ISSN: 3067-2422
Review Article
Journal of Complementary Research and Alternative Medicine

Climate Change, Induced Warming and the Impacts on Human Health

Tridib Bandopadhyay

Scientific and Environmental Research Institute, Kolkata, India

***Corresponding author:** Tridib Bandopadhyay, Scientific and Environmental Research Institute, Kolkata, India

Submitted: 19 May 2025 **Accepted:** 26 May 2025 **Published:** 31 May 2025

https://doi.org/10.63620/MKJCRAM.2025.

Citation: *Bandopadhyay, T. (2025). Climate Change, Induced Warming and The Impacts on Human Health. J of Complement Res Altern Med, 2(2), 01-10.*

Introduction

The reality of climate change and its impact on human health are no longer in the realm of speculation. International scientific organizations, such as the Intergovernmental Panel on Climate Change, have long predicted the disruptions in planetary ecology and human health that the world now faces. Climate system of the Earth is non-linear and characterized by oscillations, and fluctuations. While the causes for such changes in climate are the anthropogenic activities and increasing emission of Carbon di-oxide (CO2) and other Greenhouse gases into the atmosphere, the impacts are disproportionately distributed among the regions. Already, almost 3.6 billion people live in areas, which are highly susceptible to climate change impacts. Despite contributing minimally to global emissions, low-income countries and small island developing states (SIDS) endure the harshest health impacts. The Intergovernmental Panel on Climate Change (IPCC) in their Sixth Assessment Report (AR6) concluded that climate risks are looming larger and faster. The impacts will be more severe and sooner than previously expected. There is growing concern that climate change is increasingly posing a major scientific and medical challenge for 21st century (WHO, 2018). Together with the other parameters of global environmental changes and their cascading effects, like the ozone layer depletion, soil degradation, pollution of air, water and soil, and urbanization, the rapidly changing climate, induced by global warming are creating irreversible human health problems. Records show, high humidity and rising atmospheric temperatures are extending to all regions and sustaining for longer durations of time every year. For this, normal human thermoregulatory tolerance is being grossly affected. This unprecedented increases in humidity and temperature not only affectingfood production and food-security, but also posing potential health consequences on the population.

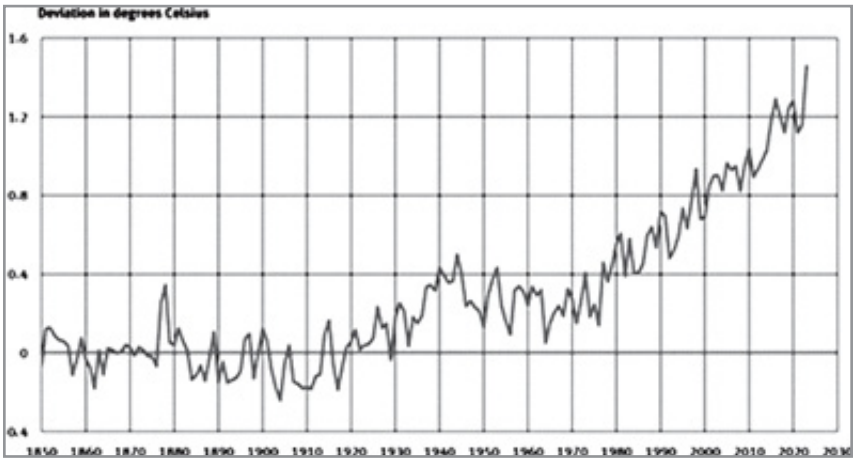
The United Nations Framework Convention for Climate Change (UNFCCC), jointly with WHO issued the "Declaration on Climate and Health" during the Conference in UAE in 2023 (COP28) to accelerate action to protect public health and communities from the growing climate impacts and strengthening of healthcare systems to cope with effects of extreme heat, air pollution, viral infections and zoonotic diseases. In the nervous system, the fundamental properties of signaling and communication require ion channel gating through electrochemical stimuli controlled by the brain- function and the mechanisms are steeply dependent on temperature. The nervous system complications of hyperthermia result from effects of temperature on ion channels. Health researchers have long known about the effects of climate change on zoonotic and other vector-borne infectious diseases and their favorable incubation, transmissibility or the conditions of exacerbation under the warming scenario. Notwithstanding that, the effects of warming climate on neurological, psychosomatic and chronic diseases like cancer are less clearly understood yet than the infectious and vector-borne diseases. The prognosis of chronic diseases does not develop in a close time-frame or in temporal proximity of the exposures to the conditions brought about by regional climate change. However, climate change impacts on humans and the ecosystems are enlarging its periphery and despite tremendous improvements in medical sciences, infiltration of technological measures in detection and various procedures, the manifestation of different diseases and the records of hospitalization or routine-use of drugs are rising, as also the warming trends of the atmosphere commensurately. The present study tries to underscore the links and effects of climate change and human health systems.

Materials and Methods

In academic pursuit, Climate Change refers to the long-term shifts in temperatures regime and weather patterns of the Earth and the effects that cascade in. Greenhouse gases emitted by various anthropogenic activities blanket the Earth. They trap the Sun's heat, without allowing that to escape to the higher atmosphere. This leads to warming of the lower atmosphere.

For theEarth-system functions, warming of the atmosphere and surface to an optimum level is important and that is required to make the evolution and sustenance of the life on Earth possible. But warming of the atmosphere beyond the threshold, causes shifts in the Earth's stable weather and climate patterns and that affects all components of the ecosystems and the living organisms drastically. Since the 1850s, with the advent of European Industrialization, the world began to warm at a rate faster than at any point in recorded history, endangering the Earth's life-support systems.

There was an incremental rise in World's average temperature since then. Climate Change now presents a fundamental threat to the ecosystems of the Earth and contributes to emergencies from heatwaves, wildfires, floods and tropical cyclones. Frequency & intensity of such extreme events are increasing in scale and frequency since the industrial-age, we take it as 1850 - 1900. The warming climate is affecting the physical environment, as well as, all other aspects of natural and human systems – including the social and economic systems. It is now a threat multiplier, undermining and potentially reversing decades of nuanced human-progress. Sixth Assessment Report (AR6-March, 2023) of IPCC concluded: "Impacts of climate change are looming larger and faster than expected. These are causing global warming and other irreversible negative impacts on environmental parameters, ecosystems &populations, livelihoods and health-systems."



The reality of climate warming is continuing to extend to new geographical regions. Records of World Meteorological Organization (WMO) indicate, the year 2024 was the warmest in the Earth's history, while the level of CO2 during the year was the highest in the last 2 million years. This trend of record-setting warming of the climate are likely to continue and cover wider areas. WHO data indicate, for the climate-stressors worldwide, about 2 billion people lack safe drinking water and 600 million suffer from foodborne illnesses annually. Over 930 million people – almost 12% of the world's population – routinely spend at least 10% of their household budget for healthcare. In 2021 alone, the global expenditure on healthcare reached a hooping $9.8 trillion, that accounted for 10.3% of global GDP.

There is growing concern that climate warming is posing a major scientific and medical challenge for the 21st century. "Although it is unequivocal that climate change affects human health, it remains challenging to accurately estimate the scale and impact of many climate-sensitive health risks" (WHO, 2018). Together with the other parameters of global environmental changes like the ozone layer depletion, soil degradation, air, water and soil pollution, deforestation and urbanization, changing climate is inducing irreversible damage to the planet and incorrigible human health problems. Sixth Assessment Report (AR6-March, 2023) of IPCC concluded: "Impacts of climate change are looming larger and faster than expected. These are causing global warming and other irreversible negative impacts on environmental parameters, ecosystems & populations, livelihoods and health-systems."

The UNFCCC and WHO together issued the declaration in 2023 (COP28) at Dubai "Declaration on Climate and Health", which aims to accelerate action to protect public health and communities from the growing climate impacts and strengthen healthcare systems to cope with the effects of extreme heat, air pollution, infections and zoonotic diseases, environmental risk factors and extreme weather events. The joint declaration stated that devastating health impacts of climate change are evident from almost 9 million deaths from air pollution and exposure of 189 million people to extreme weather events annually.

The Three Major Components of Change in Climate Are

- Rise in ambient temperature,
- Changes in precipitation patterns and
- Increased frequency of extreme weather events.

All these episodes impact the human welfare and health-systems. Over the last hundred years, repeatedly, there had been one pandemic or the other; vector-borne or foodborne or of zoonotic origin and their mutations are continuously changing continuously. Scientific literatures contend, ecosystem changes mediated by warming weather are inducing the shifts in infectious, vector-borne and zoonotic diseases (VBZDs). The VBZDs ecology depend on multiple factors, e.g. geographical location, regional altitude, local ecosystems, the host and the vectors, wherein climate and weather influenced the occurrence, incubation and spread of the disease. The present study would examine the impacts of climate change on human health in consonance with the accessible data and reports of WHO and other scientific literatures.

Discussions and Results

Earth's Climate System is non- linear, and characterized by oscillations, vis-à-vis climate fluctuations, long-term shifts in temperatures, changing humidity, weather-patterns and the impacts thereto. Heat, cold and other environmental challenges have been part of the world within which humans have evolved. But the pattern changed drastically. "Atlas of Mortality and Economic Losses from Weather and Climate Extremes" (2023, WMO Report) indicated 2 million deaths between 1970-2021 from extreme heat- impacts. Of them, 90% were from the developing countries. Low and medium-income countries, small island states (SIDS) faced the harshest of health impacts. About 3.6 billion people already live in these impact-prone areas. Climate change is increasingly understood not just as an environmental issue, but a fundamental threat to humanhealth and well-being allover. Over 930 million people, about 12% of world's population – spend at least 10% of household-budget routinely for health care. With poor people largely not under sustainable insurance cover, the increasing impacts of climate warming would worsen their health-care accessibility. An environment is considered thermo-neutral so long the body does not release additional energy to maintain its stable core temperature.

Human body is 'endothermic homeotherms', that generate own body heat and regulate the body-temperature commensurate with the environmental conditions. Hypothalamus in the brain, is the control point, that works as a thermostat to regulates the body's core temperature. The process by which the body keeps the internal environment constant despite changes in the external environment is termed as "Homeostasis": Homeo means — "sameness or similar" & stasis means — "standing". All the body organs and tissues work together for keeping the internal environment at a nearly constant state and the process is thus called so. The chemical, thermal, and neural factors interact together to maintain homeostasis. Thermo- neutrality of the body indicates the ambient temperature at which an organism's metabolic heat production is minimal and it doesn't need to generate or lose heat. At this temperature, the body can maintain its core temperature by regulating heat loss through the skin. The body temperature is influenced by this internal mechanism. When the body temperature is high, the hypothalamus initiates various processes to lower it.

These include increasing the circulation of the blood to the surface of the body, so as to allow the body to dissipation the excess heat through the skin and initiation of sweating to allow evaporation of water on the skin to cool the outer-exposing surface of the body. When the temperature is too high, the hypothalamus can initiate several processes to lower it. These include increasing the circulation of blood to the surface of the body to allow for dissipation of heat through the skin and initiation of sweating to allow evaporation of water on the skin to cool its surface. Conversely, if the ambient temperature falls below the set core temperature, the hypothalamusinitiate involuntary actions, like shivering to generate heat. The body can accordingly use more energy and generates more heat. In addition, thyroid hormone also stimulates more energy-use and heat production by cells throughout the body.

Behavioral adaptations like use of covered-shelters, shaded places, appropriate clothes, using heating and cooling systems could help maintaining the central or core body- temperature around 37°C, so as to ensure stable physiological functions of the human body. The state of balance among all the body-systems is called Homeostasis. Hypothalamus, the coordinating center, regulates the body temperature, which is achieved through homeostatic thermoregulatory mechanism. The cold and/or warm receptors in the skin, around veins and in the spinal cord area, send messages to the hypothalamus in the brain, the brain produce heat from the muscle and other organs to combat the changes. Human-body has evolved to maintain and settle within a comfort-zone of ambient temperature 20 - 36°C and Relative Humidity (RH) of 30%-60%. Neurons in the brain function best within this specific weather-range.

Higher temperatures and humidity trigger sweating and alert us for protection. The stable conditions are altered with the activities of individuals. Most of the heat in the body is generated in the liver, brain, heart, and the skeletal muscles during the individual's activities. Also, ingestion of food in the stomach follow endogenic chemical reactions and that produces potential chemical energy, which is transformed into thermal energy. The maintenance of body's core temperature is important to enable continuation of activities of all organs. When the body's core temperature drops below 35°C for some reason, it poses a medical emergency, called Hypothermia. Oppositely, when the body is exposed to high temperatures, heat- induced swelling of body-tissues occur due to trapping of fluid in the tissues, which is termed the Thermal Edema. This rate of transformation of energy varies depending on individual's general health, height and weight. Part of this energy is needed to maintain the body's core at normal temperature and for the body's internal organs to receive chemical-energy necessary for normal functioning.

The body burns calories even when in state of rest for carrying out basic functions like breathing, nutrient processing, and cell production which call for consumption of oxygen that is inhaled and is called basal metabolism. The rate of oxygen consumption or energy provision in body-surface is termed the Basal Metabolic Rate (BMR), which is approximately 43 W/m2 for humans, denoting the minimum number of calories our body may need to function at a basic level. This varies from person to person. Alteration of Basal Metabolism may hinder muscular activity with shivering and/or muscle contractions. Estimation of basal metabolic rate (BMR) and daily energy expenditure (DEE) in humans indicate the way the populations adapt to different environmental and nutritional conditions. In general, populations living in warmer climates tend to have lower BMR than those living in colder climates. However, when these parameters exceed the human tolerance level, different types of health-problems arise.

Human brain is able to maintains its own unique ecosystem. The support cell in the brain, called the astrocyte, play an intermediary role in supplying energy to the neurons. Neurons are the nerve cells that send signals all over the body to allow every activity, physical to mental - from breathing to talking, to thinking to be continued. Glucose is the principle fuel to the brain to enable continuation of all its functions The astrocytes are the brain's primary consumer of glucose and convert the molecules to another derivative, called lactate, before it is passed on to the neurons. Lactate is the sugar molecule used by mitochondria as the energy-source. Mitochondria have multiple functions like

supplying energy, and producing proteins. They are closely related to the physiology and pathology of many organs and tissues of the body. For the brain to function properly and meet its development and functioning, it has to follow definite pathways. It has to have nutrient-support and be able to provide the scope to develop the required physical parameters like the range of temperature that suits individual's desired range of comforts, and to receive the energy-inputs and stimuli to generate outputs. If these conditions are not fulfilled, the brain functions may be compromised resulting in hypoxia, addiction-tendencies, physical temperature extremes beyond its compensatory capacity, disruption in sleep, and psychological diseases. Disordered brain function can reduce the ability of the affected individual to respond to external challenges. Providing the brain with the necessary working environment is a complex task. In a high-heat condition, intrinsic thermoregulatory responses like sweating have to be functional. When these responses fail, the temperature of the brain and its host body may rise to levels that further compromise brain function, its ability to respond to environmental challenge may decline.

Emerging health risks from Climate Impacts- Climate

Disease relationships are no longer endemic. They drive the disease dynamics to all geographical regions. Despite major improvements in medical sciences, Climate Change Impacts threaten the progress made in reduction of disease burden. WHO data shows, under Climate Stress, 2 billion people face water-borne, vector-borne and zoonotic diseases and 600 million suffer food-borne illnesses annually. WHO projected an additional 250,000 yearly deaths by 2030s from climate change-related impacts on human health.

Body-function and Heat-impact

Extreme heat, events like heat-waves, floods, and storms very often worsen neurological conditions. The Arctic-region is currently warming at unprecedented rates for the last fifty years. Permafrost soils are among the largest terrestrial carbon reservoirs on Earth with an estimated and in the northern hemisphere, permafrost soils are reservoirs of organic carbon, and also of uncharacterized microbes and viruses. The consistent warming could result in thawing of large tracts of permafrost soil and pose challenges to tackle the implications on the environment as it could expose the resident microbes to atmosphere posing risks to humans, plants and animals. When the ambient temperature at which an organism's metabolic heat production is minimal and it does not need to generate or lose heat, the condition is called thermo-neutral. Normal body temperature varies for person in relation to their age, activities performed, and time of the day when it is measured. But that does not create any alarming condition for an average person.

Core temperature of any healthy human-body remain at around 37 ± 0.5°C. This core body temperature compensates the bodily heat generation with heat loss. Human body could maintain this core temperature by regulating heat loss through the skin. If the body's core temperature drops below 35°C, the individual may get into physical convulsion and need emergency care. On the other hand, when the body is exposed to high ambient temperature, heat-related edema or heat-induced swelling and even heat-stroke may take place. Messages, in the form of electrical impulses travel back and forth between the brain and other parts of the body. Special cells named Neurons, which are billions in numbers, interpret these messages, and pass-on the instructions to the respective organs to act. Transfer of information from neuron to neuron takes place through the release of chemical substances called the neurotransmitters. When the neurons communicate, electrical impulse triggers the release of neurotransmitters. The process of transmission of messages from neuron to neurons through the neurotransmitters is highly sensitivity to temperature. Alteration in neurological function might contribute directly to acute neurological manifestations of hyperthermia, like convulsions. Thermoregulation is the physiological process to maintain the body temperature.

Thermo-receptors, which are the nerve endings, present in the hypothalamus, and also in the skin, viscera, and spinal cord, detect the changes in temperature. Changes in fluid volume and electrolyte concentrations, due to excessive atmospheric or internal heat, also affect the thermoregulation system in the body. These conditions accentuate heat regulation mechanisms to increase or decrease body temperature and to return it to baseline. The body's inability to regulate the internal temperature and eliminate the rising heat increases the risk of heat exhaustion and heatstroke. The strain put on the body's internal organs for cooling itself down also puts additional stresses on the heart and the kidneys. This high body-heat condition can worsen the diabetic, cardiovascular, respiratory conditions and increase mental health-risks for persons with chronic conditions. Altered neurological functions might contribute directly to different manifestations of hyperthermia, like seizures, strokes, migraine and epilepsy etc. Medical records indicate, commensurate with the rising ambient temperature and humidity, admissions to hospitals rise, round the world, with increasing incidences of cerebral stroke, schizophrenia, migraine, epilepsy, multiple sclerosis, Alzheimer's and Parkinson's disease, and various psychiatric disorders. As the people grapple with unstable and warming weather, psychosomatic disorders viz. anxiety syndrome, depression, sleep- distortion, alcoholism, suicidal tendencies and aggressive behaviors like lawlessness, rowdyism might rise. Cognitive functions like the societal & academic activities may also be affected.

In an effort to "significantly reduce the risks and impacts of climate change," the UNFCCC, Paris Climate Agreement 2015 called for limiting the global average temperature rise in this century to well below 2°C, while pursuing efforts to limit the temperature rise to 1.5°C. Against this mark, the global average surface- temperatures have already risen (2024) by about 1.2°C since the pre-industrial era, which we take as the year 1850. While the changing environmental conditions have proven to inflict major impacts on human health-systems, health-researches have also progressed the challenging task concurrently and consistently towards providing healthcare commensurate with the rising risks of major health-problems and the increasing financial burden. All the allied compartments of health-care systems - the diagnostics and testing systems, treatment-protocols, prognosis of diseases, and prevention measures for infections, observing and restricting seasonal and other disease vectors, their mutation and manifestation processes. The healthcare systems and facilities have witnessed significant improvements over the years with the application of technologies in development of medical equipment, application of robotics, Artificial Intelligence (AI)

tools and continued researches in medicines, pharmacology and etiology.

However, the effects of climate change on chronic diseases like cancer, dementia, Alzheimer's etc. and their prognosis are less clear till now than the infectious and vector-borne diseases' and their control measures. The problems in the prognosis or manifestations in these chronic diseases arise as their progress do not take place at a fast-pace to relate to their direct impacts of climate change. Global trends indicate that cancer is also likely to become one of the major causes of death for virtually every country in the 21st century. Just as climate change is affecting the ecosystems and the populations, the prevalence of Brain Disease also has a global impact. The Lancet Neurology found that now, over 1 in 3 persons are affected by neurological conditions, meaning it is now a major cause of illness and disability worldwide. Based on 2021 data from the Global Burden of Disease, Injuries, and Risk Factor Study (GBD), the findings indicate a growing issue. The overall amount of disability, illness, or premature death (termed as, Disability-adjusted Life Years, DALYs) caused by neurological conditions has increased by 18% since 1990. In 2021, 3.4 billion individuals were affected by different nervous system conditions and the same caused about 11 million deaths. Specific impacts of climate change on mental health are difficult to identify and evaluate at the early stages.

This is, of course, true for many other mental aberrations, which may range from minimal seasonal stress leading to irritations and misbehaviors or other distress symptoms. At one stage, that may lead to major clinical disorders, involving depression, anxiety, sleep disturbances and even suicidal thoughts at some chronic stages. Rising ambient temperatures and extreme weather-related events may perturb brain function for patients with pre-existing neurological problems, trigger post-traumatic stress disorder, bipolar disorder, and other mental health conditions and may even affect persons with normal health conditions in varying degrees. Continuously rising ambient temperatures beyond normal range with prolonged droughts, water-shortage and crop failure due to climate change often lead to farmer' suicides. Hospitalizations for psychiatric disorders and emergency psychiatric visits tend to increase

during heatwaves. Atmospheric heat disrupts sleep, and poor sleep can worsen mental health problems. The other impacts of climate change on mental health may include cognitive function impairment, interpersonal aggression.

Climate Change induced Heat-wave Conditions and Impacts

The European Union's Climate Data Source (CDS) Copernicus and the World Meteorological Organization (WMO) reported in April 2024 that Europe was Earth's most rapidly warming continent, with temperatures rising at a rate twice the global average rate, and that Europe's 5-year average temperatures were 2.3°C higher relative to their pre-industrial temperatures. Europe experienced the Cerberus Heatwave in July, 2023, the hottest temperatures ever recorded in Europe. Analysis of Indian Meteorological Department (IMD) has revealed a significant increase in heat stress due to high temperatures and humidity over India in the past 40 years. The study found, the magnitude of heat stress has risen by almost 30% in India, with a significant upward trend in the spatial range of the areas facing heat stress. The study found that two primary patterns - dry or moist heat stress conditions, both triggered heat-wave conditions across India. The four months, July to October recorded the highest ever minimum temperature since 1901. It is observed, vulnerabilities from heat-wave conditions differ between men and women. The percentage of deaths were higher in women than men during the European heat wave. Negative outcomes of heat waves are also related to social factors. Women, young people, and people with lower socioeconomic status may be more vulnerable. Climate and Health Profile Report identified both direct and indirect impacts on health from extreme heat and precipitation. Health risks caused by these factors has significantly risen in recent years. Heat stress caused by heat waves has been associated with mood disorders, anxiety, and related consequences, as discussed earlier. It is now reported that people with mental illnesses were three times more likely to run the risk of death from a heat wave than those without mental illness. During pregnancy, especially in the second and third trimester, exposure to heat waves have been showed to be related to a lower average birth weight and increased incidence of preterm birth. Effects during childhood and adulthood comprised reduced schooling and economic activity, other than behavioral and motor problems and reduced IQ.

Chronic and Emergent Health Problems

The major impacts of climate change on health-problems come from seasonal variation, temperature, humidity and thermoregulation, biorhythm and circadian rhythm. The cascading effects of these climate change impacts on human health is receiving increased attention, calling for elaborate studies on the effect and etiology, study of the origin and causes of chronic diseases. The impacts affect health systems in a myriad of ways, including chronic, non-communicable, zoonotic and vector-borne diseases and mental health issues. The identification of climate-sensitive infections is crucial for mitigating the effects of epidemics and pandemics. Some of the major heterogeneous disorders leading to increasing burden of human health and life- threatening diseases are as under:

Stroke

Stroke is a heterogeneous disorder, due to either ischemia, cardiac embolism, or small vessel occlusion and/or intracerebral hemorrhage caused by small vessel rupture. It is a leading cause of disability and death among populations. Study of the increasing burden of stroke-related disabilities have shown positive correlation of rising atmospheric warming and humidity. Elderly people are the most vulnerable and susceptible to temperature changes due to disordered thermoregulation and comorbidities. Studies among populations of different countries have shown rising incidence of hospital-admission, mortality, or disability from ischemic stroke with rising temperature and relative humidity. Pre-existing cardiovascular problems may also increase the risk of stroke associated with climatic variables.

Migraine

It is a type of neurological disorder resulting in severe headache usually on one side of the head. A warning symptom occurs before or with the headache termed an aura include variousvisual disturbances like flashes of light or blind spots or nausea tendencies. Researchers corroborate rising temperatures may trigger migraine episodes or aggravate the effects. Evidence suggests, worsening climate conditions may lead to higher frequency of migraine-attack and rise in tension-type headache.

Alzheimer's Disease and Other Dementias

Globally, about 57 million people lived with Alzheimer's disease and other dementias (ADOD) — and the prevalence is projected to grow to 153 million people by 2050. While the world's population is heading to longer life expectancy, researchers projected, the highest rates of populations living with ADOD in countries facing highest impacts of climate change. People with dementia are exceptionally susceptible to hypothermia and weather events like flood, landslide or wildfires, as cognitive impairment can limit their ability to adapt behavior to the environmental changes.

Cancer

Cancer development and detection is generally a long and complex process. The detection process is influenced by the healthcare facilities, their quality and accessibility of individuals in the country, financial support-system in healthcare, social taboo, changes in environmental factors, lifestyle choices, and genetic predispositions etc. Climate change can affect the cancer incidence and treatment regime through direct and indirect pathways. Direct pathways involve exposure to risk factors that are influenced by climate change, like increased exposure to ultraviolet radiation, food systems — production, including use of chemical fertilizers and pesticides, harvesting and processing, left over preservatives and contaminants, industrial toxicants etc. Indirect pathways involve avoidance of medical consultation and tests due to high costs of healthcare, ignorance of social and environmental health-determinants that affect cancer risks. limited access to cancer healthcare services. Prognosis of cancer cases and the progress in humans takes quite a long time and without major initial effects and individuals are not put on periodic screening-tests for suspected symptoms.

The detection and pronouncement of the type of cancer and the stages of progress are generally late in majority of countries. Clear data on the incidence of cancer in populations of different social background, gender and age-profile etc. are not easily available. The influence of climate variables on incidence of different types of cancer rates are also not clearly identified. While the technological involvement in cancer- detection and the treatment regime have improved significantly, the increasing number of cancer-patients, especially in the technologically advanced and wealthy countries, is over-riding their achievements in cancer prevention, screening, and treatment. Cancer incidence rates are increasing at an alarming rate in developing countries like India. The country is facing a growing cancer burden, with a projection of 1.57 million new cases by 2025-end, as against 1.46 million new cases registered in 2022. International Agency for Research on Cancer (IARC) of WHO released the data on global burden of cancer from 115 countries. It confirmed, majority of the countries do not have adequate cancer and palliative care services, as part of Universal Health Coverage (UHC). The IARC estimates, based on the best sources of data available from the countries in 2022 highlighted the growing burden of cancer and the urgent need to address cancer inequities worldwide. Cancer research in India is also growing, where the focus in on understanding of cancer biology, its diagnostics, therapeutics and effects of life-style changes. India's National Cancer Registry Programme (NCRP) tracks cancer incidence, while the National Institute of Cancer Prevention and Research (NICPR) focuses on research and screening guidelines.

Diabetes Mellitus

It is a chronic metabolic disorder characterized by persistently high blood glucose (sugar) levels, resulting from either insufficient insulin production or the body's inability to effectively use the insulin it produces. One of the most vulnerable victims of climate change are the patients with diabetes mellitus (DM), the chronic metabolic disorder with high blood glucose levels. This is caused by body's inability to produce enough insulin or its resistance to the effects of insulin. Insulin is a hormone that helps glucose(sugar) from the intake of food enter the cells for energy. The rise in ambient temperatures increases the risk of increasing blood glucose levels in chronic and elderly patients under blood glucose-lowering medication. Air pollution of fine particulates (PM2.5) is also linked to an increased risk of insulin resistance and complications of type-2diabetes (T2D). Clinical records indicate, rise in visits of patients with DM to emergency departments, hospitalizations, morbidity and mortality during heat waves. High ambient temperatures can negatively impact glycemic variability in diabetic patients, potentially leading to increased fluctuations in blood glucose levels and a higher risk of both hyperglycemia and hypoglycemia. This effect is particularly pronounced during heatwave conditions resulting in impaired thermoregulatory mechanisms, electrolyte and body-fluid imbalances, and deterioration of kidney function for regulation, particularly among the elderly people with pre-existing chronic kidney problems.

Endocrine Disorders

Endocrine system is a network of glands that produce and release hormones. These hormones help control many important body functions, including the body's ability to change food intakes or calories into energy to power the cells and organs. The receptors that respond to the inflow of hormones and the organs impacted by less or more flow of hormones create unintended imbalances in body-function. Climate change exerts multiple effects on environmental factors, including temperature fluctuations, altered seasons, and extreme weather events, atmospheric pollution, and exposure to chemicals. All these contribute to endocrine disruption, have significant repercussions on endocrine health. Endocrine-disrupting chemicals (EDCs) are considered the most serious anthropogenic threats to the biodiversity and the ecosystems. Environmental agents and atmospheric toxicants may also trigger autoimmune thyroid disorders. Thyroid is the butterfly-shaped gland in the front of the neck that controls metabolism. The other factors may include autoantibody conditions, iodine intake-status, smoking history, family history of autoimmune thyroid disease, pregnancy, and history of medication use etc. Recognition of thyroid autoimmunity as a contributing factor to changes induced by environmental agents is crucial in these studies illuminating the pathogenesis of autoimmune thyroid disease and exploring the possible influence of environmental factors in its development. The thyroid gland takes signals from the hypothalamus in the brain and also the pituitary gland at the base of the skull.

A broad range of environmental pollutants can interfere with thyroid function, many of which may have direct inhibition of thyroid hormone or induce detectable high levels of thyroid stimulating hormone (TSH) consequently. The two main thyroid hormones, triiodothyronine (T3) and thyroxine (T4) have a major role in maintaining the body's energy levels, internal tem-

perature, hair, skin, weight etc. Substances like polychlorinated biphenyls (PCBs) act as a substance that mimics the actions of neurotransmitter or hormone. Suspended particulate pollutants in air PM2.5 and PM10 have been associated with hypothyroidism. Alters seasonal patterns with climate change may disrupt circadian rhythm affecting the production and regulation of hormones critical for various physiological processes. Extreme weather events like heatwaves, cyclones or floods also cause stress responses in the body, potentially influencing the endocrine system and contributing to hormonal imbalances.

Meningitis and encephalitis

Both Meningitis and Encephalitis involve inflammation of the central nervous system. In meningitis, it is inflammation of the meninges (the membranes surrounding the brain and spinal cord), while encephalitis is inflammation of the brain tissue itself. It is an infection and inflammation of fluid and membranes around the brain and the spinal cord. The inflammation from meningitis most often triggers symptoms of high fever and severe headache. Viral infections are the most common cause of meningitis, encephalitis. Meningoencephalitis is a neurological condition characterized by inflammation of both the meninges and the brain tissue. Viruses, bacteria, fungi and some amoeba (Naegleria fowleri) are the main causes of meningoencephalitis. These infections spread through air, water, food or contact with infected persons. Not everyone who gets these infections develops meningoencephalitis.

WHO initiatives include defeating these infections by 2030. Global Roadmap of WHO — 'One Health' relate to pathogen-specific initiatives including Japanese encephalitis, tick-borne encephalitis, measles, rabies viruses. Climate change influences the transmission of the diseases by altering the vector habitats. Changing weather patterns favour the emergence and spread of the viruses to new regions beyond the endemic areas. Rising temperatures and changes in precipitation patterns help shifting of the vector habitats and activity of the disease-vectors like mosquitoes and ticks, the carriers of viruses.

Epilepsy

It is a disease of nerve-cells when the brain does not signal properly and causes seizures. Seizers are the uncontrolled movement of electrical impulse from the brain that change sensations, behaviours, awareness and involuntary muscle movements. Conditions of Epilepsy are impacted negatively by Climate Change, specially by exposure to heat and rising temperature, the common may impacts being increasing stress, sleep deprivation, and potentially exacerbating seizures.

Multiple Sclerosis

It is a disease in which the body's immune system. There are a variety of symptoms, which include blurring of vision and fatigue, muscle cramps and weakness, loss of bladder control, loss of sensation and cognitive difficulties etc. Symptoms vary from person to person depending on individual's immune system. Sclerosis attacks the nerve-signalling system causing autoimmune disorder of the central nervous system. It can cause numbness of muscles, weakness, trouble in walking, changes in vision and other symptoms. It is an unpredictable disease and may affect people differently. Most patients find that the heat causes a flare-up. Anything that raises an individual's core body-temperature, be that fevers, hot baths, exercise, or exposure to warm environments, can make it harder for electrical signals to travel along the already damaged nerve segments, triggering an onslaught of sensory, cognitive, visionary or movement problems.

Vector Borne Infections and Climate Warming

Vector- borne diseases are caused by pathogens that are transmitted from animals to host animals or to humans. All disease vectors viz. insects, fungus, pathogenic bacteria etc. have a climate dimension that affect the life-cycle of the vector populations, pathogen development, and disease transmission positively or negatively. the largest burden on global public health disproportionately affecting people in tropical and subtropical areas. Vectors are generally ectothermic. Any alterations in weather, like temperature, rainfall and humidity, can affect their reproduction, survival, geographic distribution and, consequently enhance the ability to transmit pathogens. Warming climate potentially leads to increased geographic range of spread and longer transmission seasons. Warmer temperatures allow vectors like fleas, mosquitoes and ticks to survive and breed in areas that were previously too cold, allowing longer periods for the vector- organisms to remain active, providing scope for breeding and spreading and increasing the window of opportunity for disease transmission. According to WHO, as the climate change alters temperatures and weather patterns around the world, by 2070, an additional 4.7 billion people may be at risk of the vector-borne disease-infections like Zika virus fever, West Nile Virus, Chikungunya, Malaria, Yellow fever and Dengue etc. Thawing permafrost in the Arctic and subarctic regions pose major dangers for release of hitherto dormant viruses and bacteria.

Siberian anthrax outbreak of 2016 was linked to the thawing of permafrost and exposure to infected reindeer carcasses that had been frozen for decades. Other pathogens like fungi and parasites may also be released from thawing permafrost. Thawing permafrost may release ancient 'Zombie' viruses, the pathogens that have been dormant for thousands of years and could potentially release these ancient viruses and pose new health risks. which were dormant in frozen soil for thousands of years. Together, vector-borne diseases account for 17% of all infectious diseases and cause more than 700,000 deaths annually worldwide. However, linking spread of all vector-borne diseases to climate change can be challenging, as other factors like land-use change, thawing permafrost and glacier-melting, atmospheric pollution, changing humidity, human interference in hitherto virgin and uninhibited location etc. are also greatly responsible.

Water-borne diseases (WBDs) also transmit disease vectors. Water is the breeding ground of the pathogens and zoonotic-carriers. Various infectious diseases caused by a wide variety of pathogens transmitted through water and exhibiting strong dependence on climate and meteorological conditions like rainfall, flooding, and other extreme events promoting pathogen transmission. WBDs are generally related to food consumption by gastrointestinal infection by pathogens. Resent findings related Primary amebic meningoencephalitis (PAM), a rare and fatal infection of the brain (caused by Naegleria fowleri-brain- eating amoeba) that have been transmitted through warm freshwater during normal drinking or recreational water activities.

Psychosomatic Disorders

The words "Psycho" means "relating to the mind" and "Somatic" means "relating to the body". It is a physical illness or combination of symptom caused or worsened by psychological factors, such as stress, emotions or anxiety and contribute to the development or worsening of physical symptoms or illness. Common examples of climate warming-induced psychosomatic disorders include Irritable Bowel Syndrome (IBS), conditions of High Blood Pressure and related heart diseases, Psoriasis — a chronic and common skin disease etc. Psychosomatic disorders can happen when mental stress and distress cause or make a physical condition or worsen the existing symptoms. Mental health consequences of climate change occur from deterioration of physical health conditions for food and water shortage, societal conflicts, displacement of population for climate-disasters, uncertainty in livelihood conditions for environmental or political situations, difficulty in adaptation etc.

Indirect consequences of psychosomatic disorders include disconnection and alienation of individuals from the community, loss of cultural and social identity — which may indulge in criminal behavior, violence or aggression. Thus, physical health, mental health, human well-being and the warming atmosphere now considered to have intertwined connections.

Environmental factors are increasingly being considered important in psychiatry to understand - how changing climate patterns may translate into congenital defects, impair neurodevelopment in individuals, trigger endogenous mental disorders, arouse psychosomatic and neurological disorders. Impacts like cyclones, floods, droughts, and displacements of denizens accentuate conditions of psychological and psychopathological distress, compared to normal seasonal weather changes. Studies on mental health records conditions of mental stress, anxiety, sleep disturbance, depression, and post-traumatic stress including suicidal thoughts among individual. Peri-traumatic distress is defined as the emotional and physiological distress experienced during and/or after any traumatic event and develop severe Post-Traumatic Stress Disorder (PTSD) and related psychological difficulties. Research has shown that peri-traumatic experience, is highly related to acute stress during and immediately after a disaster. Preventative interventions are recommended in health- research studies to improve the mental health of adolescents and the elderly populations of the family and community.

Solastalgia

Worldwide, there is an increase in ecosystem distress that paves way to human distress syndromes. The concept of solastalgia, a composite of the concepts of solace and desolation, helms with the psychological distress that is induced from environmental stress. It was coined Australian philosopher Glenn Albrecht to express the distressed condition of an individual, some people or the society resulting from environmental changes, while they are directly connected to their home environment. The word 'Solastalgia' has its origins in the concepts of 'solace' and 'desolation'. Solace is derived from the Latin word 'solacium' which means the provision of comfort or consolation in the event of distress. Desolation comes from the word 'desolare', meaning alienation, loneliness etc. The word 'algia' means pain or suffering. In fine, solastalgia is the pain or suffering from the lack of solace and the sense of isolation. The sense of suffering occurs when there is recognition that the location or place that identifies the individual – is under immediate isolation or physical desolation.

It is manifest in the erosion of one's sense of belonging or identity. Solastalgia is not necessarily connected to the past, it may seek its alleviation in a future that has to be designed and created. It manifests the loss of the present as in a feeling of dislocation and conveys a sense opposite to nostalgia. It is different from Nostalgia, which is a state of mind or a mental sickness caused by individual's inability to return home (nostos — return to home or native land, algia — pain or sickness) or getting away from all known societal linkages and locations. Nostalgia is the state of homesickness that is leading to psychiatric disturbances. Solastalgia on the other hand, a relatively new concept for understanding the links between human and ecosystem health, specifically, the impacts of climatic and environmental changes on mental, emotional, and spiritual health. Climate anxiety seemed to have gripped people all over the world. Almost the entire world population is someway victims of extreme climatic events such as heat waves, floods, and cyclones. Biologists, especially entomologists, are witnessing the impacts of rise in temperature on the foraging behavior of insects. It is simply too hot for them to be active, and plants are also producing less nectar under heat stress. Given the speed and scale of global warming and climate change with biodiversity loss, rising pollution load, deforestation, unbridled resource extraction, and other environmental challenges, more and more people experience isolation from the social milieu and environmental improvements. Physical health, mental health, human well-being is all intertwined with environmental changes and the warming atmosphere and a balance and conjugation of these parameters are the desired conditions for any society.

Acculturation stress

Mental health literatures suggest that forced migration of individuals to new locations gives rise to acculturation stress, which is likely to develop the genesis of psychiatric disorders. The stressors associated with immigrants or ethnic minoritywhile going through the processes of adaptation of the host culture or ethnicity may pose psychological stresses to the individuals. Clinically, migrants suffer from psychological disorders like schizophrenia more than the host population. The new location may often pose conflicts in beliefs, values, and social customs where the migrant may feel alienated. In effect, the individuals may get into mental health issues. Acculturative stress can have a negative impact on people's psychological health, especially on the children or the elderly.

Multiple factors may contribute to the acculturative stress viz. family's legal status at the new location, forced or voluntary migration, and perceived discrimination from the ethnic majority. Based on the basic psychological needs theory, the societal context may influence the extent to which the individuals' psychological needs can be satisfied or frustrated. Acculturation stress can thus decrease the level of need satisfaction and increase the level of need frustration, which may damage the mental health of the migrant population. The marginalization of the migrant populations for belonging to different cultural, religious or linguistic groups pose adverse effects on the mental health while integration and acceptance in the social milieu of the migrants in

the new destination had the most positive effects. Different studies have identified key sources that contribute to acculturation stress and worsen mental health for the emigrants:

- Low education, proficiency or skill to take up works successfully,
- Delay in achieving proficiency of the host country's language, and Initial financial hardships.

Climate change is one of the biggest and most devastating challenges facing this world with climate action claiming a place as the SDG13 of the United Nations. The vicious cycle consisting of human decisions influencing weather changes and the consequences of such changes has created a dilemma that is quite perplexing to solve. The rise in global temperatures has led to many drastic impacts worldwide, one of which is on health.

Conclusion

hree major components define climate change – global warming, changes in precipitation patterns and increased occurrence in extreme weather events. Global warming is results from the increasing concentration of greenhouse gases, CO2, CH4, N2O. Of these, CO2 is the main constituent and for calculation purposes, its Global Warming Potential (GWP) is taken as 1 (one). The current average concentrations of atmospheric CO2 levels have crossed 400 parts per million (ppm), as against 280 ppm in 1850. IPCC brought out in the Sixth Assessment Report, (AR6), "Climate Change 2021: The Physical Science Basis", that human influence has unequivocally warmed the atmosphere, ocean, and land. Elevated temperatures and increasing frequencies of heat waves, wildfires, heavy precipitation and other weather extremes affect health-systems in multiple ways, especially for chronic diseases already present. Climate change induced global warming can alter predator and prey balance, drying of soil-moistures, changed harvesting and fallow- seasons, hunger, starvation and deaths. Downstream changes in the atmosphere, ocean, cryosphere, and biosphere may impact the occurrence and mutation of chronic diseases through the pathways of air and drinking water quality, food production processes, and supply-systems, or spread of epidemic of infectious diseases etc. Impaired responses to heat stress, including compromised vasodilation and sweating, diabetes-related comorbidities, insulin resistance and chronic low-grade inflammation make people with diabetes particularly vulnerable to environmental risk factors, such as extreme weather events and air pollution. Additionally, multiple pathogens show an increased rate of transmission under conditions of climate change. People with diabetes and other chronic disabilities have an altered immune system, which increases the mutants to work for more resistant disease–vectors. As numerous environmental factors are playing a concurrent role in the onset and severity of human diseases, understanding the modulatory effect of climate change is now a priority. Emerging health risks related to global warming and changing climate can be minimized and avoided through effective mitigation and adaptation pathways [1-22].

References

1. Intergovernmental Panel on Climate Change. (2023). Climate Change 2023: AR6 Synthesis Report. Retrieved from https://www.ipcc.ch/report/sixth-assessment-report-cycle/
2. Intergovernmental Panel on Climate Change. (2021). Climate Change 2021: The Physical Science Basis. Retrieved from https://www.ipcc.ch/report/ar6/wg1/
3. Feigin, V. L., Nichols, E., Alam, T., Bannick, M. S., Beghi, E., Blake, N., ... & Fischer, F. (2019). Global, regional, and national burden of neurological disorders, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet Neurology, 18(5), 459-480.
4. Thoma, M. V., Rohleder, N., & Rohner, S. L. (2021). Clinical ecopsychology: The mental health impacts and underlying pathways of the climate and environmental crisis. Frontiers in psychiatry, 12, 675936.https://doi.org/10.3389/fpsyt.2021.675936
5. Ossebaard, H. C., & Lachman, P. (2020). Climate change, environmental sustainability and health care quality. International Journal for Quality in Health Care, 32(1), 1–3. https://doi.org/10.1093/intqhc/mzaa036
6. Dattani, S., Rodés-Guirao, L. (2021). Mental health. Our World in Data. Retrieved from https://ourworldindata.org/mental-health
7. BMC Medicine. (2023). Diabetes and climate change: Breaking the vicious cycle. BMC Medicine, 21, 281. https://doi.org/10.1186/s12916-023-02980-x
8. Vallianou, N. G., Geladari, E. V., Kounatidis, D., Geladari, C. V., Stratigou, T., Dourakis, S. P., ... & Dalamaga, M. (2021). Diabetes mellitus in the era of climate change. Diabetes & Metabolism, 47(4), 101205.
9. Research Open World. (n.d.). Effect of climate change on endocrine disorders. Retrieved from https://researchopenworld.com/effect-of-climate-change-on-endocrine-disorders/
10. Institute for Health Metrics and Evaluation. (2024). Global Burden of Disease 2021: Findings from the GBD 2021 Study. Retrieved from https://www.healthdata.org/research-analysis/library/global-burden-disease-2021-findings-gbd-2021-study
11. Sutherst, R. W. (2004). Global change and human vulnerability to vector-borne diseases. Clinical Microbiology Reviews, 17(1), 136–173. https://doi.org/10.1128/CMR.17.1.136-173.2004
12. Doshi, S., Vuppula, S. (2024). Healthcare sustainability to address climate change: Call for action to the infectious diseases community. Journal of the Pediatric Infectious Diseases Society, 13(6), 306–312. https://doi.org/10.1093/jpids/piaa123
13. National Cancer Control Initiative. (n.d.). Cancer incidence. Retrieved from https://ncci.canceraustralia.gov.au/diagnosis/cancer-incidence/cancer-incidence
14. Kanza, T., Sissodiya, S., (n.d.). Impact of global warming on brain temperature. National Hospital for Neurology and Neurosurgery, Queen Square, London, U.K.
15. Kannuri, N. K., & Jadhav, S. (2021). Cultivating distress: Cotton, caste and farmer suicides in India. Anthropology & Medicine, 28(4), 558–575. https://doi.org/10.1080/13648470.2021.1993630
16. Daghagh Yazd, S., Wheeler, S. A., & Zuo, A. (2019). Key risk factors affecting farmers' mental health: A systematic review. International Journal of Environmental Research and Public Health, 16(23), 4849. https://doi.org/10.3390/ijerph16234849
17. Padhy, S. K., Sarkar, S., Panigrahi, M., & Paul, S. (2015). Mental health effects of climate change. Indian Journal of Occupational and Environmental Medicine, 19(1), 3–7. https://doi.org/10.4103/0019-5278.156997

18. Albrecht, G., & Albrecht, G. M. (2007). Solastalgia: The distress caused by environmental change. Australasian Psychiatry, 15(S1), S95–S98. https://doi.org/10.1080/10398560701701288
19. Borges, R. M. (2024). Solastalgia, our deteriorating environment, and spirit of place. Journal of Biosciences, 49(16). https://doi.org/10.1007/s12038-023-00405-8
20. Raffetti, E., Ahrne, M., Döring, S., Hagström, A., Mazzoleni, M., Messori, G., ... & Zarantonelllo, L. (2024). Sustainable transformations for healthcare systems in a changing climate. Cell Reports Sustainability, 1(3).https://doi.org/10.1016/j.crsus.2024.100054
21. Climate Investment Funds. (2024). The cost of inaction: Quantifying the impact of climate change on health in low- and middle-income countries. The World Bank. Retrieved from https://www.worldbank.org
22. World Health Organization. (2024). World health statistics 2024: Monitoring health for the SDGs, sustainable development goals. ISBN 978-92-4-009470-3. Retrieved from https://www.who.int/publications/i/item/9789240094703