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RISING TEMPERATURES, RISING CHALLENGES: A NARRATIVE REVIEW ON STRENGTHENING CHILD GROWTH MONITORING SYSTEMS AMID CLIMATE VULNERABILITY

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Abstract

Climate change presents an unprecedented challenge to child growth monitoring systems, with vulnerable populations disproportionately affected by malnutrition, health system disruptions, and displacement. This narrative review synthesizes evidence on the impacts of climate change on child health and explores adaptive strategies, including digital health innovations, community-based interventions, and policy responses. Case studies from climate-vulnerable regions highlight the importance of integrating growth monitoring into broader climate resilience frameworks. Recommendations include strengthening multi-sectoral collaborations, prioritizing equity in funding, and fostering community engagement to ensure sustainability. This review underscores the urgency of action to protect child health amid a changing climate.

Keywords: Child growth monitoring, Climate change, Malnutrition, Digital health, Health system strengthening.

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INTRODUCTION

Child growth monitoring, encompassing the regular measurement and tracking of children's physical growth parameters such as weight, height, and head circumference, serves as a cornerstone of public health by evaluating nutritional status and identifying developmental concerns (Yap et al., 2018). Despite its universal importance, implementation challenges persist globally. In Indonesia, only 15.3% of community health posts accurately measured body weight (Kusumawati et al., 2021), while research reveals that nearly 97% of children experience growth faltering over one-month periods during infancy (Leroy et al., 2025). Furthermore, only about one-third of all countries are currently on track to halve childhood stunting by 2030 (World Health Organization, 2023), underscoring the urgent need for enhanced monitoring systems worldwide.

These pre-existing challenges are now compounded by the escalating global threat of climate change, which imposes severe burdens on child health and existing healthcare systems. Climate change is projected to cause an additional 14.5 million deaths and $12.5 trillion in economic losses by 2050, with healthcare systems facing a predicted $1.1 trillion additional burden (World Economic Forum, 2025). Environmental and occupational risk factors already account for 18.9% of global deaths and 14.4% of all disability-adjusted life years (DALYs). The urgency is underscored by 2024 becoming the first year to exceed 1.5°C above pre-industrial levels, reaching 1.55°C (World Meteorological Organization, 2025), with human-induced warming accelerating at an unprecedented rate of 0.27°C per decade (Forster et al., 2025).

For children, climate change creates cascading health impacts through multiple pathways. Extreme weather events cause displacement and psychological trauma, while disrupted food systems exacerbate malnutrition during critical developmental periods (Hadley et al., 2023; Rylander et al., 2013). Climate-induced changes in disease vector patterns increase infectious disease risks, while water shortages and poor sanitation amplify infection susceptibility (Torres-Fernández et al., 2024; Patz & Khaliq, 2002). These interconnected challenges disproportionately affect vulnerable populations in regions such as Sub-Saharan Africa, South Asia, and Pacific Islands, where economic, environmental, and social vulnerabilities converge.

The intersection of climate change impacts with existing growth monitoring deficiencies creates a critical research gap. While robust child growth monitoring systems are essential for early detection and intervention, climate change threatens to overwhelm these already-strained systems precisely when they are most needed. This convergence demands innovative approaches that strengthen monitoring capabilities while building climate resilience.

This narrative review synthesizes evidence on climate change impacts on child health and examines strategies for strengthening child growth monitoring systems in vulnerable contexts, providing actionable recommendations for policymakers and public health professionals to address these interconnected challenges in an era of environmental uncertainty.

METHODS

This narrative review synthesizes existing evidence to examine the impacts of climate change on child growth monitoring systems and to identify strategies for strengthening these systems in vulnerable contexts. The aim is to integrate insights from diverse sources to provide actionable recommendations for policymakers and public health professionals.

A comprehensive literature search was conducted across PubMed, ScienceDirect, and Scopus using keywords such as "child growth monitoring," "climate change child health," "digital health solutions," and "policy adaptation for climate vulnerability," with Boolean operators to refine results. Gray literature from the World Health Organization (WHO) and UNICEF was also reviewed to incorporate policy perspectives and practical insights.

Inclusion criteria: English-language peer-reviewed articles, case studies, and reports published within the last 10 years that employed quantitative, qualitative, or mixed methodologies. Exclusion criteria: non-English publications, studies focusing exclusively on adult populations, and publications unrelated to public health or child growth monitoring.

Regions of emphasis included Sub-Saharan Africa, South Asia, and the Pacific Islands, selected for their heightened vulnerabilities due to economic, environmental, and social factors. A thematic synthesis approach was used to identify and organize key themes: challenges in climate-vulnerable contexts, technology-driven and community-based solutions, and policy integration within broader climate adaptation frameworks.

To structure this review around a clear, theory-driven model, we adopt the following framework, which illustrates how climate stressors interact with pre-existing health system weaknesses to impair child growth monitoring and lead to adverse health outcomes.

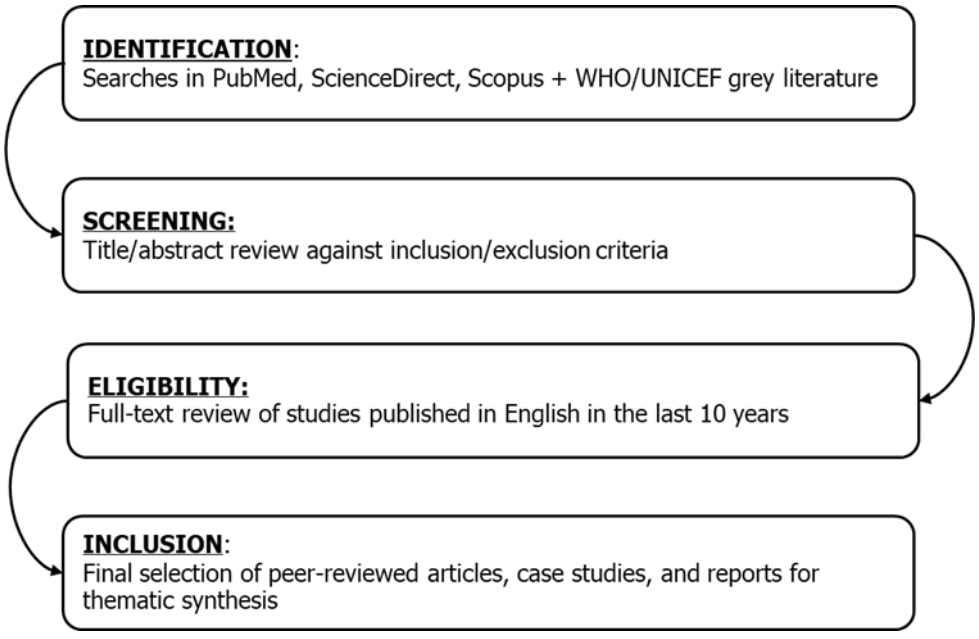

Figure 1: Narrative Review Process

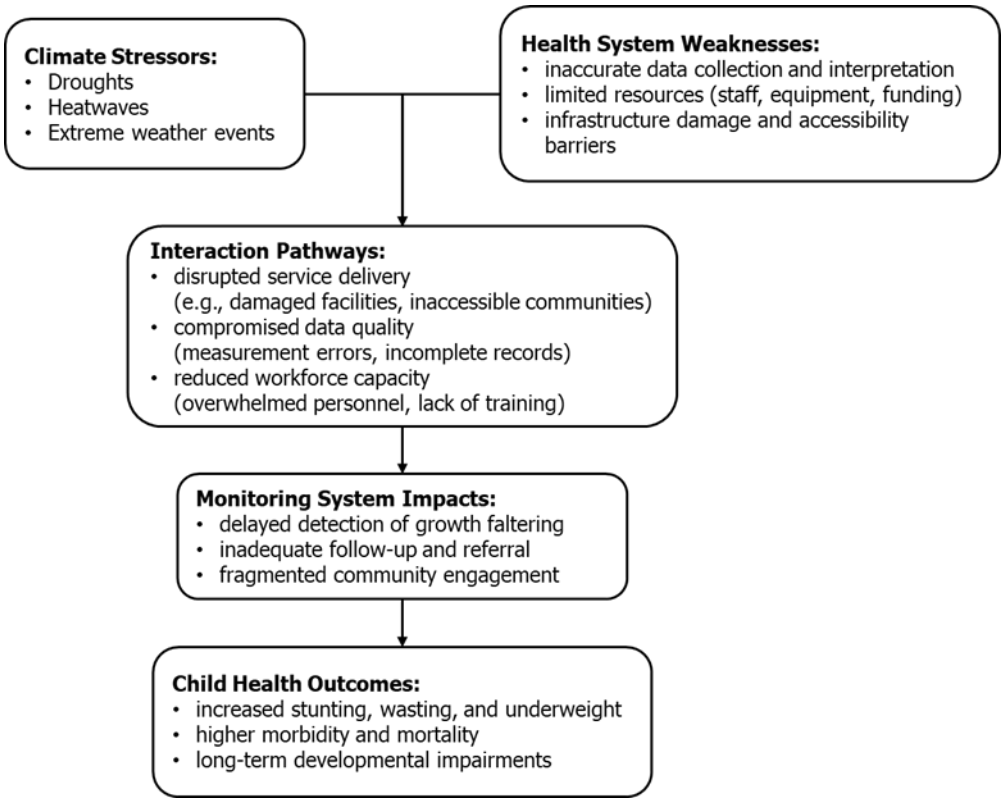

Figure 2: Conceptual framework for child growth monitoring under climate vulnerability.

RESULTS AND DISCUSSION

Synthesized Findings: Impacts and Adaptation Strategies

Climate change profoundly impacts child growth and development through three interconnected pathways: food insecurity, health system vulnerabilities, and climate-induced displacement. Food insecurity driven by crop failures, droughts, and extreme weather undermines nutritional status, leading to stunting, wasting, and underweight in children during critical early-life stages (Dimitrova, 2022; Ol, 2022). Certain groups such as boys, children of uneducated mothers, rural populations, and agricultural households are especially vulnerable due to limited coping mechanisms and resources (Dimitrova, 2022; Ol, 2022). Addressing these challenges requires comprehensive strategies such as household income support, targeted nutritional interventions, stress-tolerant crops, enhanced food markets, and social protection measures (Fanzo et al., 2024).

Health system vulnerabilities amplify climate-related impacts on growth monitoring by disrupting infrastructure and service delivery. Extreme weather events damage healthcare facilities, transportation, and communication networks, hindering child health assessments. For instance, the April 2014 floods in Honiara, Solomon Islands, destroyed infrastructure, caused a diarrhoeal outbreak, and led to ten paediatric fatalities (Natuzzi et al., 2016). Hurricanes such as Maria in 2017 further illustrate how power outages and delayed responses can result in catastrophic child health outcomes (Little & Wallace, 2020). Enhancing infrastructure resilience

and emergency preparedness through rapid environmental hazard assessments and resilient facility design is essential to maintain growth monitoring during crises (Ma et al., 2019).

Climate-induced displacement adds complexity by interrupting established monitoring systems and data continuity. Disasters force families to relocate, straining both origin and destination health services. In Bangladesh, climate-driven rural–urban migration has challenged the tracking of children's growth across settings (M.M. Ali et al, 2024), while Indonesia's economically driven migration further complicates monitoring efforts (Wahyuni et al., 2020). With projections of up to 200 million climate migrants by 2050 (Shultz et al., 2018), public health systems must integrate migration into monitoring strategies—leveraging technology, improving data collection, and fostering collaboration between affected regions (Chetto et al., 2024).

By addressing these three pathway, food insecurity, health system vulnerabilities, and displacement, policymakers and health professionals can develop holistic, climate-resilient child growth monitoring systems that safeguard vulnerable children against the multifaceted threats of a changing climate.

Digital Health Solutions

- Mobile applications for healthcare workers and parents to record and monitor growth data, enabling timely interventions and developmental assessments (Wahyudi & Sulaiman, 2024).
- Wearable devices providing continuous monitoring of vital signs and growth parameters for real-time insights into child health (Butt et al., 2024).
- Telemedicine platforms (e.g., India's Apollo Telemedicine Networking Foundation, Sehatvan mobile service) improving access to specialist paediatric care in rural and underserved areas (Chandrakar, 2024; Theodore, 2023).
- Remote patient monitoring systems allowing providers to track health indicators from a distance and tailor personalized care plans, especially for chronic conditions (Butt et al., 2024; Theodore, 2023).
- Challenges: poor internet connectivity, data privacy and security concerns; initiatives like India's Bharat Net project aim to enhance rural connectivity (Chandrakar, 2024).

Community-Based Health Initiatives

- Volunteer community health worker (CHW) models (e.g., Healthy Child Uganda) achieving reductions in diarrhoea prevalence, malaria cases, and a 53% decline in under-five mortality within 18 months (Campbell et al., 2024).
- Rural Climate Dialogues (Minnesota) engaging communities in collaborative planning to address climate-related health risks such as extreme weather and food insecurity (Myers et al., 2017).
- Climate Resilience through Community Resilience (Central Appalachia) integrating agricultural adaptation and water management to bolster food security and reduce

waterborne disease risks, indirectly supporting child growth monitoring (Campbell et al., 2024).

Capacity Building for Healthcare Workers

- mHealth platforms delivering scalable training and real-time support to HCWs in LMICs for disaster preparedness, extreme weather response, and public health emergencies (Mehmood et al., 2023).
- Nutrition education and resilience-building policies empowering HCWs to maintain effective growth monitoring under adverse conditions (Rifkin, 2023).
- Integration with international training efforts (e.g., AFHSC-GEIS collaborations on outbreak surveillance and laboratory strengthening) aligned to local priorities for sustainable capacity development (Myers et al., 2017).

Integrated, Multi-Sector Partnerships

- Public–private partnerships linking health, environmental, and education sectors to embed climate-smart agricultural practices into school feeding programs, addressing malnutrition and reducing vulnerability to climate shocks (Goncalves et al., 2024).
- Pacific Island community health programs that combine local agricultural practices with digital monitoring tools to improve both food security and child health outcomes through culturally sensitive approaches.

Policy and Global Strategies

Climate-Resilient Health System Frameworks

- Early warning systems for climate-driven health risks.
- Upgrades to healthcare infrastructure (e.g., flood- and heat-resistant clinic design).
- Improved water, sanitation, and hygiene (WASH) services.
- Community-based adaptation initiatives (Bikomeye et al., 2021; Walimah et al., 2024).

Integration into Public Health Policies

- Embedding child growth monitoring in national climate adaptation plans (Eidson et al., 2016).
- Developing child-focused vulnerability assessments to guide resource allocation (Arifuzzaman et al., 2020).
- Harmonizing protocols across national, state, and local health departments (Holmes et al., 2022).

Dynamic and Adaptive Management

- Incorporating climate modelling and continuous learning into health planning (Van Bavel et al., 2020).
- Prioritizing resilience in urban health systems, especially for marginalized communities (Hassan, 2024).
- Fostering multi-sectoral collaboration among health, environment, and education sectors (Nnaji et al., 2024).

Localized and Participatory Approaches

- Community engagement in health impact assessments (Van Bavel et al., 2020).
- Leveraging Indigenous knowledge networks for seasonal monitoring in Uganda's subsistence communities (Van Bavel et al., 2020).
- Mobile health platforms for refugee and disaster-prone settings to ensure service continuity.

Global Financing and Capacity Building

- Leveraging the Green Climate Fund and other climate finance for health infrastructure.
- Adapting national action plans (e.g., India's NAPCC) to include child monitoring systems.
- Strengthening workforce capacity through targeted training and technical assistance.

Research and Implementation Gap

Despite these frameworks and initiatives, explicit examples of climate-adapted child growth monitoring systems are scarce. This gap arises from:

- Insufficient Funding: Health-sector budgets rarely allocate dedicated resources for child monitoring within climate programs.
- Policy Disconnect: Climate adaptation policies often overlook child health priorities, while health policies may not integrate climate risks.
- Sectoral Silos: Limited collaboration between climate, health, and development agencies impedes cohesive strategy development.

Recommendations For Practise and Research

Short-Term Strategies

- Deploy digital health solutions with offline capability, including mobile health platforms and wearable monitoring devices, supported by targeted funding from governments and development agencies.

- Adapt existing healthcare facilities and deploy mobile clinics to ensure continuity of services during extreme weather events.
- Train community health workers in climate-resilient practices and provide them with resources for effective growth monitoring in diverse settings.

Long-Term Strategies

- Invest in climate-resilient healthcare infrastructure, including flood- and heat-resistant clinic design and robust supply chains for nutritional supplements and monitoring tools.
- Foster multi-sectoral partnerships between health, education, agriculture, and environment sectors to integrate climate-smart agricultural practices into nutrition and school feeding programs.
- Embed child growth monitoring within national climate adaptation plans and international health frameworks, allocating resources to prioritize vulnerable populations and address systemic inequities.

CONCLUSION

By addressing these barriers through dedicated funding streams, policy alignment, and cross-sector partnerships, global strategies can more effectively strengthen child growth monitoring under climate vulnerability.

Child growth monitoring systems must evolve to withstand the multifaceted threats posed by climate change, including food insecurity, extreme weather, and displacement which undermine infrastructure, overburden health services, and exacerbate inequities in vulnerable regions; this review demonstrates that resilience can be bolstered through targeted digital health innovations, community-based programs, capacity building, and policy integration within climate adaptation frameworks, thereby ensuring timely detection and intervention for at-risk children and guiding policymakers toward equitable, sustainable health system strengthening.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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