CLIMATE CHANGE AND ITS IMPACT ON HUMAN HEALTH: AN OVERVIEW

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Introduction

Climate change is recognised today as the biggest public health challenge of the twenty-first century, threatening to undo decades of gains in public health (Costello *et al.*, 2009). Globally, according to the 2018 *Lancet Countdown*, if temperatures continue to rise, present-day changes in agricultural production, labour capacity and vector-borne disease are indicative of an early warning of compounded and overwhelming impact. Low- and middle-income countries with the most vulnerable populations, weakest health systems and poorest infrastructure are likely to be the worst affected by climate change. This, in turn, translates into further widening of health and economic inequities. Understanding the existential threat of this new public health crisis and its impact on human health is therefore urgent and imperative for healthcare professionals. This chapter aims to outline for the reader:

1. The broad implications of climate change for India.
2. The wide-ranging impacts of climate change on human health.

Impacts of climate change for India

India is undoubtedly one of the most vulnerable countries to the impacts of climate change (Figure 6.1). With its large agricultural economy making up 18% of the country's GDP and employing nearly half of the population, substantial climate-related impacts on the workforce and economy can occur.

A 2.8% erosion of the country's GDP by 2050 is predicted, accompanied by a fall in living standards due to changes in temperature, rainfall and precipitation patterns (Mani *et al.*, 2018). There were nearly 10,000 deaths from the floods in Bihar, Odisha, Andhra Pradesh, Tamil Nadu and Kerala, and from cyclones and landslides in other parts of the country during the last decade alone (World Bank, 2019). Additional deaths due to heatwaves will increase the numbers further. While the death burden from climate change needs urgent redressal, we also need to address the huge burden of morbidity from changing disease patterns and reduced quality of life related

Figure 6.1 World map of the global climate risk index, 2019.

Source: David, E., Marie-Lena, H., & Maik, W. (Global Climate Risk Index, 2019). *Who suffers most from extreme weather events? Weather-related loss events in 2017 and 1998–2017 [Briefing Paper]*, p. 12. https://germanwatch.org/sites/germanwatch.org/files/Global%20Climate%20Risk%20Index%202019_2.pdf.

to climate change. Climate change has huge impacts on health through direct and indirect pathways:

- i. Acute changes in climatic conditions exacerbate existing diseases and trigger new patterns of disease dynamics
- ii. Acute climatic events resulting in environmental degradation and disruption of ecosystems can cause an impact on human health
- iii. Increased disease burden can occur in populations displaced by climate events (“climate refugees”)

Figure 6.2 provides an overview of the health impacts of climate change and its pathways.

The impacts of climate change on human health: an overview

Temperature and health

Extreme temperatures, especially those leading to heatwaves and cold waves of varying duration, frequency and intensity, can impact human health.

Heatwaves – As compared to 2012, there have been an additional 40 million heatwave exposure events in India in 2016, with those above 65 years being the most vulnerable (Watts *et al.*, 2018). This has caused a dangerous surge in the health impacts of heatwaves. Exposure to heatwaves of varying degrees can cause heat exhaustion, heat stress, heat syncope and heat stroke

Figure 6.2 The impact of climate change on human health.

Source: California Department of Public Health Website, Climate Change and Health Equity Program. (n.d.). <https://www.cdph.ca.gov/Programs/OHE/Pages/CCHEP.aspx>

with symptoms ranging from hot, dry skin, heat rashes/eruptions, headaches, nausea, giddiness, excessive sweating, muscle cramps, kidney dysfunction, disturbances in vision, mental impairment and sometimes loss of consciousness. Children, the elderly and those with pre-existing morbidities are particularly vulnerable with the exacerbation of cardiovascular and respiratory illnesses becoming increasingly common. Additionally, severe heatwaves can cause deaths with the most striking example being the nearly 800 excess deaths occurring within one week in the month of May 2010 in Ahmedabad (Azhar *et al.*, 2014). This topic is further discussed in the chapter titled *The Status of Heat Health in India*.

Cold waves – Exposure to extreme and moderately cold temperatures can also affect health, especially at extremes of age and in populations with pre-existing illnesses. Greater incidences of ischemic heart disease, stroke and respiratory illnesses have been recorded in regions vulnerable to extremely cold temperatures, with the highest mortality occurring in those between 30 and 69 years from stroke, and in those above 70 years of age, from respiratory diseases. The impact of extreme temperatures on health are therefore wide-ranging, and any adaptation and mitigation efforts must take into account adequate vulnerability assessments, risk stratification, health system capacity-building and appropriate and adequate management of those affected (Box 6.1).

Vector-borne diseases

The pattern of vector-borne diseases in India is showing marked changes attributable to warmer temperatures and changing rainfall patterns as a result of climate change (Box 6.2). Changes in these climatic variables in

Box 6.1 Case study

Cold waves in Terai region, Nepal

Nepal has been experiencing a rise in average temperatures due to global warming. However, a trend analysis of two recent periods, 1974–2014 and 2004–2014, showed a decreasing trend in minimum temperatures over the Terai region, which houses over 50% of Nepal's population. Vulnerable groups comprising children under 5 years of age, pregnant women and elderly citizens account for nearly 17% of the total population.

The decreasing temperatures during recent years have led to an increase in the number of cold wave days from an average of 8 days to 60 days in the past decade, impacting the poorest and the vulnerable populations the most. About 822 deaths were recorded due to cold waves between 1974–2013, compared to about 45 deaths due to heat-waves in the same period. These were mostly due to poor living conditions, inadequate heating and the consequent increase in illnesses such as acute respiratory infections, influenza, pneumonia, asthma, COPD, cardiovascular conditions, fever and hypothermia at extremes of age. Daily wage workers were also impacted and agricultural production suffered from crop losses due to very cold conditions. Inadequate heating in housing as well as hospitals was a major factor leading to hypothermia and acute respiratory illnesses in neonates and children under five. Cold conditions impacted school and workdays, with poor visibility affecting travel and leading to a greater incidence of traffic-related injuries besides impacting the aviation industry and tourism.

As part of adaptation measures, locally available firewood and straw was burnt to provide warmth. Government agencies added aid in the form of provision of warm clothes to new-borns and their mothers while distributing firewood in some pockets. However, the increasing trends of cold wave days in this densely populated region, especially during the winter months from November to February, requires a better coordinated response to protect lives and livelihoods.

Source: Pradhan, Sharma and Pradhan, 2019

recent years have impacted vector biology. Both vector growth and development time for the pathogen within the vector's body (extrinsic incubation period) are affected by rising temperatures, with vectorial capacities peaking under these conditions. The geographic spread and transmission windows have also transformed the intensity of the disease burden in previously unaffected areas. Malaria, dengue, chikungunya and Japanese encephalitis are all vector-borne diseases that are projected to increase with changing climatic conditions in India.

Box 6.2 Case study

Vector-borne disease trends in India

The *Anopheles* mosquito that carries the malarial parasite thrives in hot and humid areas. Altered climatic profiles influencing temperature, rainfall and humidity are affecting adult mosquito densities in large parts of the Indian sub-continent, and the changing transmission windows have caused the spread of disease in hitherto unaffected geographies. In India alone, an estimated 9.6 million cases of malaria were reported, with 16,700 estimated deaths due to the disease (WHO, 2018). The huge disease burden from malaria causes further stress on already burdened healthcare services. Dengue fever, spread by the *Aedes Aegypti* mosquito, has almost tripled or quadrupled in recent years, with the mosquito's survival, development and reproduction all influenced by warmer temperatures, rainfall and humidity (Lee *et al.*, 2018). Even hilly areas are increasingly prone to dengue with the disease becoming increasingly prevalent in the north-eastern states and the southern states of Kerala and Tamil Nadu (Rogers, 2015; Mutheneni *et al.*, 2017). Changing rainfall patterns in recent years, often surpassing decades of previous precipitation levels, has facilitated the ideal conditions for mosquito breeding and the spread of dengue fever across the country. Chikungunya, also transmitted by the *Aedes* mosquito, has tripled in recent years. Bihar, for example, saw an unprecedented spike in Chikungunya cases in 2017 (CBHI, 2018). The disease, transmitted by a virus, has acute onset of symptoms of fever, joint pains, muscle pains, fatigue and rash. The often debilitating and prolonged symptoms of Chikungunya fever affect worker productivity through increased work absenteeism.

The intricate links between climate change and changing vector-borne disease patterns in India warrants the development of a good framework for prevention, surveillance, diagnosis and management of these conditions, in addition to building the capacity of health and allied services (such as laboratories) for early detection. Linking these efforts with forecasting by the meteorological department will ensure effective handling of the growing burden of vector-borne diseases from climate change in India.

Water-borne diseases

The combination of warmer temperatures and increasing rainfall are favourable for the spread of temperature-sensitive pathogens through

water supplies, leading to outbreaks of water-borne diseases. Water-borne pathogens of human and animal faecal origin include several viruses, bacteria and protozoa. Cholera, for example, is climate-sensitive: the climatic suitability in certain geographical areas suitable for *vibrio* (the cholera-causing bacteria) has risen by 3% since the 1980s (Watts *et al.*, 2019). Floods can cause stormwater overflow with dissolved pathogens, contaminants from industrial and domestic waste, thereby increasing the possibilities of water-borne diseases. Altered concentrations of dissolved minerals and heavy metal contaminants are increasingly common, with high levels of arsenic (which causes severe skin and gastrointestinal conditions) and flourides (which cause dental and skeletal fluorosis) in large parts of flood-affected areas. Cancers have also been implicated through arsenic contamination of groundwater supplies. Gastrointestinal symptoms of nausea, vomiting, diarrhoea, stomach cramps and fever through water-borne diseases can cause school and work absenteeism in affected populations. Acute gastrointestinal diseases often require hospitalisation for rehydration, increasing the burden on health systems. Contaminated water used for bathing and washing purposes can cause skin and ear infections. The extreme situation of water scarcity caused by droughts and famine situations can cause diseases due to re-use and poor treatment of wastewater. The inextricable link between climate variability, access to clean water and sanitation and water-borne diseases is, therefore, an area of growing concern.

Malnutrition

The climatic impact on nutrition occurs directly and indirectly. Extreme temperatures have a severe impact on agricultural production across India, with allied sectors such as livestock rearing and fisheries also being affected. Staple crops like rice, wheat, maize and soya bean are affected, with the overall reduction in crop production and poor crop maturation patterns impacting food and nutrient availability. With undernutrition and its related impact on vulnerability to infections already existing in India, large sections of our population will suffer from the consequences of food and nutrient insecurity resulting from climate change. Studies have shown that infants show greater vulnerability to stunting and wasting in post-flood situations, with the subsequent unavoidable impact on growth and development (Watts *et al.*, 2019). With the reduction in the availability of staple cereals, fresh fruits and vegetables, coupled with rising prices, the recourse to processed foods sets off an increase in the prevalence of conditions at the other end of the malnutrition spectrum – obesity. This new triad of the link between the three pandemics of climate change, undernutrition and obesity with common drivers has been labelled a *global syndemic* (Swinburn *et al.*, 2019).

Air pollution-related diseases

Air pollution is intricately linked to climate change, with rising temperatures causing a rise in the levels of ozone, an important greenhouse gas. The combustion of fossil fuels (a major source of air pollutants) with other gaseous and particulate pollutants increases greenhouse gases like carbon dioxide and methane, thereby driving climate change. The health impact of air pollution ranges from respiratory and cardiovascular illnesses to outcomes on pregnancy and neurocognitive development of children. Addressing air pollution therefore has co-benefits for climate change. This topic is further discussed in the chapter titled *Air Pollution, Climate Change and the Health Sector: Linkages and Solutions*.

Mental health

There is a growing recognition that the overwhelming threats of changing climate manifest in worsening mental health. In the aftermath of acute climatic events such as floods and droughts, post-traumatic stress disorder occurs widely among children and adults alike. Stress, anxiety, poor coping mechanisms and the compounded impacts of conflict for food and shelter signal an urgent need to address the rising burden of mental ill-health. Recent studies have linked increasing rates of suicide to climate change (Burke *et al.*, 2018). A new condition of “eco-anxiety” or “climate anxiety” defined by the American Psychological Association in 2017 refers to the “chronic fear of environmental doom”, a fear often experienced by children and adults due to the current and future predicted state of climate change and environmental disasters (Clayton *et al.*, 2017). The trend of increased stress and suicides amongst farmers is also attributed to the influence of extreme temperatures affecting agricultural production and incomes in farmer households. The impacts on mental health of vulnerable populations such as children, women and the elderly must be recognised and an enabling environment for access to care and counselling services must be facilitated. “Solastalgia,” a loss of solace due to degradation of the environment of an individual’s belonging, is likely to disproportionately affect these vulnerable sections of our population. Enhancing the awareness and capacity of the health sector to deal with this growing burden of mental ill-health is both urgent and critical.

Key takeaways

- Climate change is an existential threat and can have wide-ranging impacts on human health. The overall impacts of climate change on human health can no longer be ignored; there is a dire need for health-care professionals around the world to prepare for the growing burden of diseases from climate change.

- The World Health Organization has designated five areas as major health impacts of climate change – malnutrition, deaths and injuries caused by storms and floods, water contamination and water scarcity related disorders, heatwaves and vector-borne diseases.
- Extreme temperatures (heatwaves and coldwaves) can exacerbate cardiorespiratory illnesses, especially in the elderly, affect labour productivity and cause school and work absenteeism.
- Climate change impacts overall food production, thereby leading to food and nutrition insecurity, with both undernutrition and overnutrition being fuelled by climatic changes
- Acute climatic events such as floods and droughts cause greater burden from water-borne diseases.
- Changing climatic conditions spur the onset of new patterns of vector-borne diseases.
- Climate change triggers onset of a range of mental health disorders.

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