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Review Article

Impact of Heatwaves on Newborns and the Elderly in India

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I N F O

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A B S T R A C T

Heatwaves are having serious health impacts on newborns and the elderly. As climatic change is increasingly evident in many parts of India, the frequency and duration of heatwaves are rising, intensifying the vulnerability of these populations. Under such circumstances, overall planning for a resilient health system for newborns and the elderly is urgently required. All categories of healthcare workers should be trained to identify warning signs and remedial measures. Similarly, people must be made aware of the consequences of heat exposure and should be given tips for home-based management.

Keywords: Climate Change, Heatwaves, Health Impact, Neonates, Senior Citizen

Introduction

Heatwaves have a significant impact on the health of vulnerable populations such as newborns and the elderly in India. Studies have shown that during heatwaves, the risk of mortality can increase by 20–30% for these vulnerable populations. Heatwaves have become increasingly frequent and intense in India due to climate change, posing significant health risks, especially to vulnerable populations such as newborns and the elderly.

Impact on Newborns

- **Physiological vulnerability:** Newborns have limited thermoregulatory capabilities, making them highly susceptible to heat stress. Studies have shown that extreme heat can lead to dehydration, hyperthermia, and electrolyte imbalance in newborns, exacerbating their vulnerability to high mortality.[1] Exposure to higher temperatures can lead to stillbirth.[1] During pregnancy, women's ability to regulate heat is decreased due to normal physiologic changes, such as increased hormonal sensitivity and changes in circulation and blood volume. This leads to adverse heat-related health effects on pregnancy outcomes such as foetal distress, neonatal intensive care unit (NICU) admissions, foetal growth restriction or low birth weight, congenital birth defects, diarrhoeal disease, vector-borne diseases (VBDs), and sudden infant death syndrome (SIDS).[2,3,4]
- **Health outcomes:** Basu et al.[5] highlight increased rates of preterm birth and low birth weight during periods of extreme heat in India. These conditions are associated with long-term health implications for newborns, including developmental delays and respiratory problems.
- **Geographical variability:** The impact of heatwaves on newborns varies across regions in India due

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to differences in climate, infrastructure, and socioeconomic factors. Coastal areas, for instance, may experience higher humidity levels exacerbating heat-related health risks.[6]

Impact on the Elderly

- **Physiological changes:** Aging reduces the body's ability to adapt to heat stress, making the elderly more prone to heat-related illnesses such as heatstroke, dehydration, and cardiovascular complications.[7]
- **Morbidity and mortality:** Studies have documented increased hospital admissions and mortality rates among the elderly during heatwaves in India (Goswami et al., 2015). The prevalence of chronic conditions like diabetes and hypertension further heightens their susceptibility to heat-related health impacts.
- **Social determinants:** Socioeconomic factors such as access to air conditioning, healthcare services, and social support networks significantly influence how heat waves affect the elderly in different regions of India.[8]

Public Health Interventions and Adaptation Strategies

- **Early warning systems:** Implementing effective heatwave early warning systems tailored to regional climates can help mitigate the impact on vulnerable populations, including newborns and the elderly.[9, 10]
- **Healthcare preparedness:** Strengthening healthcare infrastructure to handle increased patient load during heatwaves is crucial. This includes training healthcare professionals to recognise and manage heat-related illnesses promptly (Goswami et al., 2015).
- **Community outreach:** Public education campaigns aimed at raising awareness about heatwave risks and promoting adaptive behaviours, such as staying hydrated and seeking cool environments, are essential for protecting vulnerable groups (Garg et al., 2017).

This study explores how extreme heat affects these groups, the social and economic factors that worsen these effects, and the effectiveness of current public health strategies. It also highlights areas where policies can be improved and offers suggestions for better preparedness and reducing the negative effects of increasing temperatures.

Methodology

This study employs a systematic literature review approach to examine the impact of heatwaves specifically on newborns and the elderly in India. The review findings from existing studies provide a comprehensive overview of the health effects, vulnerability factors, and adaptation strategies related to heatwaves in these vulnerable populations.

Search Strategy

- **Database selection:** Relevant electronic databases such as PubMed, Google Scholar, Scopus, and Web of Science were systematically searched to identify peer-reviewed articles, reviews, and reports published between 2000 and 2023. These databases were chosen for their comprehensive coverage of biomedical and environmental science literature.
- **Search terms:** The search strategy included combinations of keywords such as "heatwave," "heat stress," "climate change," "newborn," "infant," "elderly," "aged," "India," and "health impact." Boolean operators (AND, OR) were used to refine searches and maximise retrieval of relevant literature.

Inclusion criteria

1. Studies conducted in India or specific to Indian subpopulations
2. Studies focusing on heatwaves and their health impacts on newborns (up to 28 days old) and elderly individuals (aged 65 years and above)
3. Articles written in English and published in peer-reviewed journals
4. Studies that reported empirical data on health outcomes, vulnerability factors, adaptation strategies, or public health interventions related to heatwaves

Exclusion criteria

1. Studies not specific to heatwaves or focused on other extreme weather events (e.g., cold waves, floods)
2. Studies lacking primary data or those based solely on modelling or projections
3. Articles not accessible in full-text or lacking sufficient detail for data extraction

Data Extraction and Synthesis

- **Data extraction:** Relevant data from selected studies were extracted, including study design, population characteristics, heatwave definition and duration, health outcomes observed, vulnerability factors identified (e.g., socioeconomic status, access to healthcare), and adaptation strategies discussed.
- **Quality assessment:** Each included study was critically appraised for methodological rigour, sample size, representativeness of the population studied, and appropriateness of statistical methods used.
- **Data synthesis:** Findings were synthesised thematically to identify common health impacts of heatwaves on newborns and the elderly in India. Themes may include physiological responses to heat stress, morbidity and mortality rates, regional disparities, and the effectiveness of adaptation strategies.

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Ethical Considerations

This review involves secondary analysis of publicly available data from published studies and does not require ethical approval. Proper attribution and citation of original authors' work are ensured throughout the review process.

Results

Heatwaves in India

The increasing frequency and severity of heatwaves in India pose a serious threat to public health, infrastructure, and the economy. As temperatures rise due to climate change, the country is experiencing more frequent and intense heatwaves, especially in regions like the Indo-Gangetic Plain and central India. These areas are particularly vulnerable due to their high population density, inadequate infrastructure, and limited access to resources.

Heatwaves can have a range of impacts on society, including power outages, water shortages, agricultural losses, and strain on healthcare systems. The most vulnerable populations during heatwaves are often the elderly, children, and individuals with pre-existing health conditions. The extreme heat can lead to heat-related illnesses such as heat exhaustion, heatstroke, and dehydration, which can be life-threatening if not addressed promptly.

In addition to the immediate health impacts, heatwaves can also have long-term consequences on the economy and infrastructure. For example, power outages during heatwaves can disrupt essential services, such as healthcare, transportation, and communication, leading to economic losses and decreased productivity. Moreover, the strain on health infrastructure during heatwaves can overwhelm hospitals and healthcare facilities, further exacerbating the impact on vulnerable populations.

Effects on Newborns

Increased Risk of Dehydration and Electrolyte Imbalance

Due to their unique physiological characteristics, newborns are highly vulnerable to fluid and electrolyte imbalances during heatwaves. Their underdeveloped thermoregulatory systems and high surface area to body mass ratio make them more susceptible to dehydration and electrolyte disturbances than older children and adults.

During heatwaves, newborns are at risk of excessive sweating, which can lead to rapid fluid loss and electrolyte imbalances. Additionally, their immature kidney function may not be able to efficiently regulate electrolyte levels in the body, further increasing the risk of complications.

Depleting essential electrolytes like sodium, potassium, and calcium can have serious consequences for newborns. Electrolytes play a crucial role in maintaining proper nerve and muscle functions, as well as regulating fluid balance in the body. When these electrolytes are imbalanced, newborns may experience symptoms such as weakness, irritability, seizures, cardiac arrhythmias, and organ dysfunction.

Susceptibility to Heat-Related Illnesses

Newborns are indeed at a higher risk of developing heat-related illnesses, such as heat exhaustion and heat stroke, during heatwaves. Their underdeveloped thermoregulatory systems and limited sweat response make it challenging for them to effectively regulate their body temperature in hot weather conditions.

When exposed to high temperatures, newborns can quickly become overheated, leading to hyperthermia, a condition characterised by an elevated body temperature. This can manifest as symptoms such as fever, irritability, lethargy, rapid breathing, and in severe cases, seizures. Hyperthermia can progress rapidly and result in heat exhaustion or heat stroke if not addressed promptly.

Heat exhaustion is a milder form of heat-related illness that can occur when the body is unable to cool itself effectively. Symptoms of heat exhaustion in newborns may include excessive sweating, cool and clammy skin, nausea, and vomiting. If left untreated, heat exhaustion can progress to heat stroke, a more severe condition characterised by a dangerously high body temperature, confusion, rapid heart rate, and loss of consciousness.

Elevated Risk of Respiratory Distress and SIDS

Heatwaves can indeed exacerbate respiratory problems in newborns, putting them at an increased risk of respiratory distress and potentially contributing to the risk of Sudden Infant Death Syndrome (SIDS). The combination of high temperatures, humidity, and poor air quality can place a strain on an infant's immature respiratory system, making it harder for them to breathe properly.

Newborns are more susceptible to respiratory issues during heatwaves due to their smaller airways and underdeveloped respiratory muscles. When exposed to extreme heat and poor air quality, newborns may experience symptoms such as laboured breathing, wheezing, coughing, and apnoea (pauses in breathing). These respiratory difficulties can lead to serious complications and may even be life-threatening if not addressed promptly.

One of the key ways to protect newborns from respiratory problems during heatwaves is to maintain a cool, well-ventilated environment. Keeping the infant's living space at a comfortable temperature, using fans or air conditioning to circulate air, and ensuring good indoor air quality can help reduce the risk of respiratory distress. It is also important to avoid exposing newborns to smoke, pollutants, or allergens that can further irritate their delicate respiratory systems.

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Closely monitoring newborns for any signs of respiratory distress is crucial during heatwaves. Parents and caregivers should pay attention to changes in the infant's breathing patterns, such as rapid or laboured breathing, wheezing, or coughing. If a newborn shows signs of respiratory distress, it is essential to seek medical attention promptly to prevent complications and ensure proper treatment.

In the context of Sudden Infant Death Syndrome (SIDS), heat waves can potentially increase the risk of sudden and unexplained infant death. While the exact causes of SIDS are still not fully understood, environmental factors such as overheating, poor air quality, and respiratory issues have been implicated as potential contributors to SIDS cases. By taking steps to maintain a safe and comfortable environment for newborns during heatwaves, caregivers can help reduce the risk of SIDS and protect their infants from respiratory complications.

Increased Likelihood of Preterm Birth and Low Birth Weight

Heatwaves can indeed have significant implications for foetal development, potentially leading to adverse outcomes such as preterm birth and low birth weight. The impact of extreme heat on pregnant individuals can induce stress and trigger physiological responses that may affect the developing foetus. Maternal stress during pregnancy has been associated with an increased risk of preterm birth and low birth weight.

Furthermore, extreme heat can also disrupt placental function, which is essential for providing oxygen and nutrients to the developing foetus. Any disruption in placental function can compromise foetal growth and development, leading to potential complications during pregnancy and childbirth.

Newborns born preterm or with low birth weight are already vulnerable and may have underdeveloped thermoregulation systems, making them more susceptible to the effects of heat waves. These infants may struggle to regulate their body temperature effectively, increasing their risk of heat-related complications and heat stress.

Importance of Hydration, Nutrition, and Proper Clothing

Hydration, nutrition, and proper clothing are essential components of ensuring the well-being of newborns during heatwaves.

Hydration

Newborns are more susceptible to dehydration during heatwaves due to their small size and immature thermoregulatory systems. Parents must prioritise hydration by offering breastmilk or formula frequently, as well as plain water for older infants if recommended by healthcare providers. Signs of dehydration in newborns include dry mouth, sunken fontanels (soft spots on the baby's head), and decreased urine output. Promptly addressing dehydration is essential to prevent complications such as heat exhaustion or heat stroke.

Nutrition

Proper nutrition plays a key role in supporting the body's ability to cope with heat stress. Healthcare providers should advise parents on maintaining a balanced diet for their newborns, including foods rich in electrolytes, minerals, and hydration. Breastmilk or formula should remain the primary source of nutrition for infants, supplemented with hydrating foods such as fruits and vegetables. Adequate nutrition can help newborns maintain their energy levels and stay hydrated during periods of high heat.

Clothing

The clothing newborns wear during heatwaves can significantly impact their comfort and safety. Parents should dress their infants in lightweight, breathable fabrics that allow for efficient heat dissipation. Over-bundling can lead to overheating and increase the risk of heat-related illnesses. Choosing appropriate attire, such as loose-fitting outfits and hats to protect from the sun, can help regulate the baby's body temperature and prevent heat stress. It's important to check the baby's temperature by feeling their neck or back to ensure they are not overheating.

By prioritising hydration, nutrition, and proper clothing during heatwaves, parents can help protect their newborns from the potential risks associated with extreme temperatures. Consulting with healthcare providers for personalised recommendations and staying informed about heat safety guidelines can further support the well-being of infants during hot weather conditions.

Recommendations for Mitigating Heatwave Impacts

Mitigating heatwave impacts is crucial to protect vulnerable populations, including newborns. Here are some recommendations for healthcare providers, parents, and policymakers:

Healthcare Providers

- Educate parents on the risks of heatwaves and the importance of proper hydration, nutrition, and clothing for newborns.
- Provide specific guidance on how to keep newborns cool and hydrated during hot weather.
- Monitor newborns closely for signs of heat-related illness and provide prompt medical attention if needed.

Parents

- Keep newborns in cool, well-ventilated environments during heatwaves.

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- Limit outdoor activities during peak heat hours and seek shade when outdoors.
- Dress newborns in lightweight, breathable clothing and use hats to protect them from the sun.
- Offer frequent breast milk or formula to ensure adequate hydration.
- Be vigilant for signs of heat stress or dehydration and seek immediate medical attention if any concerning symptoms arise.

Policymakers

- Invest in infrastructure improvements to provide accessible cooling centres for vulnerable populations, including newborns and their families.
- Implement policies to ensure affordable access to air conditioning for low-income households.
- Develop heat emergency response plans that include specific measures for protecting infants and young children.
- Support community outreach and education programs to raise awareness about heatwave risks and prevention strategies.
- Collaborate with healthcare providers and local organisations to ensure coordinated efforts in mitigating heatwave impacts on newborns and other at-risk groups.

By working together, healthcare providers, parents, and policymakers can take proactive steps to protect newborns and vulnerable populations from the impacts of heat waves and ensure their safety and well-being during extreme weather events.

Elderly

Physiological Vulnerabilities of the Elderly

The elderly population face a range of physiological disadvantages that heighten their sensitivity to extreme heat. These include diminished sweat gland function, reduced cardiovascular fitness, and impaired thermoregulation which are crucial for the prevention of the adverse impact of heat. Additionally, many elderly individuals take several medications for their pre-existing health problems that interfere with the body's ability to regulate temperature, putting them at an even greater risk of heat-related illnesses like heat stroke, dehydration, and heat exhaustion. Preexisting medical conditions, such as cardiovascular and respiratory diseases, further compound these vulnerabilities, making the elderly far more susceptible to the devastating health consequences of heatwaves.

Increased Mortality Rates During Heatwaves

The elderly population in India is particularly vulnerable to the effects of heatwaves due to age-related physiological changes, underlying health conditions, and limited access to resources. Heat-related illnesses such as heat stroke, dehydration, and heat exhaustion can lead to serious complications and even death in the elderly. One of the key challenges faced by the elderly during heatwaves is their reduced ability to regulate body temperature and adapt to extreme heat.

Limited access to cooling systems, inadequate housing conditions, and lack of awareness about heatwave risks further compound the vulnerability of the elderly population in India. Many elderly may not have access to air conditioning or fans, live in poorly ventilated homes, or lack the financial resources to afford cooling measures during heatwaves.

Socioeconomic Factors Exacerbating the Crisis

- **Poverty and Lack of Resources**: Many elderly Indians, especially those living in rural areas or urban slums, lack access to necessities like clean water, nutritious food, and adequate shelter. This socioeconomic disadvantage compromises their ability to cope with the additional stresses of extreme heat, making them even more vulnerable to heat-related illnesses and mortality.
- **Social Isolation and Neglect**: The elderly in India often face social isolation and neglect, particularly those without family support networks. This lack of a social safety net can prevent them from accessing essential resources and seeking timely medical attention during heatwaves, further exacerbating the crisis.
- **Gender Disparities**: Elderly women in India face disproportionate challenges, as they often have lower socioeconomic status, reduced access to healthcare, and limited decision-making power within the household. These gender-based inequalities compound the vulnerabilities of older women during heatwave events.

Community-Based Support Systems

- **Neighbourhood cooling centres:** Establishing community-based cooling centres in residential areas, with access to water, shade, and basic medical care, can provide vulnerable elderly residents protection from heat waves.
- **Volunteer-led outreach:** Engaging local volunteers to conduct regular welfare checks on elderly residents, distribute information on heat-related health risks, and assist with essential tasks can help mitigate the impacts of extreme heat events.
- **Intergenerational solidarity:** Fostering intergenerational support networks, where younger community members assist and care for the elderly, can strengthen the social safety net and improve access to critical resources during heat waves.
- **Elderly-centred disaster response:** Incorporating the unique needs and vulnerabilities of the elderly into

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community-level disaster preparedness and response plans can ensure that this population receives the targeted support they require during extreme heat events.

Government Policies and Interventions

Heat Action Plans

The development and implementation of comprehensive heat action plans, led by state and local governments, can help mitigate the impact of heat waves on the elderly through early warning systems, cooling infrastructure, and targeted public outreach campaigns.

Improved Healthcare Access

Increasing the availability and affordability of healthcare services, particularly in remote affordability of healthcare services, particularly in remote and underserved areas, can ensure that the elderly have access to the medical care they need during extreme heat events.

Social Protection Schemes

Strengthening and expanding social protection programs, such as pensions, food subsidies, and housing assistance, can help address the socioeconomic vulnerabilities of the elderly and improve their resilience to heat waves.

Capacity Building

Investing in training and capacity-building programmes for healthcare professionals, community volunteers, and caregivers can aid in better recognising and responding to heat-related illnesses in the elderly.

Data Collection and Research

Improving data collection and research on the impacts of heatwaves on the elderly, including mortality rates, health outcomes, and socioeconomic factors, can inform more effective policies and interventions.

Multisectoral Collaboration

Fostering collaboration between government agencies, healthcare providers, community organisations, and the private sector can help to develop and implement comprehensive strategies to protect the elderly from heatwave risks.

Gaps in Current Policies and Interventions

Lack of Targeted Strategies

Current policies and interventions often lack a targeted approach to address the specific needs of newborns and the elderly, leaving these vulnerable populations inadequately protected during heat waves.

Inadequate Funding and Resources

Public health programs aimed at mitigating heatwave impacts are often underfunded, limiting their ability to scale and reach the most affected communities.

Insufficient Coordination

Effective coordination between different government agencies, healthcare providers, and community organisations is crucial but often lacking, hindering a comprehensive and coordinated response to heatwave emergencies.

Limited Data and Research

Gaps in data collection and research on the long-term health impacts of heatwaves, particularly on newborns and the elderly, impede the development of evidence-based policies and interventions.

Recommendations for Improving Heatwave Preparedness

Targeted Interventions

Develop and implement targeted strategies to protect newborns and the elderly, including dedicated cooling centres, mobile healthcare units, and enhanced home-based care support.

Strengthened Early Warning Systems

Improve the accuracy, timeliness, and accessibility of early warning systems, ensuring that alerts reach the most vulnerable populations through multiple channels, including mobile apps and community-based outreach.

Increased Funding and Resources

Allocate sufficient funding and resources to public health programs focused on heatwave preparedness and response, enabling the expansion of critical infrastructure and services.

Limitations

- **Publication bias:** The review may be subject to publication bias, as studies with significant findings are more likely to be published. We were unable to review unpublished documents and isolated reports on the impact of heatwaves on newborns and the elderly.
- **Data heterogeneity:** Variability in study methodologies and definitions of heatwaves across studies may limit the comparability and generalisability of findings.

Conclusion and Future Research Directions

Heatwaves pose a serious threat to public health in India, with newborns and the elderly bearing the brunt of the physiological impacts. Addressing this issue requires a multifaceted approach that addresses the gaps in current

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policies, enhances community resilience, and fosters greater collaboration between stakeholders. Continued research on the long-term health implications of heatwaves, as well as the development of innovative solutions, will be crucial in safeguarding the most vulnerable members of society.

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