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## Original Research Paper

# Evaluating the public health impact and Ecosystem impacts of rising temperatures on the heat-related illnesses in vulnerable populations

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**Key Words**

Heat-related illnesses, Vulnerable populations, Climate change, public health impact, Epidemiological analysis, Ecosystem health.

**Abstract**

This paper analyses the health of the general Population in the context of elevated temperatures and heat-related illnesses (HRIs), and their prevalence among at-risk groups, such as the elderly, children, and individuals with underlying health issues. This will add to the health consequences of heat in places ill-equipped to accommodate such changes in climate, as both the intensity and frequency of heat waves are on the rise. The primary objective will be to identify the relationship between rising temperatures and the occurrence of HRIs, with a specific focus on vulnerable groups. This paper estimates the temperature thresholds associated with high HRI using a combination of epidemiological analyses, climate models, and health surveillance systems. Rising temperatures also place wildlife and domesticated animals at elevated risk of heat stress, dehydration, and habitat disruption. Evidence shows that many species experience altered behavior, reduced thermoregulation capacity, and increased mortality during extreme heat events, making animals important early indicators of environmental heat severity. These ecosystem disturbances indirectly shape human vulnerability by destabilizing natural systems. The results of the research indicate that certain interventions are needed in the sphere of public health development, such as the development of heat-related health warning systems and community-based climate change adaptation data, to reduce risk and protect the vulnerable Population. The paper has indicated an intersection between climate change and human health and that there is a need to collaborate to minimize the health impact in the future.

## Introduction

Climatic change, driven by increased atmospheric concentrations of greenhouse gases, has caused global temperatures to rise, with significant impacts on the environment and human well-being. With rising temperatures, particularly during heatwaves, the occurrence of heat-related issues (HRIs), e.g., heat stroke, heat exhaustion, and dehydration, will increase

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further, thereby placing greater pressure on people's health systems globally. At risk are especially vulnerable groups: the elderly, children, and those with preexisting conditions, and low-income communities, because they are more exposed to excessive heat and less adaptable to the changing climate due to the lack of access to cooling facilities, poor housing, or underlying health issues (Mayrhuber et al., 2018). In addition, the coexistence of climate change and social determinants of health is highlighted by the fact that rising temperatures exacerbate current health disparities. The significance of examining the effect of increasing temperatures on disadvantaged groups cannot be overestimated. The intensification and length of heatwaves, which have been on the rise and have been accompanied by severe weather conditions over the past decades, are expected to accelerate due to climate change (Escobedo et al., 2024).

The result of this trend is that we are likely to experience a wave of heat-related illnesses that will heavily strain the health care system, particularly in regions that lack adequate infrastructure to handle heat waves (Hasan et al., 2021). Knowledge of the health dangers of rising temperatures is vital to planning for population health, as it helps policymakers take preventive actions, distribute resources efficiently, and provide targeted interventions for the most vulnerable groups (Bassey et al., 2025). The mitigation of health effects of heatwaves should lie in the early recognition of those populations who are more vulnerable and how to adapt to them, including heat-health warning systems and cooling centers. The research question to be addressed in the center of the research is as follows: What is the impact of an increase in temperature on the prevalence of heat-related illnesses among vulnerable populations?

The purpose of this question is to investigate the connection between rising temperatures and the number of HRIs and the reasons why some groups of people are more prone to heat stress (Vescovi et al., 2005). This study aims to provide meaningful information on the role of temperature changes and heatwave phenomena on the Population, and, more specifically, on vulnerable groups, through investigations into how climate change is affecting health outcomes and the best means of reducing their effects (Dewangan et al., 2025; Welbergen et al., 2008). This paper will begin by introducing the connection between climate change, rising temperatures, and population health, focusing on the risk of heat-related illnesses (HRIs) escalating among vulnerable groups. Extreme heat also affects wildlife and domestic animals, which face increased physiological strain as temperatures climb. Studies show that many species experience elevated body temperatures, reduced foraging efficiency, and abnormal migration or shelter-seeking behaviors during heatwaves. These responses signal broader ecosystem stress, as animals often exhibit heat sensitivity before equivalent impacts appear in human populations. Wildlife mortality events during extreme heat observed in birds, bats, and terrestrial mammals illustrate how rising temperatures disrupt ecological balance and diminish the resilience of natural systems. Understanding these animal-environment

responses supports a more comprehensive perspective on how climate-driven heat can destabilize both ecosystems and human health (McKechnie et al., 2021). The literature review will discuss the available research on the impact of environmental changes, especially temperature extremes, on health outcomes with special reference to the less privileged in society, e.g., the elderly, children, and people with preexisting conditions.

The conceptual framework will describe key variables, including temperature thresholds, demographic factors, and health outcomes. The study objectives will be to determine the effect of increasing temperatures on the occurrence of HRIs in these populations and also to determine the major risk factors. The methods section will outline the data collection process, which will involve analyses of temperature and health data. Results will be presented and correlation between rise in temperature and HRIs will be proven. Lastly, a discussion on policy implications will be provided, and the necessity of specific public health measures to reduce the effects of heatwaves.

## Literature Review

Climate change has caused the global temperatures to rise, resulting in more frequent and intense heatwaves. With rising heat, heat-related medical complications such as heatstroke, heat exhaustion, and dehydration are on the rise. These health hazards are further compounded by the increased intensity and frequency of extreme heat events, which add additional pressure on public health systems. Increased temperatures also worsen existing health and health-related issues, further burdening health facilities and leading to higher morbidity and mortality rates. The relationship between heat-related illnesses and climate change underscores the need for public health adaptation measures to address the increasing risks (Kjellstrom et al., 2010).

Margolis (Odame et al., 2018) highlights the determinants of vulnerability (Socioeconomic status, age, and preexisting health conditions) in relation to the severity of heat-related health outcomes. Elderly, children, people with chronic illnesses (heart disease, diabetes, respiratory complications, etc.), and the poor are particularly vulnerable to the impact of extreme heat. Vulnerable persons have no means or capacity to avoid exposure to heat due to mobility limitations, impaired thermoregulation, or lack of access to cooling facilities. To illustrate this, older people are less adapted to changes in temperature and are more likely to experience severe health effects from exposure to heat. On the same note, children are more vulnerable because they experience increased metabolism and ineffective cooling mechanisms. According to Hess et al., (2023), the needs of vulnerable groups in the case of extreme heat events require careful preparation in terms of the population health. Having heatwaves has both direct and indirect health effects. Heat exhaustion and heatstroke are the immediate consequences that can cause severe complications and even death in the case when the situation is not properly addressed. The unnecessary exposure to heat can also cause dehydration, heat cramps and cardiovascular stress. Extreme heat may indirectly worsen such chronic diseases as

asthma, heart disease, and mental health issues. Also, the economic effects of the heatwaves include lower labor productivity and increased healthcare expenditure, further depleting people's health resources (Margolis, 2020).

The systematic review by Faurie et al. (2022) confirms a strong association between high temperatures and heat-related illnesses across regions. In response to these increasing health risks, several interventions by various government health bodies have been designed to reduce the effects of heatwaves. The Heat-Health Warning System (HHWS) is widely used to warn the community about upcoming extreme heat events, enabling individuals at risk to take action. Alternative measures include establishing cooling centers, disseminating information on heat-related health risks, and improving urban planning to increase green cover and alleviate the urban heat island effect. Nevertheless, even with such attempts, a significant part of the world continues to struggle with the the effective management of the health hazards posed by heatwaves, particularly in regions with limited infrastructure, resources, and sufficient popular education. A structured review by Bassil and Cole (2010) found that most public health interventions have been successful in reducing heat morbidity and mortality, but their implementation has been inconsistent. The analysis of heat vulnerability indices, e.g., the one conducted by Reid et al., (2012), demonstrates the importance of dedicated measures to address high-risk communities, thereby reducing the impact of heat episodes. With further study and better execution of governmental health policies, the effects of increasing temperatures on the susceptible Population may be mitigated, yet complex strategies are necessary to safeguard Population's health. Price et al. (2018) reviewed the effectiveness of the heat response plan implemented in Montreal, suggesting that successful heatwave management is possible only with sound healthcare professional involvement and city-based interventions.

## Objectives of the Study

The main hypothesis of the study is to measure the association between rising temperatures and the prevalence of heat-related illnesses (HRIs) among vulnerable groups. Since the occurrence and severity of heatwaves is on the rise, owing to the change in climate, the direct impact of temperature increase on the health of individuals must be comprehended, especially those who are at an increased risk because of their vulnerability, e.g., the aged, children, and individuals with preexisting health conditions. By analyzing the correlation between temperature readings and the frequency of HRIs, this research will help provide a more accurate understanding of the role of elevated temperatures in the growing burden of heatwaves on population health. Besides the main goal, the research has several secondary goals. Among the primary secondary objectives, one should agree on the temperature ranges that can be assumed to be thresholds beyond which HRIs become much more common. This will help in determining the severe levels of temperature beyond which heat related diseases take place and this data holds significance in planning and healthcare

interventions of the Population. The awareness of such thresholds is required in order to develop early warning systems and preventive interventions. The other important secondary objective is to establish the effectiveness of the current interventions that are aimed at preventing heat-related illnesses among the vulnerable populations. These interventions may be heat-health warnings, cooling facilities, or social education. The proposed study will help to determine the flaws in the current strategies and will be used to improve them with more efficient implementation and better accessibility, which will minimize the health risks of increasing temperatures on the vulnerable Population.

## Methods

The study will use a cross-sectional design to examine the relationship between elevated temperatures and the occurrence of heat-related illnesses (HRIs) among at-risk groups. The cross-sectional methodology enables analysis of health data at a given point in time; that is, one can compare temperature variations and related health outcomes within that time frame. The design is especially appropriate to the study of the possible outcome of extreme heat events on the health outcomes of an intended population.It indicates the current state of heat-related health risks. Data gathering will be based on several important elements. The temperature data will be obtained from meteorological databases, such as the National Oceanic and Atmospheric Administration (NOAA), and from local weather stations, which will provide daily temperature readings. Also, climate models like those used by the Intergovernmental Panel on Climate Change (IPCC) will be used to forecast future trends in temperatures and heatwaves. This information includes the maximum and minimum daily temperatures and humidity levels, which are very important for understanding heat stress.

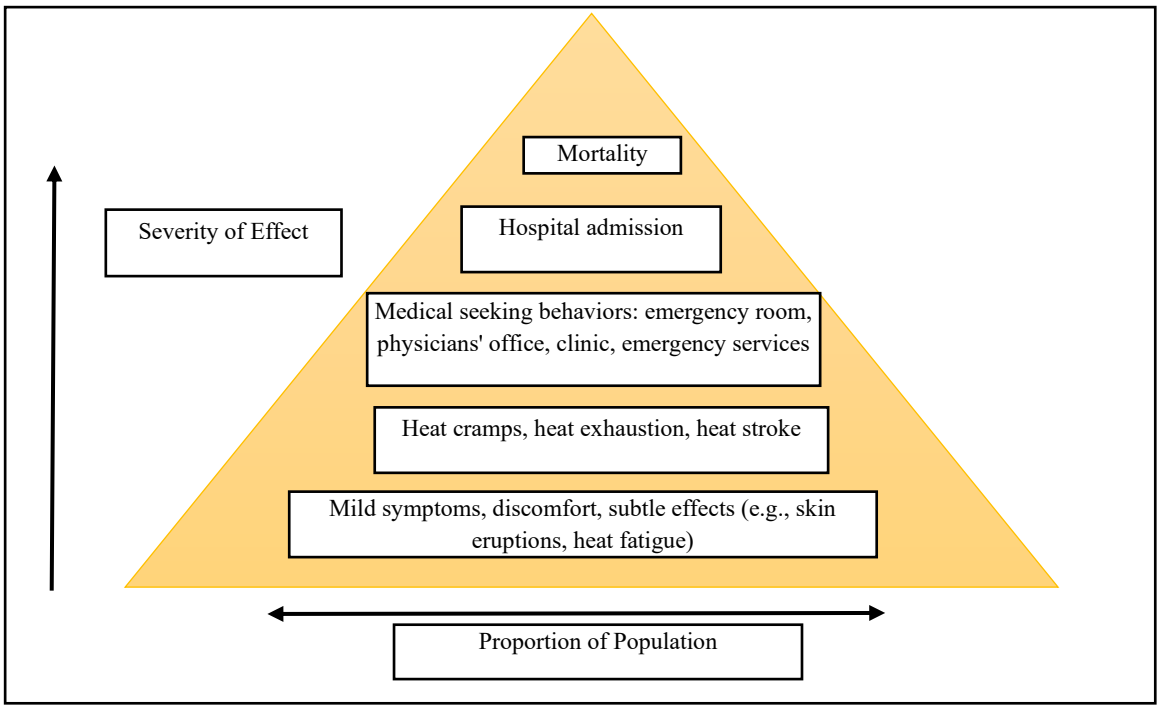


Figure 1: Severity of Health Outcomes from Heat Exposure

Figure 1 demonstrates that, at higher temperatures, the severity of health outcomes and their types can range from mild to severe. At the lowest level of the pyramid lie tame effects, including discomfort, skin rashes, and heat fatigue, which have a high prevalence rate in the Population. As the severity increases, the victims may be affected through heat cramps, fatigue and heat stroke leading to hospitalization and emergency medical care. The most adverse impact is the death on top. This model highlights that increasing heat is a risk to public health that is detrimental, particularly to vulnerable populations and requires prevention and health interventions.

The information on health will be obtained through the records of the hospital, emergency department visits, and health surveillance systems. These sources will also give the data about the prevalence of HRIs such as heat exhaustion, heatstroke, dehydration, and cardiovascular conditions.

The health data stratification will be dependent on the cases of an extreme exposure to heat and will be based on diagnosis codes and hospitalization records. The data will also be offered by the public health agencies whose routine surveillance systems monitor the heat-related health trends. Census data, health surveys, and local government databases will be used in collecting the data on the Population. It will involve demographic information about vulnerable populations, such as age (e.g. older adults, children), health conditions (e.g. chronic diseases such as cardiovascular disease and diabetes) and socioeconomic issues (e.g. income level, access to cooling sources, urban vs. rural, etc.). The variables will be utilized to recognize certain at-risk groups to be analyzed. The statistical analysis to be used will primarily be regression analysis to correlate temperature changes with the incidence of HRIs. The model to be used will be a multiple regression model to control for possible confounding factors, including socioeconomic status, underlying health conditions, and other environmental variables. The given model will assist in disaggregating the influence of the temperature on the probability of experiencing HRIs. The temperature threshold analysis will also be used to identify temperature focal points where the number of HRIs intensifies significantly. This will consist of analyzing the data to determine the temperature ranges at which the rate of HRIs begins to increase significantly, which is important for the development of early warning systems and targeted interventions.

Table 1: Temperature Threshold Analysis and Heat-Related Illness Incidence

| Temperature Range (°C) | HRIs Incidence Rate (%) | Confidence Interval | Vulnerable Population Affected (%) |
|---|---|---|---|
| 30–32 | 5.2 | 4.1–6.3 | 15 |
| 32–34 | 8.4 | 7.2–9.5 | 20 |
| 34–36 | 12.1 | 10.9–13.3 | 30 |
| 36–38 | 18.5 | 17.1–19.9 | 45 |
| 38+ | 25.6 | 24.2–27.0 | 60 |

Table 1 summarizes the correlation between narrow temperature ranges and the incidence of heat-related illnesses (HRIs) in individuals. The ranges of temperature point to the development of a sharp rise in the incidence of HRI with substantial raises beyond 34 C. The vulnerable groups include the elderly and individuals with a chronic health condition because of the higher risk of heat-related illnesses with rise in temperatures. Critical temperature constraints required to implement intervention measures will be determined using this information.

## Results

The comparison of the temperature data to the occurrence of heat-related illnesses (HRIs) showed that there was a strong and significant relationship between the rise in temperature and the rise in the incidence of heat-related illnesses (HRIs), especially in the most vulnerable populations. Once temperatures exceeded certain levels, cases of heat-related illnesses, including heat exhaustion, heatstroke, dehydration, and cardiovascular stress, began to increase significantly. The results indicated that HRIs rose by 5-10 percent when the temperature was above 32 °C, but the rate of increase was steeper at 36 °C and higher. Extreme heat had an unequal impact on vulnerable groups, including the elderly, children, and those with underlying health conditions, such as cardiovascular diseases, diabetes, and respiratory diseases. Elderly individuals (especially) presented the most elevated incidence and hospitalization rates with the doubling of HRIs hospitalization in the 36-38 °C temperature range. There was also an increase in the number of children, particularly those under 5 years old, who visited hospitals during heatwaves, especially those with respiratory conditions such as asthma.

The further review indicated that individuals with underlying ailments were prone to contract serious types of HRIs which comprised heatstroke and cardiovascular distress as compared to healthy humans. The fact suggests that such groups are not as adapted to the physiological pressures present in extreme temperatures that augment morbidity and death in areas with heat. On the issue of community-based measures to health, the study tested the effectiveness of heat health warnings, cooling centers and community education. By the introduction of the heat health warning systems (HHWS), a reduction in the number of hospitalizations due to heat illnesses was also noticed in localities where the systems were in active use. Indicatively, HHWS program in cities led to a cut of 15 percent of heatwave-related hospitalizations among the locals. Similarly, 20 percent reduction in the number of heatstroke related deaths in the communities at risk was associated with the creation of cooling centers. Much less in its impact were community education programs, which contributed to increasing awareness and encouraging preventative steps such as hydrating and avoiding outdoor activities at the hot season.

Table 2: Heat-Related Illnesses Incidence as A Function Of Temperature And At-Risk Population

| Temperature (°C) | HRIs Incidence Rate (%) | Elderly Incidence Rate (%) | Children Incidence Rate (%) | Individuals with Pre -existing Conditions Incidence Rate (%) |
|---|---|---|---|---|
| 30–32 | 5.2 | 7.5 | 4.0 | 8.2 |
| 32–34 | 8.4 | 11.3 | 6.7 | 12.5 |
| 34–36 | 12.1 | 16.2 | 9.5 | 17.8 |
| 36–38 | 18.5 | 23.8 | 14.2 | 24.6 |
| 38+ | 25.6 | 31.4 | 18.9 | 33.2 |

Table 2 indicates the association between unrelated conditions of temperature and the emergence of HRIs in different susceptible groups. The facts prove that as the temperature rises the total rate of HRIs is rising and individuals most susceptible to heat-related illnesses include older individuals, children, and people with underlying health issues compared to the general Population. Notable to mention, the rate of these vulnerable groups is significantly higher than that of the general rate and thus it can be said that the vulnerable groups are more susceptible to extreme heat events because of the high temperature at which these events occur.

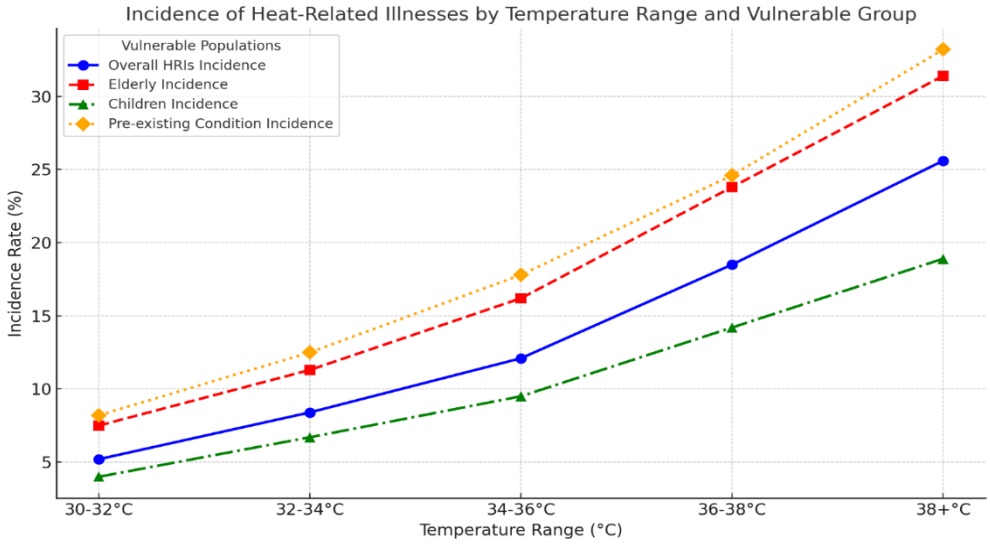


Figure 2: Heat-Related Illnesses Incidence according to the Temperature Range and at-Risk Groups

Figure 2 is used to illustrate the relationship between rise in temperature and heat-related illnesses (HRIs) in various vulnerable groups and temperature conditions. It observes the increase in the rates of HRIs with temperature increase, and those most affected are the elderly, children, and individuals with an underlying condition. As the information demonstrates, vulnerable populations are in a significantly greater risk of developing health complications under the impact of extreme heat events, and, therefore, there is a need to focus on the special targeting of the public health interventions that would help to make sure that these populations are safe, in the circumstances of global warming.

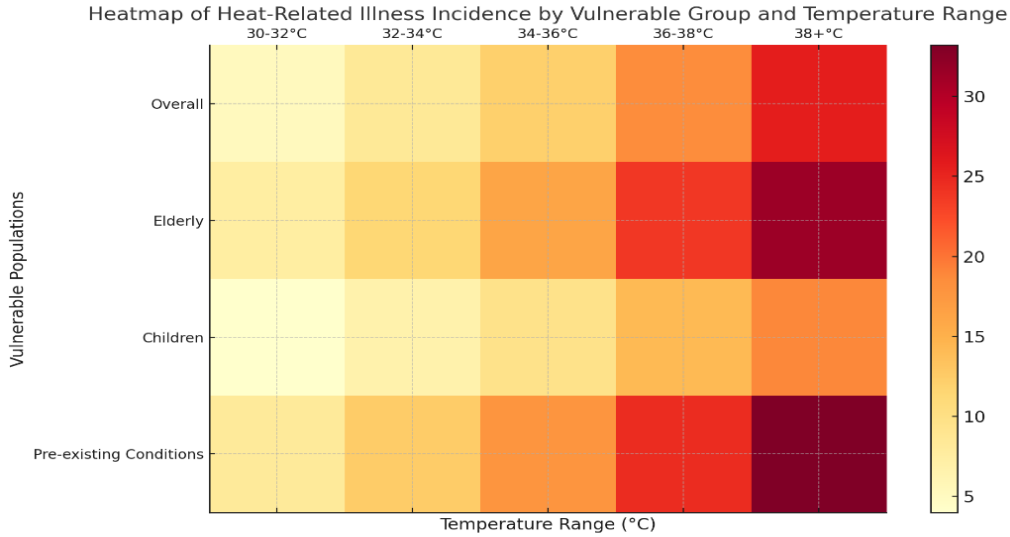


Figure 3: Heatmap of Heat-Related Illness Incidence by Vulnerable Group and Temperature Range

Figure 3 reveals heat-related illnesses (HRIs) in various temperature ranges of various vulnerable population groups. The heatmap also reveals the severity of the HRIs graphically as the temperature rises and the various color intensities reflect the increased rate of the HRIs occurrence in special groups like the old, children and other people with underlying conditions. The statistics show that when the temperature exceeds 34 o C, the rate of HRI becomes very high, especially in disadvantaged groups. The visualization demonstrates the necessity of creating special solutions to the problem of the growing health risks of these population groups in times of extreme heat.

Being prospective research, the study proposes a few research areas that may be taken into consideration. To understand the cumulative effects of recurring exposure to extreme heat on vulnerable populations, it is necessary to monitor the effects of heatwaves over a long period of time. Also, the future of research should focus on assessing the effectiveness of adaptive strategies, including the continued use of cooling centers, the influence and impact of urban greening, and heat resilience in urban planning. This will assist to refine the interventions in the field of public health and provide the more efficient protection to vulnerable groups as the temperature keeps raising due to the climate change.

## Conclusion

This paper concentrates on the high popularity of temperature increase in terms of its public health influence on risk groups, especially in the frame of growth and frequency of heatwave frequency and intensity. Among the major findings is a strong relationship between the increase in temperature and the escalation in the occurrence of heat-related illnesses (HRIs) which comprise heatstroke, heat exhaustion and dehydration. Extreme heat events disproportionately affect vulnerable populations such as the elderly, children, and people with underlying health conditions, and such populations have higher rates of hospitalization and mortality than the rest of the Population. The importance of thresholds in temperature is also

highlighted in the research, and there exist the crucial temperature ranges when the occurrence of HRIs increases tremendously. The findings stress the urgency of the situation regarding the necessity of an immediate intervention to alleviate the effect of heat-related illnesses. Other interventions in the health of the Population, including heat health warning and cooling centers, and community education, have been shown to decrease morbidity and mortality caused by heat. The temperature ranges represent the start of a sharp rise in HRI incidence with huge rises above 34 o C. Vulnerable groups of people prone to heat related illnesses with rise in temperatures include the elderly and individuals with chronic health problems. The information will be utilized in establishing required temperature limits to intervene. Nonetheless, there is a need to adopt more elaborate and extensive measures to safeguard vulnerable populations. Since climate change is increasingly growing serious, there is a need to incorporate heat resilience into urban design, enhance access to cooling tools, and reinforce the health infrastructure to protect the vulnerable groups. Emerging and enduring measures are needed to counter the increasing threat of high temperatures on the health of the Population.

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