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HEAT WAVES HEALTH IMPACT ON ELDERLY AND OUTDOOR WORKERS IN CHANDRAPUR CITY, CENTRAL INDIA

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Abstract
Purposive random sampling in Central India was conducted from December to March to determine the health effects of heat waves on outdoor workers and the elderly in Chandrapur City. There were 200 senior people (>60 years old) and 300 outdoor workers (>40 years old) in the sample population. A carefully created, field-tested interview schedule was given to the sample population to gather information about the health impact of heat waves. The results are documented for two aspects: diseases and symptoms brought on by heat waves. A control population made up of 10% of the sample population groups was chosen to compare these results. According to the study's findings, symptoms in the elderly include headache, weariness, dizziness, hyperhidrosis, dyspnea, and dehydration. Heat rashes, sleep disturbance, heat exhaustion, heat stroke, elevated blood pressure, impaired renal function, and hyperthermia are among the illnesses they have. Symptoms of heat waves for outdoor workers include decreased focus and productivity, fatigue, lightheadedness, profuse perspiration, elevated tension, and disorientation. They include prickly heat, headaches, weariness, and heat stroke. The study's conclusions demonstrate how susceptible these sample population groupings are to heat waves. Therefore, preventative actions should be taken to lessen exposure to heat waves and, consequently, the illnesses and symptoms that are linked to them.

Key Words: *Elderly, Central India, Chandrapur, Climate change, Health impact, Heat wave, Outdoor workers*

Introduction

Over the past 20 years, extreme weather events have increased in frequency and intensity worldwide. The five consecutive years after 2015 were the warmest on record, with 2016 being the hottest year on record (World Meteorological Organization, 2019, 2020). Anthropogenic climate change is shown by rising global temperatures (Christensen *et al*., 2007). Warmer years and more extreme weather events are predicted as a result of climate change, which could seriously endanger human health and well-being (Filippelli *et al*., 2020). The Intergovernmental Panel on Climate Change predicts that in the upcoming years, there will be hotter days,

higher temperatures, and more frequent droughts over large geographic areas. The India Meteorological Department defines heat waves based solely on maximum temperatures. It defines a heat wave as "if the maximum temperature of a station reaches at least 40°C or more for Plains, 37°C or more for coastal station and at least 30°C or more for Hilly region" (IMD, 2020).

There is no globally accepted metric for defining heat extremes, and heat waves are not consistent across the globe (Perkins *et al*., 2012). Of all the natural hazards in the world, heat waves have the greatest death rate (De *et al*., 2005). Globally, there were over 125 million more people at risk of heat waves between 2000 and 2015. About 70,000 people died as a result of a catastrophic heat wave that hit western Europe in 2003 (Coumou and Rahmstorf, 2012). Because of their direct and serious effects on human health, heat waves are commonly considered to be silent killers (Patz *et al*., 2005; Hondula *et al*., 2014, Heo *et al*., 2019, Ray *et al*., 2021). Heat cramps, fatigue, stress, and heat stroke are among the serious health effects of heat waves (Oldenborgh *et al*., 2018). Significant effects are seen in children, the elderly, and people who already have heart, pulmonary, kidney, and mental health conditions (Nitschke *et al*., 2007; Hansen *et al*., 2008; Wilker *et al*., 2012; Steffen *et al*., 2014). During the same period, outdoor workers' output decreased by 5.3% globally (Watts *et al*., 2017).

States in central, northern, and northwest India are the most susceptible to variations in the country's typical weather, according to the World Bank (2018). The Vidarbha region of Maharashtra State of India is home to seven of the ten most affected hotspot districts. According to the Top 10 District Hotspots in India's Predicted Change in Living Standards and Characteristics, the Chandrapur district comes at the top. As the earth's surface temperature continues to increase and the global population ages and unemployed individuals are engaged as outdoor workers, there is a notable lack of studies on the impact of heatwaves on the elderly and outdoor workers. According to the literature evaluation, no studies have been done on the health effects of heat waves brought on by climate change on Chandrapur City's outdoor workers and the elderly. Consequently, this is the subject domain's identified knowledge gap. This study was suggested to be conducted to investigate the health effects of heat waves on the elderly and outdoor workers in Chandrapur City to close this knowledge gap with fresh information. The information gathered from this study will help to clarify the various illnesses and symptoms that these sample populations experience as a result of heat waves. Furthermore, the outcome of the study will help to formulate a policy at the local level for reducing the heat-wave-induced health impacts on these sample populations in the form of a 'heat-wave action plan'. The potential benefits of preventing heat exposure-related mortality in elderly and outdoor workers could be significant.

Study Area

Chandrapur, formerly known as Chanda, is a city and municipal corporation located in the Chandrapur district of Maharashtra state, India, at latitude 19.57^{o}N and longitude 79.18^{o} E (Figure 1). The city occupies 70.02 square kilometers and is located at an elevation of 189.90 meters above mean sea level. The

city has a hot and dry climate. December is the coldest month, with average low temperatures of 9°C and high temperatures of 23.2°C. May is the hottest month, with an average high temperature of 43°C and a mean low temperature of 28.2°C. On June 2, 2007, the highest recorded temperature was 49°C. Between January 1899 and 2021, the lowest temperature ever recorded was 2.8°C. The monsoon season lasts from June to September. Rainfall in the city averages 1249.4 mm per year. There are 59.2 wet days on average.

Fig. 1: Study area

Material and Methods

Sample Population

To elicit the sample population of older individuals (n = 200) and outdoor workers (n = 300) from the study area, purposeful random sampling was used. Those in the sample population who worked outside and resided in homes without artificial cooling systems met the study's inclusion criteria. The elderly included in the study were more than 60 years of age and outdoor workers with age >40 years. Although an effort was made to include both sexes in the study, male respondents predominated because of field limitations. Ten percent of the people in each group who lived in cement homes with artificial cooling during the summer months were chosen as a control population to compare the outcomes for these sample populations.

Interview Schedule

A carefully designed and developed interview schedule was created to get information from the sample population. Twenty-five sample participants participated in the pilot project, and the interview schedule was updated and modified based on their comments. To evaluate the effects of heat waves on the health of these sample populations, a thorough and independent interview schedule was used. The tool has four areas viz. respondents profile, impact on elderly and outdoor workers with questions in each section with relevant options.

Options were prepared using the Likert scale. Obtaining quantifiable data was emphasized to reach a comparable and conclusive conclusion.

Data Collection

Upon arriving at the homes of the respective respondents during the field investigation (December to March), the study's basic information was explained, and after obtaining their consent, the sample population was included in the study. Those who met the inclusion criteria were chosen as the sample population (n=500), and they were informed about the study and assured of the confidentiality of their responses. One-on-one interviews were conducted, with the interview schedule explained in the local languages (Hindi and Marathi) to ensure that the right answers were obtained, and the responses were graded by a research assistant to prevent errors.

Measurement of the Variables

This study attempts to evaluate the health effects of heat waves on outdoor workers and the elderly. A Likert scale was employed to evaluate these factors. A sequence of "points" (odd numbers) on this rating scale enables a question or remark to be measured numerically. Nine symptoms were chosen from the literature to be included in the health impacts evaluation for the elderly. Six were included in the study after screening, while nine statements were found for the disease, and seven of those were included in the study. After screening, ten of the fifteen heat wave symptoms for outdoor workers that were found in the literature were added to the study. Of 12 diseases in outdoor workers, eight were considered as a part of the study.

Data Entry and Analysis

The software was used to analyze the primary data that was gathered during the field inquiry. All interview schedule data was coded, compiled, and examined by the goals of the study. Tools for data verification including multi-collinearity reduction and outlier detection were employed. SPSS version 21 was used to conduct the analysis. The percentage responses obtained by the sample population of the corresponding groups regarding the diseases and symptoms of heat waves under consideration are calculated for the corresponding points on the statement's Likert scale. These percentages are used for comparison and further assessment of heat waves-induced health impacts on the sample population.

Results and Discussion

Impact on Elderly

The heat waves-induced symptoms in the elderly are presented in Figure 2. From the figure, it can be seen that dehydration, dizziness, hyperhidrosis, fatigue, headache, and dyspnoea were recorded. Dehydration and fatigue were observed in all sample populations followed by hyperhidrosis (93%) and headache (80%). The dizziness (53%) followed by dyspnea (40%) were recorded to be the minimum symptoms. A difference between the sample and control population for heat wave-induced symptoms was observed with the sample population reporting a higher percentage as compared with the control population.

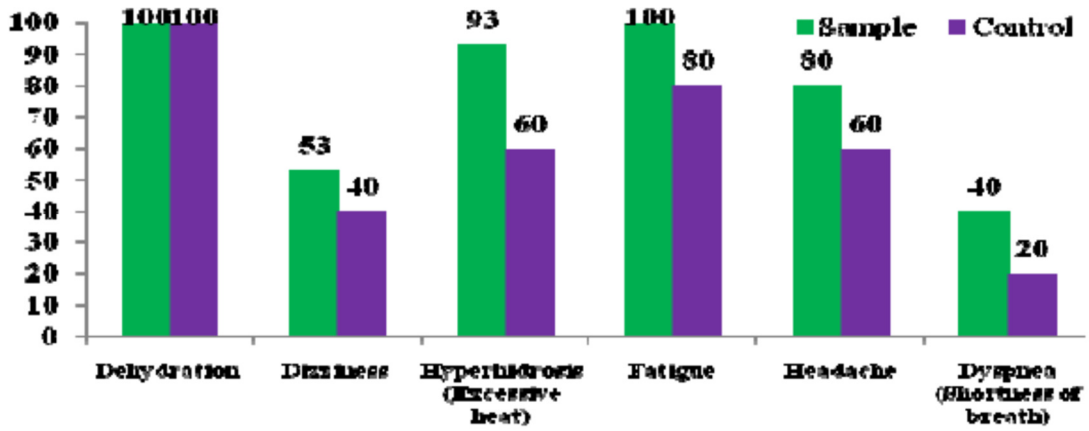

Fig. 2: Heatwave-induced symptoms in elderly

The heat waves-induced diseases among the elderly are presented in Figure 3. From the figure, it can be observed that heat rashes and sleep disturbance were reported by all sample populations followed by heat stroke (80%) and blood pressure increase (67%). The renal function (33%) and hyperthermia (13%) were reported to be the minimum percentage of diseases among the elderly. Heat exhaustion was also reported by 66% sample population. In the control population also the disease symptoms were recorded although their percentage was lesser than the sample population.

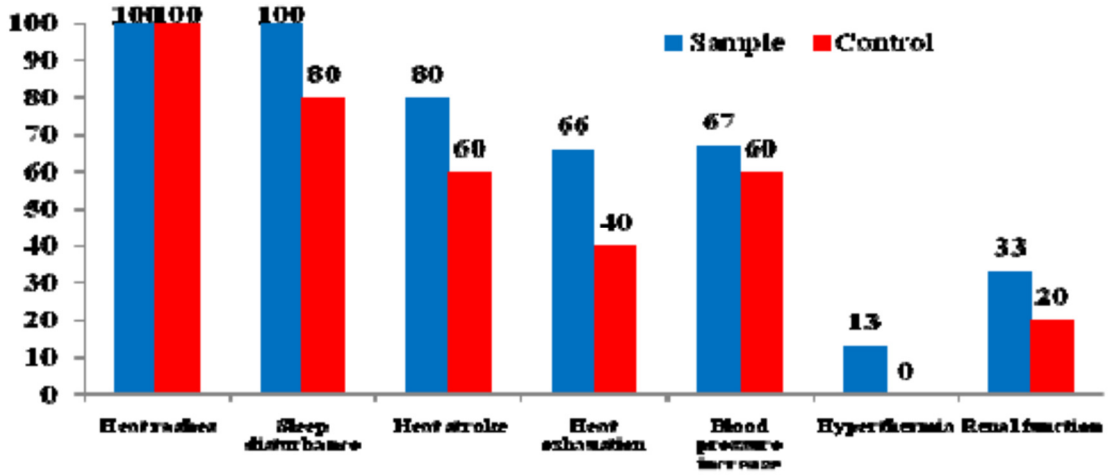

Fig. 3: Heatwave-induced diseases in the elderly

In the elderly population of Australia, there were notable links between heat waves and increased mortality rates. Mortality rates spiked in the initial days of a heatwave but then dropped to lower-than-expected levels. Overall, heatwaves were linked to a 28% rise in deaths on average. The most significant increases were generally seen during more severe heatwaves in various large cities (Cheng *et al*., 2018). According to Liss *et al*. (2017), the general relative risk of heat-related hospitalizations (HH) during a heatwave episode was 6.9 [95% CI: 4.8–9.8]. The

relative risk for HH during the first heatwave of the season increased significantly to 13.3 [95% CI: 7.4–24.0]. For subsequent heatwaves, the risk decreased to 3.7 [95% CI: 2.4–5.8].

A range of adaptive methods was documented about the health consequences and behaviour of older adults in southern Australia. During periods of excessive heat, 75% of them continue their normal activities and appointments. Nonetheless, 25% rated their health as fair to bad, and 74% used medicine for chronic illnesses. Medication for mental health, heart failure, diabetes, or respiratory health, reporting a lower health status, using mobility aids, and being female were all significantly linked to hot health outcomes in a multivariate model (Nitschke *et al*., 2013). Van Iersel and Bi (2009) opinioned that a heat health warning system (HHWS) for an aging population based on accurate information about the location of vulnerable people, their access to communication technology, the facilities available to them, and their ability to respond effectively to an HHWS should be developed.

Impact on Outdoor Workers

The heat wave-induced symptoms in outdoor workers are presented in Figures 4 (a) and (b). From Figure 4 (a) it can be observed that the heat waves affect the concentration and productivity of all the outdoor workers. As productivity depends on the concentration this finding indicates that heat waves affect the overall working of the workers. A similar observation was also recorded for dehydration and tiredness. Dizziness was also reported by 64% sample population. The other symptoms viz. confusion (44%), enhanced stress (84%), excessive sweating (100%), and accelerated pulse (92%) are also reported by outdoor workers (Figure 4b). Excessive sweating was reported by all sample populations followed by accelerated pulse (92%). Excessive sweating and an accelerated pulse can be a symptom of heat exhaustion, a condition that occurs when the body overheats. The heat waves confused 44% of respondents which may result in enhanced stress in 84% sample population. The dizziness, confusion, and stress can be correlated with each other. As all sample populations have reported affected concentration due to heat waves it results in 44% of respondents with signs of confusion. The enhanced stress and productivity are also correlated with each other and are directly proportional to each other. The higher the stress more it affects the productivity of the outdoor workers. Similarly, excessive sweating and dehydration among these workers were found to be directly proportional to each other. As these workers are working in outdoor environments for significant periods during intense summer (~ 6-9 hours) have reported 48% of respondents with heat stroke incidences. This was more than double the number of workers who worked in indoor environments.

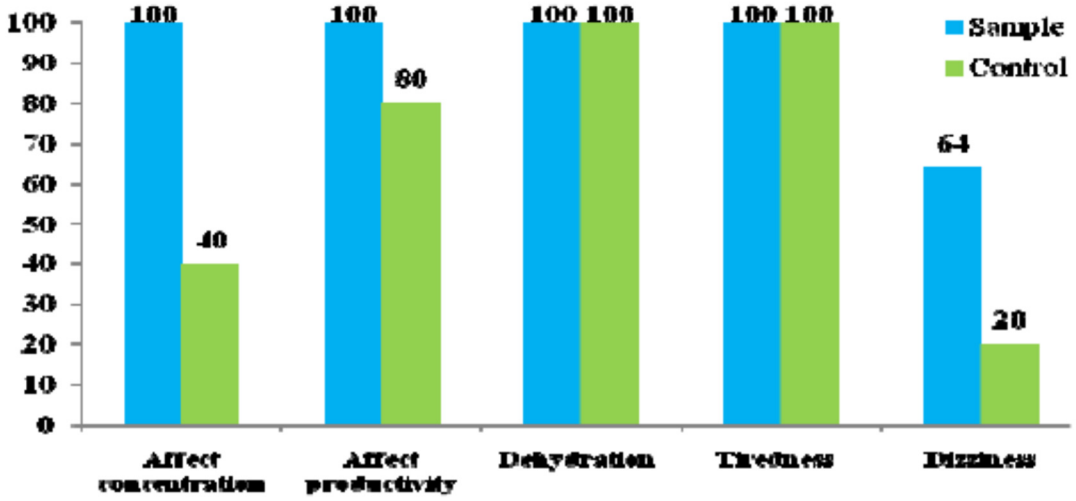

Fig. 4 (a): Heatwave-induced symptoms in outdoor workers

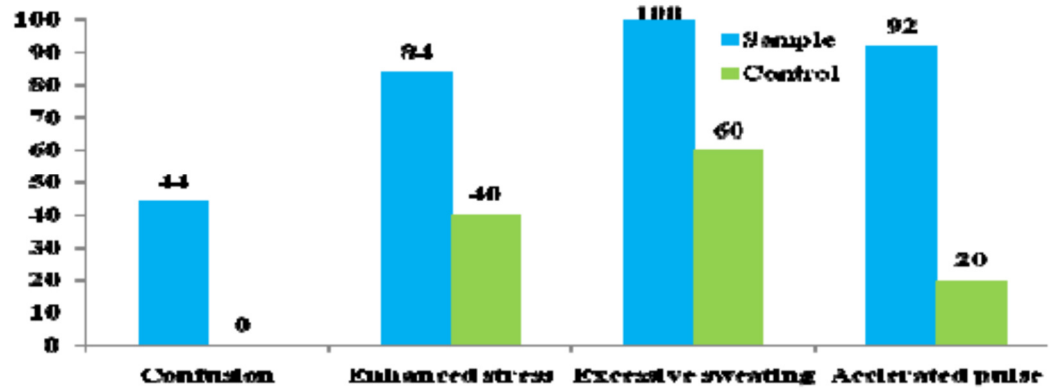

Fig. 4 (b): Heatwave-induced symptoms in outdoor workers

The heat wave-induced diseases in outdoor workers in presented in Figures 5 (a) and (b). From the figure, it can be observed that heat stroke, headache, exhaustion, prickly heat, muscle cramps, fainting, nausea/vomiting, and heat cramps were the diseases reported by respondents. The prickly heat was reported by all sample populations followed by headache (80%) and muscle cramps (80%). The heat exhaustion symptoms include headache (80%) and nausea/vomiting (36%). A positive correlation was observed between muscle cramps (80%) and heat cramps (72%). The fainting was reported by the respondents (64%). The possible reason for the same can be assigned to heat exhaustion it is called heat syncope and it occurs when someone loses consciousness due to low blood pressure. Thus, it can be also stated that these workers may have low blood pressure which is due to heat exhaustion resulting in fainting. Heat cramps are muscle spasms that occur during or after intense physical activities in hot weather in these outdoor workers. They are signs of heat-related illness and can lead to more serious conditions like heat exhaustion or stroke. As these

workers sweat excessively (100%) may be prone to heat cramps because of the loss of fluid and electrolytes. Muscle cramps are a symptom of heat cramps which are painful muscle spasms that can occur during or after physical activity in hot environments.

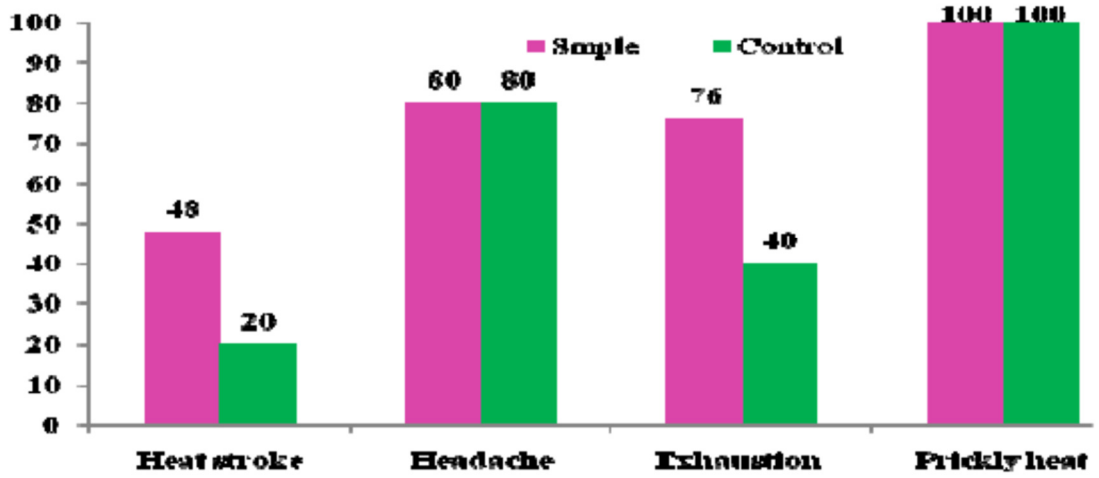

Fig. 5 (a): Heatwave-induced diseases in outdoor workers

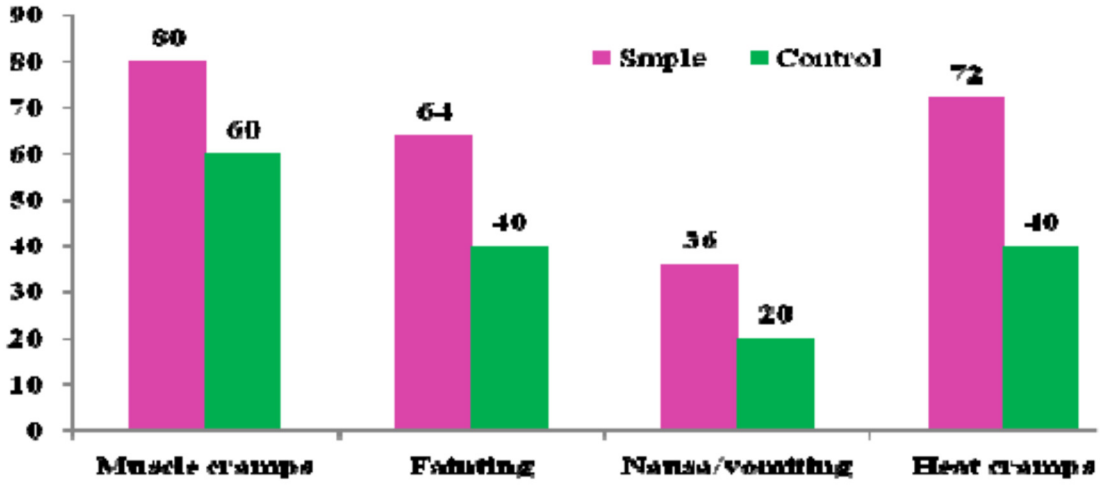

Fig. 5 (b): Heatwave-induced diseases in outdoor workers

Pogacar *et al*. (2019) reported the self-assessment of heat stress by outdoor workers in Slovenia and Greece, has an effect on productivity (Slovenia 69%, Slovenia 71%; $p > 0.05$) as also on well-being (Slovenia 74%; $p < 0.01$) and. Exhaustion (Greece 51%, Slovenia 62%; $p > 0.05$), headache (44%, 53%; $p > 0.05$), excessive perspiration (67%, 85%; $p = 0.01$), and thirst (70%, 82%; $p = 0.03$) were the most common symptoms and illnesses. Drinking more water was the most popular strategy to lessen heat stress (Greece 64%, Slovenia 82%; $p = 0.001$). Messeri *et al*. (2019) reported migrant workers in the construction and agricultural industries indicated that their jobs required more effort than those of

local Italian workers ($\chi^2 = 17.1$, $p = 0.001$), but they also claimed that heat had less of an impact on their productivity ($\chi^2 = 10.6$; $p = 0.014$) and thermal discomfort. Yoon *et al*., (2021) demonstrated that heat exposure is a risk factor for death and infectious, cardio-cerebrovascular, and genitourinary diseases, as well as injuries or accidents among workers. The association between death outdoors and maximum temperature had a threshold of 31.2°C with a day-zero lag effect.

Conclusion

The elderly and outdoor workers owing to their physiological, metabolic, and behavioural characteristics are vulnerable to heat-induced symptoms and diseases. The diseases depend upon symptoms as they are often interdependent upon each other. As this sample population groups are more exposed to heat waves than the control population the symptoms and diseases associated with them are more. Because they live in semi-urban areas, the sample group rarely uses artificial cooling techniques, mostly due to the high expense of both purchase and operation. Over the next few decades, climate change is predicted to increase the health impact due to heat waves. Therefore, more significant approaches are needed to deal with the increasing frequency and severity of heat waves, especially for outdoor workers, and the elderly. The precautionary and prevention measures should be carried out individual level and at the regional level by local government authorities in the form of a policy as a 'heat action plan'. This will reduce to a larger extent the mortality and morbidity associated with heat waves thus reducing the diseases and paving the way for a quality of life.

Precaution and Prevention

To reduce the detrimental health impact of heat waves on elderly and outdoor workers, preventive and protective measures must be implemented. One of the precautions that should be performed is to avoid the sun, especially between 12:00 noon and 3:30 pm. It is recommended to drink as much water as one can, even if one is not thirsty. Wear loose, light-coloured, lightweight cotton clothing that is permeable. Wear shoes or slippers, a hat or umbrella, and protective goggles when one is outside in the sun. Avoid doing physically taxing activities when the weather is hot. Keep windows and doors open to allow adequate ventilation in the kitchen, and avoid cooking during peak hours. When travelling, have water on hand and avoid dehydration-causing substances including tea, coffee, alcohol, and carbonated soft beverages. Avoid eating stale meals and stay away from foods high in protein. When working outside, cover one's head, neck, face, and limbs with a damp towel and wear a cap or umbrella. Consult a physician immediately if one feels ill or faint. Use Oral Rehydration Solution and homemade drinks such as rice water, buttermilk, lemon water, etc. to replenish the body's fluids. Keep the windows open at night and utilize drapes, shutters, or sunshades to keep the house cool. Use wet cloths, fans, and cold water baths frequently.

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