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Opinion

Impact of Climate Change on Hepatic Health from Pathogenic Perspectives: The Iceberg That Sank Titanic Ship!

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Climate change (CC) represents a public health issue that affects the global burden of various diseases, with the possibility of premature deaths. Several studies have observed that CC influences the appearance and geographic distribution of different global health issues, through significant environmental and weather change patterns related to water, air and food products, as well as ecosystems, agriculture, industries, settlements, economies, temperature changes, and precipitation.[1,2] A recently published data revealed that CC has hazardous impacts on different aspects of hepatic health. First, CC may result in the rise of communicable/non-communicable liver diseases, due to deforestation/encroachment into animal habitats. Thus, several species were forced to migrate to areas in close contact with humans, increasing the risk and remap of the distribution of communicable liver diseases. On the other hand, CC interacts with several factors that affect the development, concentration, and dispersion of air pollutants, which result in various non-communicable liver diseases. That is, atmospheric stability restricts the dispersion of pollutants in CC, leading to body penetration by these pollutants, either through skin contact or inhalation, causing damage and mutations/cancer in the internal organs, and usually affecting hepatic and pulmonary systems.[3–5] In addition, it is known that frequent exposure to desert sand dust particulate matter may induce hepatotoxicity/hepatocarcinogenesis. Therefore, desertification and climate change may be considered as attributing factors for such risk.[6] Furthermore, environmental hazards, such as global warming and altered precipitation patterns, may contribute to the frequent rise of hepatotoxic cyanobacterial blooms, and may provide a favourable environment for maintaining the growth of aflatoxigenic-producing fungi with hepatocarcinogenic mycotoxin production.[7,8]

To date, the exact relationship between climate crisis, ecological disruption, and non-alcoholic fatty liver disease (NAFLD) has not been well-addressed. It has been observed that the global NAFLD-related health issue goes in parallel with the deterioration of the climate, which is not coincidental, pushing researchers to search for the exact pathogenesis of such complex interactions. Furthermore, obesity has been linked to NAFLD, poverty, food insecurity, and malnutrition, due to foundering agriculture and infrastructure (global warming). This has led to food insecurity, including refined processed foodstuffs, which resulted in poor energy intake, obese appearance, and related metabolic products. Moreover, hot tropical regions have been associated with sedentary lifestyles, with the lack of outdoor activities, including exercise, and the frequent use of motorized transportation, due to the associated uncomfortable risky high temperatures (hyperthermia), contributing to raising greenhouse gas emissions. All these may subsequently contribute to the increase in unhealthy food intake, obesity, and NAFLD. Lastly, climate change related to air pollution may promote NAFLD in selected cases, who have central obesity with the malpractice of eating junk food rich in fat. This may be attributed to the hypothesis of oxidative stress release with further inflammatory response stimulation, and the disruption of hepatic lipid metabolism, thereby fostering NAFLD. To date, the exact pathophysiology of NAFLD-related climate change remains unclear, and is subject for further evaluation and investigations.[9–12]

For environmental biohazards, biological hepatotoxins, Aflatoxins, are mycotoxins produced by Aspergillus flavus and parasitic foodborne fungi. These have been shown to thrive in hot and damp climates. Aflatoxin B1 is the potent mycotoxin of Aspergillus spp., which was proven to be hepatocarcinogenic. The subsequent increase in ambient temperature and humidity may contribute to the development of liver cancer, through promoting such mycotoxin production.[8,13] Second, it was observed that rising ambient temperatures may contribute to the geographical redistribution of various parasitic liver infections, including bilharziasis and Fasciola hepatica (liver flukes). For example, unexpected schistosomiasis outbreaks were observed in swimmers in the Cavu River in southern Corsica. Furthermore, there have been unprecedented levels of future fasciolosis risk in parts of the UK, with possible related serious epidemics in Wales by 2050.[14,15] Third, due to global warming, there is an increased risk of drinking contaminated water with Cyanobacteria (blue-green algae), including microcystin ingestion. Microcystin represents cyanobacterial hepatotoxic metabolites that promote liver inflammation, particularly progressing NAFLD to non-alcoholic steatohepatitis. Recent related studies have reported an increase in microcystin ingestion, and that climate change may have contributed to the increase in liver disease-related mortality in the United States.[7,16,17] On the other hand, coastal water warming along the Carolinas and east United States may aggravate Vibrio vulnificus infections, which is a

Abbreviations: CC, climate change; NAFLD, non-alcoholic fatty liver disease.

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Table 1. Impact of climate change on liver health

Climate change	Impact
Hot and damp climates	i) Promotes Aflatoxins AFB1 production, potent mycotoxins produced by Aspergillus flavus and proven to be hepatocarcinogenic; ii) May aid in the geographical redistribution of various parasitic liver infections, including bilharziasis and Fasciola hepatica (liver flukes); iii) Hyperthermia caused by heat-related disorders, is directly cytotoxic to hepatocytes and associated with peripheral vasodilatation that alters hepatic blood flow and related metabolic changes.
Global warming	i) Increases the risk of drinking contaminated water with Cyanobacteria including microcystin (cyanobacterial hepatotoxic metabolites); ii) May aggravate Vibrio vulnificus infection, a gram-negative bacteria related to coastal waters that complicate fatal sepsis in chronic liver disease patients.
Disasters related to global climate change (i.e flooding, coastal erosion, air pollution, and agricultural disruption)	i) It's associated with increased immigrants to promote epidemics of waterborne infections (viral hepatitis A and E) because of poor hygiene and sanitation; ii) Raises a critical issue of unknown liver diseases among the refugees as reported by EASL– Lancet Commission; iii) Rise of communicable/non-communicable liver diseases owing the deforestation/encroachment into animal habitats; iv) Air pollutants concentration and dispersion may lead to non-communicable liver diseases.

gram-negative bacteria correlated to coastal waters that complicate fatal sepsis in chronic liver disease patients.[18] Lastly, disasters related to global climate change, including flooding, coastal erosion, and agricultural disruption due to the increase in immigrants, have been shown to promote epidemics of waterborne infections (viral hepatitis A and E). Poor hygiene and sanitation were observed in South Sudan, raising a critical issue of unknown liver diseases in refugees, as reported by the EASL-Lancet Commission.[19] In addition, heat-related disorders, such as heat stroke caused by hyperthermia, have been proven to cause injury to different systems, including the hepatic system. Hyperthermia is directly cytotoxic to hepatocytes, and associated with peripheral vasodilatation, which alters hepatic blood flow and related metabolic changes.[20,21] To date, studies are presently being conducted to correlate and investigate the impact of different environmental risk factors on liver health, in order to identify better outcomes (Table 1).

Therefore, there is a strict need for rapid footsteps for awareness in different community sectors (the public, patients, healthcare authorities and hepatologists), in order to obtain the proper understanding of the causal relationship between global climate change and liver health. These entails encouraging further studies, conferences, meeting discussions and workshops, which involve individual and institutional finances, tailoring clear universal guidelines of liver care, as well as other related health issues. Examples of these are the positive impact of lifestyle modifications on fatty liver disease, which has been recommended in different international guidelines/societies, and encouraging physical activity, including walking and cycling, instead of motorized transport.[19,22] On the other hand, there is an urgent need to raise the awareness of different continents on climate change through launching global meetings, particularly in Africa, since this represents as the most vulnerable continent effected by climate change. That is, over 100 million Africans will indeed be threatened due to global warming up to 2030, as reported by the Intergovernmental Panel on Climate Change.[2] Recently, the 27th United Nations Climate Change Conference, which was held in Egypt, and attended by over 92 heads of state and approximately 35,000 representatives/delegates from 190 countries, agreed on policies that limit global temperature rises and adapt to impacts associated to climate change.[23] Furthermore, the Billion-dollar National Climate Change Strategy 2050 was launched in Egypt to promote a healthier, greener, and stronger Egyptian economy, including adaptation/mitigation programs for all sectors until 2050.[24] In conclusion, the definite impact of climate change on liver health remains unclear, requiring further evaluation and investigations. Thus, there is an urgent need for properly sustained eco-health services provided by hepatologists. This can be generalized as a global message for all hepatologists to work as a team in protecting patients and the planet, under the motto of "Eco liver".

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Conflict of interest

The author declares that no competing interest.

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