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THE IMPACT OF SUNLIGHT EXPOSURE AND ELEVATED TEMPERATURES ON HUMAN HEALTH IN INDIA OVER A DECADE: A COMPREHENSIVE REVIEW

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ABSTRACT
The heat wave which is one of the major problems through the last few decades, in which India as a big nation and huge population get affected with multiple disease some of which get influenced by the heat wave during last few decades. As per the data published by many Indian and foreign publisher it was clear that the effect of heat wave was clearly enhancing the health related problems like electrolyte imbalance, respiratory Issues, migraine, skin cancer, solar keratosis, psoriasis, and many more skin or immunity related conditions and diseases. It was reported that the raise in temperature occurs by more than 10°C in south and west resign of the nation. Also several cases were reported about the death causality in this resign of Indian continent in between the year of 2015 to 2024. This article provide the sufficient information about effect and other related terms of heat wave in this article we also enlighten those disease that might get vast and showing very drastic condition in the terms of health management and also sometimes in the form of death motility rate, also our aim for this article is to give the combine solution to those population they are either suffering or going to be the one who get suffered. This article combined the data which was based on the articles includes the solution and making one interested towards the upcoming scenarios.

Keywords: - Heat wave, India, Skin Diseases, and Mortality rate

INTRODUCTION
The Nation India is Suffering from significant climate change events in the last few years, as frequently the high temperatures and heat waves were reported it become the changing point in Indian meteorological history. As per the report of the summer of March 2022 it was observed that this year was the hottest since 1901.it was concluded theta if this current patterns continue the effect in the form of global temperatures will likely rise by 1.5 degrees Celsius in between the upcoming years of 2030 and 2052, and that will leading to more frequent and severe heatwaves. This pattern of heatwave is consistent with global trends, as the World Meteorological Organization (WMO) has declared 2023 the warmest year on record. [1]

The term heat waves can be defined as the unusually and excessively raise in temperatures of any region. They are mostly classified as per their duration, intensity, and impact on mortality rates. The

intensity over the 97th annual percentile for two consecutive days is another way to describe a heatwave, which is a predefined hot weather condition. It was reported that the average worldwide temperature was risen by more than 1.2°C during the time of industrial revolution, which has also increased the frequency of extreme heatwave occurrences and raised the global mortality rate, also pre-existing medical illnesses such as mental health disorders, heart and kidney problems, and dehydration can be impacted by hot temperatures. Rising temperatures have the potential to cause water scarcity in regions such as west resign and increase the likelihood of forest fires in the north of the nation, which leads the condition critical and increase the air pollution which also fever's the condition of the heat wave. [3]

As per the source of ISRO it was clear that the there is a difference in the temperature in different resign of the country India, as we move from the East side to the north side the temperature difference was observed this reassign is covered with the mountains like Himalayas and having much numbers of river [25]. The condition of the west and the south resign of the nation is drastic because the most this part of the country faces a lot of heat wave as directed in the fig1.

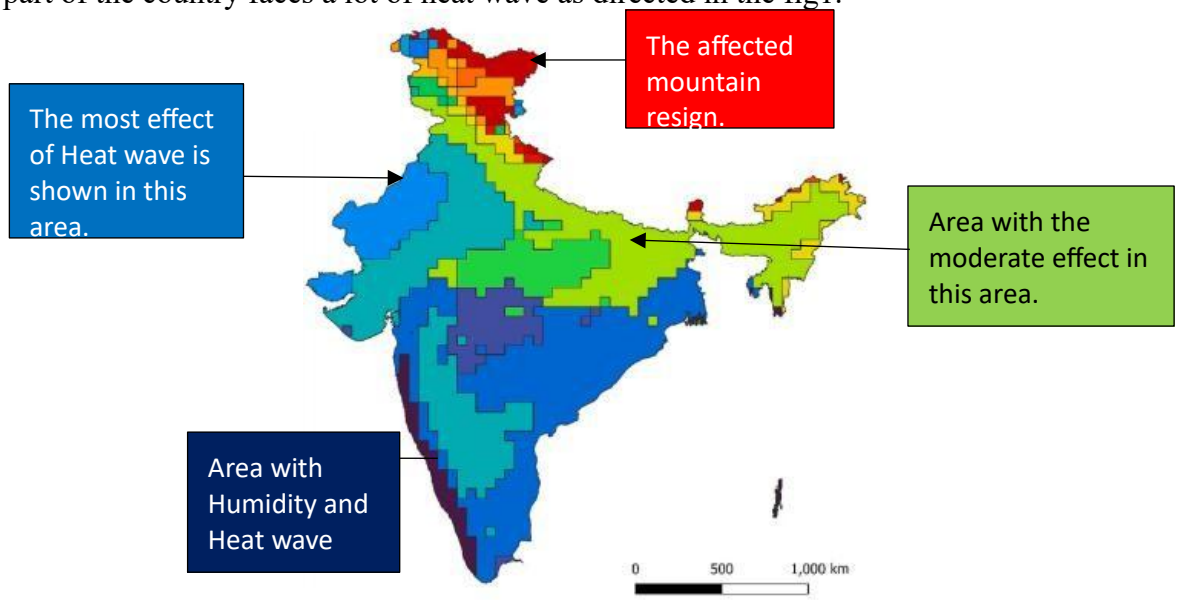

Fig 1:- The Depiction of Different resign and their Heat wave condition [6].

The major health risks associated with prolonged exposure to ultraviolet (UV) rays are also significant. UV radiation can cause major health related conditions, includes skin cancer and effect over the open parts like eye, it can damage that impairs vision. As the heat waves become more frequent in the last recent years, which is influence the anthropogenic climate change. As Asia become the centre because of its globe positioning and specially India has a diverse climate that can be broadly categorized into several major climate zones also it is consider as the middle-income country as per the word economic forum, where environmental exposures are increased by unplanned urbanization due to old infrastructural models, poor ventilated housing, and shrinking urban green cover of forest the nation is facing the change more frequently. [4]

Effect over population

Heat waves becoming most dangerous natural dangers over the years, often going with it unnoticed is due to their lack of direct impact on death and destruction over the majority of cases. But how ever heat waves have a stronger effect on vulnerable populations specially of the rural areas and the poor areas of the urbanized zone.

The effect on several aged people is seen particularly children under one year old and elderly people over the age of 50.

Table 1:- Effect as per age of Population

Age	Effect
>10	Dehydration, Malnutrition, Vomiting, and Motion sickness.
10-18 (Girls)	Dysfunction in Menstrual cycle Because of dehydration, Headache, and Loss of Body weight. etc.
10-18 (Boys)	Poor eye sight, and Dehydration
20-50	Arise of several disease.
<50	Weakness associated with other Disease condition

In between the year of 2013 and 2022, new-borns and the old aged peoples had suffered with 108% more heat wave days per year compared to the year of 1986 to 2005. In the recent 2022, the National Crime Records Bureau (NCRB) of India's Ministry of Home Affairs reported 730 deaths form heatstroke which is high till date, also the accounting for 9.1% of the total accidental deaths form natural causes includes heat waves. From the year of 2015 to 2019, the NCRB reported over 6,537 heatstroke-related deaths, whereas the Integrated Disease Surveillance Programme (IDSP) reported 3,775 deaths. The Lancet Countdown's 2023 report anticipated 10,989 (55%) higher heat-related deaths for people over the age of 65 in India between 2018 and 2022 compared to 2000 and 2004. Based on mid-century estimations (20412060), India and China will be the most affected countries due to their enormous populations, with heat-related mortality in India estimated at 128,681 at 2°C and 259,658 at 3.7°C. [1-4] The major effect was observed in those communities of the nation particularly the grade-D vulnerable communities in Municipal Corporation of several cities and this get rise over time.

Condition of Heat wave

The India Meteorological Department (IMD) has developed specific criteria to define heatwaves. In regions with maximum temperatures up to 40°C, a 5°C–6°C rise above normal is classified as a moderate heatwave, while a rise of 7°C or more indicates a severe heatwave. For areas where maximum temperatures exceed 40°C, an increase of 5°C or more is considered a severe heatwave, and an increase of 3°C–4°C is classified as a heatwave. Heatwaves are also declared when the maximum temperature exceeds 45°C for two consecutive days [9, 15].

A heat wave is a prolonged period of excessively high temperatures, typically lasting for several days or even weeks, which significantly exceeds the average temperatures for a given region during that time of year. Heatwaves are characterized by persistent daytime temperatures, often above 40°C (104°F) in some regions, combined with high humidity levels, which can exacerbate the perceived heat and increase the risk of heat-related illnesses.

Key characteristics of a heatwave include:

1. **Duration and Intensity**: The Heat waves typically last for three or more consecutive days some times over the period of month, which is critically associated with temperatures significantly above the average for that time of year as per the normal given range or recorded range. The specific temperature threshold for a heat wave varies from region to resign. In India temperatures exceeding 40°C (104°F) for several days can constitute a heat wave which was also recorded in the year of 2023. [30] The intensity and duration can lead to increased cases of heat-related illnesses, such as heat exhaustion and heatstroke. [2]

2. **Geographical Spread**: Heatwaves can affect large geographical areas simultaneously, including urban, rural, and coastal regions. This widespread impact can lead to a substantial strain on public health resources and infrastructure. [5]

3. Health Impacts: Heatwaves are associated with an increase in mortality and morbidity, particularly among vulnerable populations such as the elderly, young children, and those with pre-existing health conditions. Heat-related illnesses include heat exhaustion, heatstroke, and exacerbation of chronic cardiovascular and respiratory diseases. [2]

4. Environmental Effects: In addition to their direct impact on human health, heatwaves can lead to other environmental hazards such as droughts, wildfires, and reduced agricultural productivity. These secondary effects can have long-term consequences on food security and the economy. [6]

5. Urban Heat Island Effect: In urban areas, the heatwave effects can be intensified due to the urban heat island effect, where cities experience higher temperatures than their rural surroundings. This phenomenon is caused by human activities, such as industrial operations, transportation, and reduced vegetation, which contribute to higher heat absorption and retention in cities. [7]

Effect over last decade

The effects of heatwaves in India over the last decade have been substantial, influencing various aspects of public health and environmental conditions.

1. Health Impacts:

Mortality: Recent studies, have shown that heatwaves significantly increase all-cause mortality in India . The impact varies across different regions and demographics, with older adults and those with pre-existing health conditions being particularly vulnerable. [8, 9]

Heat Stress: Heatwaves exacerbate heat stress, which can lead to severe health issues including heat exhaustion and heatstroke. Vulnerable populations, including older adults and those with chronic diseases, are at higher risk. [1, 8]

Skin Diseases: Prolonged sun exposure during heatwaves can contribute to skin diseases, highlighting the need for effective sun protection. [1, 10]

2. Environmental and Climatic Trends:

Heatwave Characteristics: Studies project an increase in the frequency and intensity of heatwaves in India due to climate change. These projections suggest that heatwaves will become more severe and frequent in the future, further straining public health and
infrastructure. [3,6]

Historical Data: Research has documented the historical impacts of significant heatwaves, such as the 2010 Ahmedabad heatwave, which resulted in excess mortality.[11]

3. Policy and Intervention:

Heatwave Alerts: There have been efforts to improve heatwave alert systems to better prepare and protect communities. Enhancing these systems is crucial for mitigating health impacts.[12]

Community-Based Interventions: Effective community-based strategies, such as public awareness campaigns and heatwave preparedness plans, are essential for reducing the impact of heatwaves.[13]

4. Future Directions:

Adaptation and Resilience: Addressing the challenges posed by heatwaves requires a multifaceted approach, including improving public health infrastructure, implementing adaptive strategies, and enhancing climate resilience. [8, 11]

Related risk of Heat wave

Heat waves in India contribute to a variety of heat-related illnesses and can exacerbate preexisting health conditions. Some of the primary diseases and health issues associated with heat waves include.

Table 2: Risk factors for heat related disease [48]

Non-Modifiable Risk Factors	Modifiable Risk Factors
Age (geriatric patients or children)	Dehydration
Autonomic disorders that cause widespread anhidrosis (Ross syndrome, chronic idiopathic anhidrosis, Sjögren syndrome)	Prolonged exposure in a warm humid environment
Trauma with spine injuries	Occupational categories (military personnel, athletes, construction, field, mining, or well workers, etc.)
Endocrinological disorders (diabetes, hyperthyroidism)	Addictive behaviours (alcoholism, cocaine, amphetamine, heroin use, etc.)
Neurological disorders (epilepsy)	Drugs (anticholinergics, beta-blockers, diuretics, neuroleptics, anaesthetics, topiramate)
Skin diseases (scleroderma, burns)	Infections
Hereditary disease (malignant hyperthermia)	Obesity

1. Heat-Related Illnesses

Heat Exhaustion: This condition occurs when the body loses excessive amounts of water and salts through sweating. Symptoms include heavy sweating, weakness, dizziness, nausea, and headache. It can be treated by moving to a cooler place, drinking fluids, and resting.[24]

Heatstroke: Heatstroke is a more severe condition where the body's temperature regulation fails, leading to a dangerously high body temperature. Symptoms include confusion, hallucinations, loss of consciousness, and even seizures. Immediate medical attention is required as heatstroke can be life-threatening. [5,10]

2. Skin Conditions

Sunburn: Prolonged sun exposure during heatwaves can cause sunburn, which damages the skin's outer layer and results in redness, pain, and peeling. Severe cases can lead to blistering and increased risk of skin cancer.[14]

Heat Rash: Also known as prickly heat, this condition occurs when sweat ducts become blocked, leading to red, itchy bumps on the skin. It typically affects areas where sweat accumulates, such as the neck, back, and armpits.[30]

Chronic Skin Conditions: Conditions like eczema can be exacerbated by heat and sweat, leading to increased itching and irritation. Long-term exposure to UV radiation from the sun also raises the risk of skin cancer.[10,14]

3. Cardiovascular and Respiratory Problems

Cardiovascular Stress: Heatwaves can increase the risk of cardiovascular events such as heart attacks. High temperatures put extra strain on the heart as it works harder to cool the body, which can be particularly dangerous for individuals with existing heart conditions.[8] **Respiratory Issues:** High temperatures can worsen respiratory problems for people with conditions such as asthma or chronic obstructive pulmonary disease (COPD). Poor air quality during heatwaves, often exacerbated by pollution, can lead to increased respiratory symptoms and hospitalizations.[23]

4. Increased Mortality

Excess Mortality: Heatwaves are linked to increased mortality rates due to the direct effects of heat stress and the exacerbation of pre-existing health conditions. Elderly individuals, young children, and those with chronic illnesses are particularly vulnerable. [2,11]

5. Occupational Heat Stress

Workplace Risks: Workers in sectors such as construction, agriculture, and manufacturing face heightened risks of heat-related illnesses due to prolonged exposure to high temperatures. This can lead to decreased productivity, increased absenteeism, and higher risk of heat stress and heatstroke.[41]

6. Hydration and Nutritional Issues

Dehydration: Extended exposure to heat can lead to significant fluid loss, resulting in dehydration. Symptoms of dehydration include dry mouth, dark-coloured urine, fatigue, and dizziness. Severe dehydration can lead to more serious health issues such as kidney damage.[4]

Electrolyte Imbalance: Heat exposure can disrupt the balance of electrolytes in the body, affecting nerve and muscle function. This can lead to muscle cramps, weakness, and, in extreme cases, heat-related complications.[49]

6. Solar Keratosis: It is a condition in which the patients having complications over skin because of direct sun light exposure and result into major skin damage [15].

7. Skin Cancer

Increased Risk: Prolonged exposure to UV radiation from the sun during heatwaves can damage skin cells and increase the risk of skin cancer. This includes:

Basal Cell Carcinoma (BCC): The most common type of skin cancer, which typically appears as a pearly bump or a scaly patch. It is usually found on sun-exposed areas like the face, neck, and arms.

Squamous Cell Carcinoma (SCC): This type appears as a firm, red nodule or a scaly, crusted surface. SCC can also occur on sun-exposed areas.

Melanoma: The most dangerous form of skin cancer, which starts in the melanocytes (cells that produce pigment). It often appears as a new or changing mole, with irregular borders and multiple colours. [10,14]

Sunburn and Skin Cancer Risk: Repeated sunburns, especially severe ones, can significantly increase the risk of developing skin cancer later in life. Both UVA and UVB rays contribute to skin damage and cancer risk.[14]

8. Mental Disorders:

Anxiety, symptoms in people with bipolar disorder or depression, suicide attempts, suicide completion, aggressive behaviour, mental fatigue.[50]

Prevention and Treatment of Heatwave-Related Diseases

Heatwaves are increasingly recognized as a significant public health threat, leading to a range of health-related issues, particularly among vulnerable populations such as the elderly and those with pre-existing health conditions.[8] Pharmacists are in a unique position to intervene by providing preventive strategies and effective treatments. This guide outlines the role of pharmacy in managing conditions exacerbated by extreme heat.

1. Prevention Strategies A. Hydration and Electrolyte Management

• One of the primary health risks during a heatwave is dehydration, which can lead to serious complications. Pharmacists can recommend Oral Rehydration Solutions (ORS) as they are specifically designed to replace lost fluids and electrolytes efficiently. The World Health Organization states that ORS is particularly effective for at-risk populations, including the elderly and those with chronic illnesses.[16]

• Below Diagram shows the Components of Effective Oral Rehydration Solutions

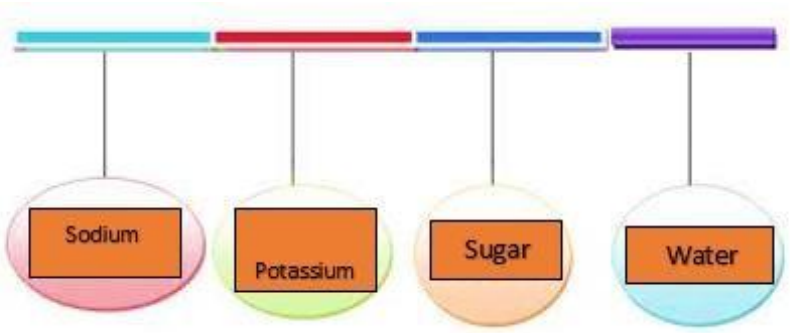

Fig 2: - Components of Effective Oral Rehydration Solutions

- Key Components: Sodium, potassium, glucose, and water.
- Usage: Encourage patients to drink ORS regularly during heatwaves, especially if they exhibit signs of dehydration such as excessive thirst, dry mouth, or dark-coloured urine.

B. Patient Education

- Pharmacists should actively educate patients regarding medications that can heighten sensitivity to heat. For instance, diuretics can lead to increased urine output, which may exacerbate dehydration during hot weather.[19] Educational points include:
- Encouragement of Regular Fluid Intake: Remind patients to increase their water consumption when taking such medications.
- Awareness of Symptoms: Teach patients to recognize symptoms of heat-related illnesses (e.g., heat exhaustion, heat cramps) and the importance of seeking medical attention if these symptoms occur.[17]

2. Treatment Strategies

A. Pharmacological Treatments [18]

- In the event that a patient develops heat-related illnesses, pharmacists can recommend appropriate remedies. Antipyretics such as acetaminophen or ibuprofen can be utilized to manage fever that may arise due to heat exhaustion.
- Indications for Use: Fever over 101°F (38.3°C) and body aches.
- Dosage Guidance: Always consider age, weight, and existing health conditions when recommending dosages.
- In severe cases of dehydration or heat exhaustion, intravenous fluids might be necessary, and pharmacists should be prepared to coordinate care with healthcare providers.

B. Monitoring and Adjusting Medications[19,17]

 Regular medication reviews are crucial, especially for elderly patients and those with chronic diseases. The World Health Organization emphasizes the importance of evaluating a patient's current medication list to proactively identify any drugs that may interact poorly or exacerbate heat sensitivity. Review Process

1. Assess each medication for its potential impact on hydration.
2. Discuss alternative medications or adjustments as necessary.
3. Provide advice based on individual health profiles.

C. Follow-Up Care

 Follow-up is essential for individuals at higher risk for heat-related complications. The Centers for Disease Control and Prevention (2020) highlight that consistent follow-ups help monitor hydration status and ensure medication efficacy. Follow-Up Strategies

1. Schedule regular check-ins via phone or in-person visits during peak heat times.

2. Use tele pharmacy services to check in on patients who may have difficulty visiting a pharmacy.
3. Encourage patients to report any developing symptoms of heat-related illnesses promptly.

Table 2: - Treatment strategy

Heat-Related Illness	Symptoms	Treatment	Prevention
Heat Cramps [9,49]	Muscle pains or spasms in the abdomen, arms, or legs	Move to a cooler place and rest. Drink water or sports drinks. Do not resume strenuous activity until a few hours after cramps subside.	Stay hydrated and avoid strenuous activities during peak heat hours. Wear light clothing.
Heat Exhaustion [8,12]	Heavy sweating, weakness, cold, pale, and clammy skin, fast and weak pulse, nausea or vomiting	Move to a cooler environment. Loosen clothing, apply cool, wet cloths, and sip water. Seek medical attention if symptoms worsen or last more than an hour.	Drink plenty of fluids, take cool showers, and wear light, breathable clothing. Avoid the sun during midday hours.
Heat Stroke [5,10]	High body temperature (above 103°F), hot, red, dry, or moist skin, rapid and strong pulse, unconsciousness	Call emergency services immediately. Move the person to a cooler place, use cool cloths or a bath to lower body temperature. Do not give the person fluids.	Avoid prolonged exposure to heat. Use air conditioning or fans, and take frequent breaks in the shade or cool areas.
Heat Rash [13,14]	Red clusters of small blisters that look like pimples on the skin	Keep the affected area dry. Use powder to soothe rash.	Keep the skin cool and dry. Wear loose, lightweight clothing.
Dehydration [1]	Thirst, dry mouth, dizziness, dark urine, fatigue	Drink water or electrolyte-rich drinks slowly. Seek medical attention if symptoms are severe.	Drink water regularly, even if not thirsty. Avoid caffeine and alcohol, which can increase dehydration.

Future Prediction

The increasing frequency and intensity of high temperatures, particularly heatwaves, pose significant challenges to public health in India. Projections suggest that climate change will exacerbate these conditions, leading to more severe and prolonged heatwaves, which could have dire consequences for human health. This section explores the future possibilities and the potential health impacts of rising temperatures in India.

1. Increasing Frequency and Severity of Heatwaves

As global temperatures continue to rise, India is expected to experience more frequent and intense heatwaves. Research indicates that the number of heatwave days will significantly increase across the country, with some regions experiencing as many as 30 additional days of extreme heat per year by the end of the century. This increase in heatwave frequency and duration will likely result in higher all-cause mortality, as heatwaves have been strongly associated with increased death rates, particularly among vulnerable populations such as the elderly, children, and those with pre-existing health conditions.

2. Impact on Public Health Infrastructure

The growing threat of extreme heat will strain India's public health infrastructure. Hospitals and clinics may become overwhelmed with cases of heat-related illnesses, including heatstroke, dehydration, and exacerbations of chronic conditions such as cardiovascular and respiratory diseases. In response to these challenges, there is a critical need for improved heat-health action plans, which

include early warning systems, public awareness campaigns, and the establishment of cooling centers in urban areas.

3. Vulnerability of Urban Populations

Urban areas in India are particularly vulnerable to the effects of rising temperatures due to the urban heat island effect, which causes cities to be significantly warmer than their rural surroundings. This effect is exacerbated by the high density of buildings, limited green spaces, and extensive use of concrete and asphalt, which absorb and retain heat. As a result, urban populations are at a higher risk of heat-related illnesses and mortality. Future strategies should focus on urban planning that includes the development of green infrastructure, such as parks and tree-lined streets, to mitigate the urban heat island effect.

4. Potential for Increased Air Pollution

Higher temperatures can exacerbate air pollution by increasing the formation of ground-level ozone and other harmful pollutants. This is particularly concerning in Indian cities, where air quality is already a significant public health issue. The combination of extreme heat and poor air quality can lead to an increase in respiratory and cardiovascular diseases, further burdening the healthcare system.

5. Adaptation and Mitigation Strategies

To address the future challenges posed by rising temperatures, India must implement a range of adaptation and mitigation strategies. These could include the development of heat-resistant crop varieties to ensure food security, the promotion of passive cooling techniques in buildings, and the expansion of access to clean and reliable energy sources to reduce the reliance on air conditioning, which can contribute to greenhouse gas emissions. Furthermore, enhancing public education on sun protection practices and the risks of heat exposure is crucial for reducing the incidence of heat-related illnesses.

The future of high temperatures in India presents significant challenges, particularly in terms of public health. The increasing frequency and intensity of heatwaves, coupled with the vulnerability of urban populations and the potential for increased air pollution, underscore the need for comprehensive and proactive measures. By investing in adaptation and mitigation strategies, India can better protect its population from the health risks associated with rising temperatures and ensure resilience in the face of climate change.

Conclusion:

As per the review done on the topic heat wave and its health-related effect which conclude that the rising temperatures and increasing frequency of heatwaves in India pose severe public health challenges, particularly for vulnerable populations such as the elderly and children. The intensification of these extreme weather events, driven by climate change, is expected to result in more frequent and severe heatwaves, leading to higher mortality rates and exacerbating existing health conditions like cardiovascular and respiratory diseases. Urban areas are especially vulnerable due to the urban heat island effect, which amplifies heat exposure. Additionally, higher temperatures may worsen air pollution, further impacting public health. To address these challenges, India must implement comprehensive adaptation and mitigation strategies, including improving public health infrastructure, enhancing urban planning to mitigate heat effects, and increasing public awareness of heat-related risks. Proactive measures are essential to protect the population and build resilience against the escalating threats posed by climate change.

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