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Balancing Education and Health Among Rural Schoolchildren During Prolonged Heat Wave in the Philippines

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Abstract

Intensifying heat waves disrupt learning environments in the Philippines, particularly in rural areas where schools often lack adaptive infrastructure. Many rural classrooms are built with heat-retaining materials, such as concrete, which trap excessive heat, leading to indoor temperatures exceeding safe comfort levels. These conditions lead to dehydration, fatigue, and reduced cognitive function, directly impairing students' focus and academic performance. Schoolchildren are particularly vulnerable due to their developing thermoregulatory systems, higher metabolic demands, and potential preexisting health conditions. These risks are further amplified in rural communities with limited access to cooling, healthcare, and adaptive resources. These challenges require practical, context-specific interventions. Schools can adopt energy-efficient designs, improved ventilation, and passive cooling techniques to create safer indoor environments while reducing environmental and financial costs. Adjusting school schedules during periods of extreme heat can minimize exposure while minimizing disruption to education. Moreover, heat-health education programs can raise awareness and promote adaptive behaviors among students and families, thereby enhancing community resilience. Integrating climate change and heatwave preparedness into the curricula of the Commission on Higher Education and the Department of Education can equip learners with essential coping skills. Meanwhile, simple measures such as hydration protocols, shaded rest areas, and proper ventilation offer immediate protection for schoolchildren's health and learning outcomes.

Keywords: adaptive infrastructure, education, health, heat wave, Philippines

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Introduction

The recent prolonged heat waves across the Northern Hemisphere, including the Philippines, have profoundly disrupted communities, affecting millions of people and prompting the suspension of in-person classes in numerous schools due to escalating public health concerns. In some regions, temperatures have soared to an unprecedented 51°C, conditions classified as dangerous and warranting extreme caution, as heatwaves are defined by thresholds that combine maximum temperature and exposure duration.[1-5] These extreme events are not isolated; they reflect the increasing intensity and frequency of climate change-induced heat extremes globally, disproportionately affecting tropical regions.[6] In rural areas of the Philippines, where socioeconomic resources and infrastructure are often limited, balancing the dual imperatives of education and health is even more challenging amidst these relentless heatwaves.[3,7-8]

Geographically, the Philippines lies along the Pacific Ring of Fire, a 25,000-mile horseshoe-shaped belt of intense volcanic and seismic activity, where geothermal energy potential is vast due to significant heat flow from the Earth's interior. While this geothermal richness represents an important renewable energy opportunity, it also underscores the region's vulnerability to natural heat waves, necessitating adaptive approaches to community planning and learning delivery.[9,10] Moreover, anthropogenic warming amplifies the already high baseline temperatures in the tropics, which not only reduces physical comfort but also impairs cognitive performance, learning concentration, and productivity, particularly in school settings.[7] Rural classrooms, which frequently lack proper ventilation,

thermal insulation, or cooling systems, often become stifling environments that exacerbate children's vulnerability to heat-related illnesses.[3,7,8,11-13]

This study used a narrative review approach to examine the growing impact of heat waves on learning environments in the Philippines. This approach analyzed and integrated existing literature, policy documents, and institutional guidelines to provide a critical yet practical discussion that connects scientific evidence with context-specific, real-world interventions to improve school resilience to extreme heat.

Results and Discussion

Table 1 indicates that children are physiologically more susceptible to heat stress than adults because their thermoregulatory systems are still developing, they have a higher surface area-to-body mass ratio, and they rely heavily on adult supervision for self-care.[12,14-16] This heightened vulnerability increases the risks of dehydration, heat exhaustion, asthma exacerbations, and even impaired neurocognitive development when heat exposure is prolonged.[17] Traditional school environments in rural areas amplify these risks, as metal-roofed classrooms can reach internal temperatures exceeding outdoor heat by several degrees. Insufficient awareness among teachers and parents regarding heatwave risks further aggravates the situation.[8,18-19]

To address these multifaceted challenges, educators and communities can adopt innovative, and context-appropriate adaptation strategies. The reimagining of classroom spaces is an essential starting point. Outdoor learning environments shaded by trees or artificial canopies provide relief from direct sunlight and foster a deeper connection with nature, enhancing comfort, engagement, and the overall learning experience.[2,20] Similarly, retrofitting classrooms with heat-resistant building materials, such as concrete roofs or plywood ceilings under metal roofs, significantly lowers indoor temperatures, reduces overheating hours, and creates safer learning environments.[6,19] Flexible scheduling is another vital measure that enables schools to avoid the hottest parts of the day, limit strenuous outdoor activities, and suspend classes during extreme heat alerts, thereby reducing children's exposure to dangerous conditions.[8,18]

Technology also offers critical solutions. Remote learning platforms and digital resources, such as e-books, online tutorials, and virtual lectures, enable educational continuity during extreme heat by allowing schoolchildren to learn in cooler environments at home or in community cooling centers. A cool environment in

Table 1. Article Reviews on Challenges and Adaptation Strategies of Rural Schools during Heat Surge in the Philippines and Other Countries

Challenges	Descriptions/Impacts	Adaptation Strategies
Physiological vulnerability of children	Children have underdeveloped thermoregulation, a higher surface-area-to-body-mass ratio, and dependence on adults, making them prone to dehydration, fatigue, asthma exacerbations, and cognitive impairment.	Hydration protocols, teacher and student training to recognize heat-related illnesses, shaded rest areas, and heat-health education.
Overheating in traditional school infrastructure	In rural areas, metal-roofed classrooms trap heat, often exceeding outdoor temperatures, causing unsafe learning conditions and increasing absenteeism.	Retrofitting with heat-resistant materials (concrete roofs, and plywood ceilings), improved ventilation, and passive cooling are recommended.
Cognitive decline and reduced learning outcomes	Heat stress impairs neurocognitive development, reduces concentration, and worsens academic performance, especially during prolonged exposure.	Flexible academic scheduling to avoid peak heat hours, reduce outdoor activities, and shade outdoor learning environments.
Low awareness among teachers and parents	Misconceptions and limited understanding of the risks of heatwaves worsen children's vulnerability in rural schools.	Community-based awareness campaigns, involving parents and health workers that integrate heat risk education into school curricula.
Limited access to adaptive resources in rural areas	The scarcity of cooling facilities, clean water, and health services heightens risks for children in rural areas of the Philippines.	Participation in tree-planting, green schoolyards, partnerships with local agencies, and localized adaptation research.
Heat stress during physical activities and sports	Student-athletes face greater risks of heat exhaustion and reduced performance during outdoor training.	Adjusted training schedules, modified safety thresholds, wearable cooling devices, and shaded play areas.

schools means areas where the temperature is kept comfortable using natural methods or technology, such as shaded spots, better airflow, or air conditioning, helping to protect children from heat stress and supporting their health, focus, and ability to learn. Such environments are essential because prolonged exposure to extreme heat impairs children's health, behavior, and learning outcomes, increasing absenteeism, fatigue, and reduced skill acquisition over time.[4,8,14,18,21,22]

Behavioral and policy-level adaptations are equally important beyond structural interventions. Institutionalizing comprehensive heat safety protocols in schools, such as ensuring access to clean drinking water, implementing frequent hydration breaks, providing shaded rest areas, and training staff and schoolchildren to recognize and respond to heat-related illnesses, strengthens immediate protection.[15,18,22] In addition, integrating heat risk management into the health education curriculum helps build long-term resilience in children, while community-wide awareness campaigns involving parents and local health workers can enhance early prevention. Planting trees to increase shaded play areas and naturalizing schoolyards improves thermal comfort, promotes environmental awareness, and supports broader climate adaptation goals.[3,23]

These strategies recognize that heatwaves are not only environmental hazards but also systemic threats to children's health, learning, and future human capital, particularly in rural settings with limited resources. Schools can mitigate the harmful effects of extreme heat by prioritizing both immediate protective measures and long-term adaptive strategies, ensuring that education remains accessible, equitable, and safe in an increasingly warming world.[24]

Addressing the intensifying challenges of extreme heatwaves in the rural Philippines calls for a multi-layered approach that combines climate-resilient infrastructure, adaptive pedagogy, and health-focused interventions. These strategies align with the Philippines' commitment to achieving the UN Sustainable Development Goal No. 4 on inclusive and equitable education under the 2030 Incheon Declaration for Education.[7] Rural classrooms, particularly those with metal roofs, often reach temperatures higher than outdoor levels, exacerbating dehydration, cognitive fatigue, and absenteeism among schoolchildren.[6,16] Retrofitting schools with concrete roofs, plywood ceilings under metal roofs, improved ventilation, and shaded outdoor areas significantly reduce indoor overheating, creating safer and more conducive learning environments.[19,25] In addition to these physical improvements, implementing flexible academic scheduling, organizing shaded assemblies, and reducing outdoor activities during peak heat periods helps minimize direct heat exposure.[8,16,26]

Health-focused interventions enhance resilience, particularly in rural schools, where children's vulnerability is increased by limited access to healthcare services. These interventions include integrating heat risk awareness into the curriculum, training teachers and schoolchildren to recognize heat-related illnesses, and promoting proper hydration practices.[8,27] In rural areas, where water scarcity and poor infrastructure often intensify the risks of extreme heat, community-based initiatives have become even more critical. Therefore, partnerships between the education office and local communities play a vital role in supporting vulnerable groups, particularly children living in poverty or with preexisting health conditions, who are disproportionately affected by heat extremes.[11,13,28]

However, much of the existing research on extreme heat has been conducted in the Global North, leaving significant gaps in understanding the lived realities of rural and underserved communities in the Global South, despite evidence that they are likely to experience the most severe impacts. Addressing these gaps is essential to designing inclusive, context-specific adaptation strategies that better protect children, who remain among the most vulnerable as global temperatures continue to rise.[22,28,29] Nature-based solutions, such as tree planting and green schoolyard programs, offer dual benefits by mitigating thermal stress and fostering environmental awareness among schoolchildren.[23,30]

In rural contexts, where open spaces are often abundant but underutilized, community participation can adapt such initiatives to local ecosystems. Localized climate adaptation research involving higher education institutions can inform evidence-based policies that consider both urban and rural needs, while innovative cooling interventions, such as misting systems or wearable cooling vests, can enhance comfort during outdoor activities in schools with limited structural protection.[13,18,26,31] By combining infrastructural retrofitting, flexible learning policies, technological integration, and community-led adaptation efforts, Philippine educational agencies such as the Commission on Higher Education and the Department of Education can create learning environments that safeguard

children's health, enhance educational equity in both urban and rural schools, and sustain academic engagement in an increasingly warming climate.

Conclusions

This study highlights the vital role of health-focused, community-driven interventions in strengthening schoolchildren's resilience, particularly in rural areas where limited access to healthcare increases vulnerability to extreme heat. Given the persistent research gap between the Global North and the Global South, developing context-specific adaptation strategies that respond to the lived realities of rural and underserved communities is crucial to ensure that children, especially those living in poverty or with health risks, are not left behind. Nature-based and technological interventions, such as green schoolyards, tree planting, and innovative cooling systems, can effectively reduce thermal stress while promoting environmental awareness. By aligning infrastructure improvements, flexible learning systems, and community participation, the Commission on Higher Education and the Department of Education can create safer, more equitable learning environments that protect children's health and sustain educational engagement amid a rapidly warming climate.

Abbreviations

None.

Ethics Approval and Consent to Participate

Not applicable.

Competing Interest

The author confirmed that he had no conflicts of interest to disclose.

Availability of Data and Materials

Not applicable.

Authors' Contribution

EO was solely responsible for the manuscript's preparation, including editing, reviewing, revising, and organizing, leading to its final version.

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Declaration on the Use of Artificial Intelligence

The author declared that an Artificial Intelligence (AI) tool was used for language editing and grammatical refinement to enhance the clarity and readability of the manuscript. Specifically, ChatGPT was utilized for this purpose. The AI tool further assisted in organizing ideas derived from the literature review.

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