Are we ready to tackle the threats posed by climate change?

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Climate change and human health

Climate change is happening, and as professionals, we must not underestimate or ignore it[1]. Global environmental change poses a serious risk to humanity[2]. The rise in greenhouse gas emissions has elevated global temperatures, instigated extreme weather events, and led to rising sea levels that can jeopardize food security and nutrition, promote the spread of infectious diseases, and displace communities, significantly impacting human health[3,4]. Global warming is leading to climate change, with potentially adverse effects on human health. In addition to global warming, certain air pollutants, including PM2.5, NO_2, SO_2, CO, and tropospheric O_3, can result in various health issues for both humans and animals. The effects of climate change on human health can be categorized into four key areas: the impact of global warming on humans, deforestation and land degradation, changes in marine ecosystems, and disruptions to water supply systems[5].

A recent study has identified various climate-related factors, including extreme weather events (affecting temperatures and precipitation), air quality issues, allergens, food and water scarcity, and shifts in the spread of pathogens and vectors[6]. These factors can be related to health outcomes sensitive to climate, including diseases caused by vectors, cardiovascular diseases[7], gastrointestinal disorders[8], neurodegenerative disorders[9,10], allergic reactions[11], and kidney-related disorders[12].

The relationship between climate change and a wide range of diseases

Numerous studies have indicated an increase in gastrointestinal infections, hepatitis, and cancer among at-risk individuals (such as those with chronic conditions) who endure heat waves, air pollution, drought, and flooding[12]. Additionally, air pollution may be linked to conditions such as eosinophilic esophagitis, peptic ulcer disease, appendicitis, hospitalizations for abdominal pain, irritable bowel syndrome (IBS), and inflammatory bowel disease (IBD)[12].

Global warming can alter the distribution of vectors, including insects and certain birds, that transmit infectious diseases. In addition, other contagious diseases, including tick-borne diseases (Lyme disease), malaria, dengue fever, chikungunya, zika virus, Rocky Mountain spotted fever, leishmaniasis, food-borne diseases such as salmonella and campylobacter, and water-borne diseases like cholera and schistosomiasis, may emerge[13]. Therefore, global warming plays a role through direct and indirect mechanisms. It directly alters the distribution of pathogens and their vectors. Indirectly, it contributes to famine and human and animal migration[14].

Rising temperatures are directly associated with an increased risk of wildfires, which in turn leads to the excessive release of air pollutants. Both short-term and long-term exposure to PM2.5 and other pollutants, such as CO, NO_2, SO_2, and PM10, elevate the risk of cardiovascular events, including increases in both systolic and diastolic blood pressure, occurrences of fatal and non-fatal acute myocardial infarction (AMI), heart failure (HF), cardiac arrhythmias, coronary heart disease (CHD), and stroke[15].

Droughts caused by global warming increase the incidence

of wildfires. Asthmatic individuals exposed to wildfires may experience more frequent asthma attacks. Conversely, rainfall and flooding can lead to water intrusion in homes, promoting mold growth. Exposure to these molds can exacerbate asthma attacks, allergic rhinitis, and conjunctivitis. Elevated temperatures may also alter the onset, duration, and intensity of pollen release[16].

Global warming contributes to the development of heat stress nephropathy, a condition caused by dehydration, which increases the body's susceptibility to chronic kidney disease (CKD), distinct from that caused by diabetes or hypertension[17]. It causes a drop in systolic and diastolic blood pressure, concentrated urine, and elevated potassium levels in urine[18,19]. Rhabdomyolysis, which is believed to result from heat and muscle trauma due to the high temperatures on the Pacific coast, can lead to acute kidney injury (AKI). Over time, prolonged AKI may result in CKD[20,21].

Some studies suggest a correlation between climate change and the incidence of neurodegenerative diseases. Some studies demonstrated a 4% increase in ischemic stroke cases as a result of a 1°C increase in temperature[22]. Heat-related strokes are predicted to increase by 300% and 500% by 2050 and 2070, respectively[23]. Delirium, disorientation, seizures, and lethargy are the most important consequences of this type of stroke. Alzheimer's disease and Parkinson's disease, and multiple sclerosis, have gained attention as consequences of hot climates[10,24,25]. Matrix metalloproteinase degrades membranes and is up-regulated by high temperatures[26]. Hyperthermia counteracts the protective effects of tissue plasminogen activator, increasing blood-brain barrier permeability and potentially leading to edema[27]. The generation of reactive oxygen species (ROS) plays a crucial role in the development of hyperthermia, underscoring the importance of understanding this connection to address the effects of elevated temperatures on the body effectively[28].

Climate change effects on consumption patterns and drug usage

Research suggests that climate change may increase the demand for certain medications. For example, the use of metoprolol for heart conditions, albuterol for asthma, heparin for severe kidney disease, and donepezil for Alzheimer's disease, has risen in climate-impacted scenarios compared to standard usage levels[29].

Climate change effects on DNA

Environmental temperature variations can affect DNA methylation in specific genes, including ICAM-1, CRAT, F3, TLR-2, iNOS, ZKSCAN4, ZNF227, ZNF595, ZNF597, ZNF668, CACNA1H, AIRE, MYEOV2, NKX1-2, and CCDC15. These alterations in DNA are connected to several health issues. Specifically, changes in the methylation of ZKSCAN4 and ICAM-1 are associated with an increased risk of hypertension and cardiovascular diseases[30].

Climate change effects on product stability and safety

High temperatures pose a threat to product stability and safety. Research indicates that exposure to heat and UV light can cause toxic substances, such as phthalates and bisphenol A, to leach from plastic packaging, thereby increasing the risk of contamination within supply chains[31]. Certain pollutants may interact with volatile organic compounds (VOCs) in the products, potentially leading to the formation of harmful secondary pollutants upon skin application. Regarding stability, a study in Bangladesh found that formulations of ampicillin, sulfamethoxazole, and trimethoprim stored at 25°C, as well as acetaminophen and vitamin B stored at 30°C, showed poorer stability compared to 137 different brands of these medications[32].

Conclusion

Shifts in climate due to global warming and associated air pollution, play a significant role in the onset of mental health issues, infectious diseases, digestive disorders, cardiovascular conditions, and immunological challenges. Additionally, these environmental changes can influence the effectiveness of medications and cosmetic products. Climate change may alter the usage patterns of specific pharmaceuticals, potentially jeopardizing their stability. Certain drugs can have intensified harmful effects due to climate change, particularly heat-related reactions and increased antimicrobial resistance. The pharmaceutical industry is a significant source of greenhouse gas emissions and contributes to environmental and animal toxicity.

Manufacturing processes for drugs such as antibiotics, anesthetics, and morphine significantly contribute to these problems. Furthermore, these processes can harm wildlife and disrupt food chains. Therefore, it is essential to implement strategies that effectively address the consequences of ecological shifts. Such strategies should prioritize enhancing the resilience and equity of the healthcare system while also working to reduce greenhouse gas emissions and limit air pollution. By taking these actions, we can more effectively mitigate climate change and its impacts on humans, animals, and the environment.

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The views and opinions expressed in this article are those of the authors.