Respiratory disease	[15,17,18]

temperature and humidity[16,17] as well as exposure to air pollution[15,17,18] are associated with respiratory diseases.

Continuous exposure to extreme heat is a major factor triggering interrelated health problems. Previous research has shown that, in terms of food security, extreme heat can reduce the nutritional quality of plants, including protein, zinc (Zn), and iron (Fn), contributing to the risk of malnutrition.[23,24] This decrease in nutritional content is caused by temperature disrupting plant physiological mechanisms, including nutrient absorption, transportation, and assimilation.[23] In addition to impacting nutrient availability, exposure to extreme heat also negatively impacts the integrity of body systems and causes tissue damage in organs.[25] Exposure to extreme heat also impacts skin health by increasing the rate of trans-epidermal air evaporation, which damages the skin's barrier function.[26] This condition is followed by the activation of pro-inflammatory proteins and transient receptor potential vanilloid (TRPV) ion channels which cause itching and redness of the skin.[27] Furthermore, extreme heat have been shown to adversely affect children's mental health, increasing the risk of stress, anxiety, depression, sleep disorders, decreased concentration, learning disorders, and behavioral problems.[28]

Drought is a form of climate change that contributes to increasing the risk of diarrhea and malnutrition in children, especially in low-income countries. Long-term drought conditions can reduce water availability and degrade sanitation, thereby increasing food contamination with pathogens that trigger diarrhea.[22] Furthermore, drought can disrupt food production and availability, ultimately impacting children's nutritional status and increasing the risk of malnutrition.[29] This creates a self-perpetuating cycle, where malnutrition weakens children's immune systems, increasing their susceptibility to various infections, including diarrhea.[30]

Humidity, temperature, air pollution, and extreme weather have been shown to impact children's respiratory health due to the high sensitivity of the respiratory system to changes in environmental conditions.[5,31] Children's respiratory systems are more vulnerable to exposure to airborne particles due to the narrow diameter of the respiratory tract, especially in the bronchioles, increasing the risk of airway obstruction and impaired respiratory function.[31] Previous research explains that air pollutants such as dust particles (PM), nitrogen oxides (NOx), sulfur oxides (SOx), and black carbon can worsen respiratory symptoms, disrupt lung development and immune responses in children.[32,33]

Overall, these findings confirm that environmental exposures related to climate change impact health. Children's physiological immaturity and high sensitivity to environmental changes further exacerbate these risks. Therefore, comprehensive mitigation and adaptation strategies are needed, including strengthening environmental health monitoring, improving food security and sanitation, controlling air pollution, and strengthening child-focused health service interventions to protect children's health and mitigate the long-term impacts of climate change.[4,34]

Conclusion

Based on the literature review, climate change factors such as extreme heat, humidity, drought, and air pollution are associated with various adverse health outcomes in children, including malnutrition, diarrhea, respiratory

diseases, allergies (skin, respiratory, food, and general), and mental health problems. These findings indicate that climate change is a significant determinant of increased health risks among children and requires greater attention in healthcare practice and further research. Preventive strategies, early monitoring, and strengthened health system capacity are essential to mitigate these impacts. Further research is needed to support evidence-based interventions and policies to protect children's health.

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Authors' Contribution

This article was written by EW, DAN, WOSM, LL, WL who contributed to all stages including conceptualization, literature search, literature screening, data extraction, results, discussion, and conclusion. EW was involved in the conceptualization and research planning, while EW and DAN participated in data collection. All authors contributed to the literature screening process. DAN and WOSM performed data extraction and developed sub-themes. The discussion and conclusion were conducted by EW, DAN, and WOSM. LL and WL made significant academic contributions through scientific guidance and assistance in the manuscript refinement process, so that the quality of this article could be substantially improved. All authors participated in providing critical revisions of the manuscript.

Conflict of Interest

All of authors declare no conflict of interest.

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