



Impacts of Climate Change on the Incidence of Cholera

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Significant effects on public health result from the ongoing phenomenon of climate change, which is characterized by previously unheard-of changes in global climatic patterns and the reappearance of infectious illnesses. The deadly diarrheal illness known as cholera, which is caused by the bacteria *Vibrio cholera*, has become more commonplace in recent times as cases and outbreaks have increased significantly worldwide. This review delves into the complex interactions between climate change and cholera incidence, providing insight into the biological, environmental and socioeconomic elements that shape the disease's dynamics. There are several ways that cholera can spread, including through tainted food, water and environmental sources. Food hygiene, insufficient water quality and poor sanitation all increase the risk of cholera transmission. Reviewing the relationship between cholera incidence and climate change, the review explores the direct and indirect effects of climate change on human health while analyzing the relationship between cholera incidence and climate change. Temperature variations, precipitation patterns and extreme weather events all have a major impact on the dynamics of the cholera epidemic. The review also investigates how wind waves and rainfall affect the prevalence of cholera. Severe weather events and dynamic rainfall patterns have the potential to overwhelm sanitation infrastructure, contaminating water supplies causing cholera outbreaks. Wind waves do not directly cause cholera, but they do play a role in its spread by contaminating water supplies.

Keywords: Cholera Disease, Climate Change, Incidence, *Vibrio Cholera*

Introduction

Climate change may be a speculation or long-term changes within the state of the climate are known through the changes that happen within the climate and proceed [1]. Since the move period started, the climate on Soil has changed significantly, with the last ten years of the 21st century being the hottest years [2]. The ancient *V. cholera* bacteria is the cause of the acute watery diarrhea sickness known as cholera [3]. The gram-negative, comma-shaped *Vibrio cholera* bacteria are classified into 200 serogroups using serological analysis. Among these, the strains *V. cholera* O1 and O139 are the ones that have recently caused cholera epidemics. The strain of *V. cholera* O1 has been divided into two bio types, classical and El Tor, based on its biochemical structure. It has lately switched to the El Tor bio type. Every biotype is further subdivided into three serotypes: Ogawa, Inaba and the uncommon Hikojima type [4]. A common symptom of cholera is the abrupt onset of watery diarrhea, which can rapidly cause dehydration and even death. Its impact on public health is equally significant as it frequently causes repeated outbreaks in susceptible populations and, in severe situations, a sharp increase



in epidemics that may quickly span international boundaries and submerge entire regions [5]. Globally, the number of cholera cases and their geographic distribution have increased since 2021. Cholera outbreaks were recorded in 23 countries in 2021, particularly in the WHO Regions of Eastern Mediterranean and Africa. As of 2022, more than 29 nations had reported cholera cases or outbreaks, following the current trend. Comparing those nations to prior years, several of them reported increased rates of cases and case fatality ratios (CFRs). In 2021, the average worldwide cholera CFR reported was 1.9% (2.9% in Africa), far higher above the permissible level of less than 1% and the highest in more than ten years [6].

Cholera Disease

V. cholera is the extremely transmissible disease that causes cholera. There are four possible infection levels: mild, moderate, severe and asymptomatic. In early stages, cholera patients may not have any fecal matter or substance in their diarrhea, which is typically painless. The term "rice water stool" refers specifically to cholera victims. They smell like fish and are starchy in color, more similar to water used to wash rice or contain uncooked rice [4]. Gram-negative *Vibrio cholera* is the causative agent of cholera. It lives in brackish water naturally. The illness is a highly communicable, acute bacterial infection that arises from the colonization and growth of V. cholera bacteria within the intestine. When high-risk individuals consume infectious amounts of germs from tainted food, vegetables and water, they become ill [7].

Transmission of Cholera

Drinking water infected with sewage is the primary way that susceptible individuals spread the highly deadly disease cholera. Food items are believed to be a significant means of cholera transmission, in addition to water. During food preparation, trash can contaminate food, especially if contaminated food handlers work in unhygienic conditions. Foods' physical and chemical properties that aid in V. cholera's survival and growth. High moisture, neutral or alkali pH, a low ambient temperature, high organic matter content and the absence of other competing bacteria are characteristics of O1 and O139. In several nations, seafood including fish, shrimp, crabs, oysters and clams has been linked to cholera outbreaks. Certain instances have also been linked to contaminated rice, sorghum and vegetables. Other items that can spread cholera include chicken, pork, dairy products and fruits but not sweet fruits [8]. The largest ecological reservoir of V. cholera is zooplankton, which is among the numerous hypothesized hosts, carriers and reservoirs of infection. Humans can become infected by eating fish and seafood or water infected with an infectious amount of free-floating V. cholera or zooplankton harboring V. cholera, or by oral-fecal transmission between human hosts. Environmental factors in water bodies that support bacterial development have an impact on these transmission channels [9].

Risk Factors

Poverty is linked to risk factors for cholera, such as poor food hygiene (e.g., street food), infected drinking water and inadequate sanitation. One important way to lower the risk is to wash your hands with detergent prior to and following eating as well as after urinating. Female sex, blood group O, retinol insufficiency and hypochlorhydria (in patients on histamine receptor blockers, anti-acids and proton pump inhibitors) are among the biological characteristics that have been identified as cholera risk factors. Furthermore, gastrectomy and *Helicobacter pylori* infection are two important factors that contribute to the development of severe disease.



Malnutrition makes people more susceptible to the illness, particularly small children [4]. Untreated water supplies, surface water exposure, unsafe water transport and storage, untreated drinking water, outdoor feces, unsanitary hygiene and joint sanitation were reported by significantly more cases than controls in a recent review and meta-analysis of the role of water sanitation exposure in 51-item cholera control studies [5].

Incidence

In the past, cholera was historically widespread throughout the Asian subcontinent, including Indonesia, India, Bangladesh, Vietnam, Thailand, Pakistan, Nepal and Iraq, according to the World Health Organization [10]. Afghanistan (IRIN) September 14, 2009 - In the last two months, there have been reports of 28 cholera and/or acute watery diarrhea (AWD) related deaths in Afghanistan. This organization reports that in 11 of the 34 provinces in the nation, there have been at least 673 instances of AWD and/or cholera documented [11]. Nine countries Afghanistan, Iraq, Islamic Republic of Iran, Lebanon, Pakistan, Somalia, Sudan, Syria and Yemen have reported possible cholera cases in the WHO's Eastern Mediterranean region in 2022 and 2023. Eight of these nine nations kept reporting possible instances of cholera and AWD in 2023. A total of 32,590 new AWD/suspected cholera cases, including 18 associated deaths, were reported from 6 Member States during the reporting period (weeks epi 33–34, 2023): Afghanistan (15,663 cases; 11 deaths), Iraq (92 cases; 1 death), Pakistan (7 confirmed cases; 0 deaths), Somalia (539 cases, 0 deaths), Sudan (113 cases, 5 deaths) and Syria (16,176 cases, 1 death) [6]. Many nations fail to record cholera cases or deaths because of inadequate or nonexistent surveillance systems. In order to limit economic losses from tourists and exports, as well as to prevent widespread panic in the community, certain governments exercise caution when declaring cholera outbreaks [4].

Climate Change

Human communities and individuals are exposed to dangers related to climate change that have an impact on human health both directly and indirectly. The risks are higher and more unequally distributed for underprivileged people and communities. Changes in temperature, patterns of precipitation and the rate and intensity of extreme weather events (heat waves, hurricanes and floods) have direct effects on heat-related illnesses, deaths and injuries. The impacts of climate change on water resources, food production systems, population movements and the establishment and frequency of infectious illnesses are examples of indirect pathways. The epidemiological dynamics of several infectious agents, such as water-borne, food-borne and vector-borne infections, can be impacted by climate change [12]

Effect of Climate Change on the Incidence of Cholera

Laboratory-created micro-ecosystems that are defined chemically to examine how certain environmental factors affected *Vibrio cholera* growth and activity, sea salt solution was employed. A total of ten *V. cholera* strains, comprising clinical and environmental isolates, 01 and non-O1 serovars and growth responses under simulated estuarine conditions were compared. There were populations that ended up almost the same size. The extended life period of *V. cholera* was shown to be influenced by temperature and salinity. It was found that the bacteria could only live (i.e., be cultivable) for less than 4 days at a temperature of 10°C and an estuary salinity of 25°C [13]. The lowest average monthly incidence of cholera occurs at temperatures below 23.25 degrees Celsius (23 cases/month). Cholera occurred 39 times per month in areas with temperatures below



23.25°C and less than 4.13 hours of sunshine each day. Higher temperatures (23.25–28.66 °C) and sunshine (≥ 4.13 hours per day) were associated with the second-highest cholera incidence (44 cases per month). The highest incidence of cholera (54 cases per month) was noted when temperatures were above 28.66°C and sunlight was present for at least 4.13 hours per day [14].

Effect of Rainfall on the Incidence of Cholera

Rainfall patterns are changing in relation to climate change. In certain places, septic tanks and sewage treatment plants can become overloaded by heavy and frequent rainfall, which can contaminate wells and surface waters. Conversely, less rain in some regions could result in drought and a shortage of water, which could raise the microbial load in rare water sources, force people to utilize infected rainwater, or create competition for limited supplies of water. A country's ability to provide clean and safe water, sanitation and drainage systems may be compromised by changing rainfall patterns, rising temperatures and severe weather that is frequent and severe. These factors can contribute to natural disasters in nations with weak infrastructure and have a significant impact on the spread of water-borne illnesses like cholera [15].

Effect of Wind Waves on the Incidence of Cholera

The primary cause of cholera cases is the watery spread of the *Vibrio cholera* bacteria. Although wind waves may not directly cause cholera, they can contribute to the disease's transmission through a number of indirect methods. Storms and floods are examples of wind-related occurrences that can contaminate water supplies with sewage and other pollutants. In addition to disrupting the sanitation infrastructure, these occurrences raise the possibility of the spread of cholera. The cholera caused by *Vibrio* has crossed continents with the aid of winds. The present investigation backs up the theory that cholera germs are transferred from a water source to another by aero plankton, which are tiny living organisms that float in the air, can be swept up by the wind and land far from their source. Health officials may benefit from knowing that *Vibrio cholera* can spread by air since it can more accurately estimate the disease's geographic spread [16].

Conclusion

This review delves into the intricate relationship between climate change and the resurgence of cholera, emphasizing the multifaceted factors contributing to the disease's prevalence. The evidence highlights the urgency of addressing environmental, biological and socio-economic determinants to effectively mitigate the global burden of cholera. Human activities, particularly poor sanitation and contaminated water sources, are identified as crucial contributors, exacerbated by socio-economic factors like poverty and inadequate healthcare infrastructure.

The review emphasizes challenges in reporting accuracy and advocates for transparent, collaborative efforts among nations. The key conclusion is clear: tackling cholera resurgence requires a multidisciplinary and coordinated approach, involving robust public health interventions, improved sanitation and enhanced surveillance systems. Collaboration on an international scale is imperative, emphasizing timely reporting and acknowledging cholera's transboundary nature. Ultimately, the findings underscore the interconnectedness of



climate change, environmental factors and cholera resurgence, necessitating a collective commitment to sustainable practices and resilient public health systems to curb the rising tide of cholera globally.

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