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THE EPIDEMIOLOGY OF EMERGING AND RE-EMERGING INFECTIOUS DISEASES

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Abstract

Globally, vector-borne illnesses that are emerging or reemerging provide a serious threat to public health. In the last 20 years, several of these illnesses have spread to new areas and are resurfacing or forming at an accelerating rate. Research has shown that the emergence or reemergence of these diseases is largely determined by the interactions that occur between pathogens, hosts, and the environment. Furthermore, the introduction and/or reemergence of vector-borne diseases has been strongly connected to socioeconomic and demographic factors as travel, trade, urbanization, globalization, human population growth, and intimate relationships with livestock. Other studies highlight the main aggravating factors for the establishment and reemergence of vector-borne infectious diseases as the continuous evolution of infections, the growth of reservoir populations, and the usage of antibiotic drugs. Certain research, however, categorically assert that vector-borne infectious disease emergence and comeback are related to climate change. Our ability to prevent the numerous newly developing and resurgent vector-borne infectious diseases that may occur in the future appears doubtful, even if many significant emerging and re-emerging vector-borne infectious diseases are becoming better controlled. In order to investigate global trends of developing and re-emerging vector-borne illnesses as well as the difficulties in controlling them, this work evaluates and synthesizes the body of existing information. Additionally, it makes an effort to shed light on the epidemiological characteristics of the main vector-borne illnesses, such as dengue, Chikungunya, West Nile fever, Chikaungunya fever, Rift Valley fever, Zika fever, and Crimean-Congo hemorrhagic fever.

Keywords: Vector-borne disease, emerging, re-emerging disease, global trends, review.

1. Introduction

Global public health challenges include vector-borne diseases that are developing or reemerging (1). These illnesses spread through interactions between vectors, animal hosts, climatic factors, infections, and vulnerable populations of people rather than through direct human contact (2). Vector-borne illnesses are becoming more prevalent and account for a disproportionate amount of newly discovered infectious diseases, the great majority of which are virus-based. In the last 20 years, a number of vector-borne pathogens have spread to new areas, and the incidence of an equal number of endemic diseases has increased. Even though endemic pathogen invasions and appearances are typically considered to be distinct occurrences, a number of endemic pathogens are really spreading at a restricted rate in tandem with changes in their habitat. Prior research has indicated that human infectious illnesses carried by vectors, such as dengue and yellow fever, have a broader distribution range (3).

Although it is still up for debate, the rise in vector-borne illnesses seems to be related to climatic conditions and climate change. There is no denying that climate affects many facets of nature, including global warming (4). The twenty-first century is a critical time for the effects of climate change. According to some earlier research, by 2,100, average world temperatures will have increased by 1.0–3.5°C (5), increasing the likelihood of a number of vector-borne illnesses. Variations in the weather and climate have an immediate effect on the diseases' vectors and patterns of transmission.

Although building dams and irrigation projects can increase the need for food and energy in developing nations, they have raised concerns about the continuous spread, amplification, or introduction of novel vector-borne infectious illnesses (6, 7). For example, changes in the environment brought about by an increase in population and water resources can aid in the spread of schistosomiasis to locations where it is not endemic (8, 9). Since infectious illnesses are a constant threat to the world, it is imperative to understand how once-dominant vector-borne diseases are resurfacing and minimizing the harm they inflict. These infections either go unnoticed or get overlooked. Thus, to promote appropriate public health responses, ongoing knowledge of infectious diseases and advancements in control efforts are required (10). The purpose of this study is to evaluate the main vector-borne infectious diseases that are emerging or have reemerged, along with the difficulties in controlling them.

2. Factors that Influence the Development and Recurrence of Vector-Borne Illnesses

Over time, infectious diseases can emerge and re-emerge. Pathogens go through several stages of adaptation before posing a threat to an epidemic (11). The emergence or reemergence of infectious illnesses is significantly influenced by the interactions between hosts, pathogens, and the environment. Furthermore, a variety of variables, including ecological, environmental, and demographic ones, could influence this adaptation and the subsequent onset of disease. These elements have an impact by fostering favorable circumstances that increase contact with an unfamiliar pathogen or its natural host or aid in its dissemination. When combined with the problem of medication resistance and the ongoing evolution of microbial and viral variations, these elements allow for the frequent emergence and possibly even rise in infection. Numerous factors, including both non-climate and climate-related ones, can contribute to the establishment and spread of newly emerging or resurgent diseases (2).

3. Climate Variability and Climate Elements

Long-term changes in weather patterns and the frequency of extreme weather occurrences are referred to as climate change. It is one of the numerous interrelated risk factors for infectious diseases spread by vectors. A significant issue is the effect of climate change on the frequency, season of transmission, duration, and dissemination of vector-borne illnesses (12). Pathogens can be directly impacted by climate change through changes to their survival, reproduction, and life cycle; or they can be indirectly impacted by changes to their habitat, environment, or competitors, as well as changes to the patterns of human-pathogen and human-vector contact.

In order to determine whether or not insect-borne diseases can persist, temperature directly affects how long pathogens spend in their extrinsic incubation phase in insect vectors. It appears that a disease needs a normal temperature range to thrive and survive. In a similar vein, temperature influences have a significant impact on vector development and survival (13). For example, in the ecology of the Japanese encephalitis virus (JEV), the two thresholds—the minimum temperature of 25–26°C for JEV transmission and the maximum temperature of 22–23°C for mosquito development—play crucial roles (14, 15). High temperatures also hasten the development and reproduction of diseases that are spread by vectors, during the extrinsic incubation period, or in the environment (16). Therefore, increasing human encroachment on natural areas coupled with the direct effects of climate change on habitat and ecosystem change are negatively restricting biodiversity, which in turn is affecting the establishment and spread of infectious illnesses (17).

Research revealed that although vector-borne disease risks are inherently sensitive to variations in weather and climate (18, 19), the debates surrounding the effects of climate change on these diseases center on how much weather and climate influence the occurrence and severity of these diseases relative to human efforts to manage pathogens and their vectors (20). However, a number of vector-borne illnesses that are significant for public health are zoonotic, meaning that wildlife maintains them and that human efforts to control them will naturally have less of an impact on their occurrence (21). Certain vector-borne zoonotic illnesses have specific links to meteorological and climatic conditions, even though they are not the most frequently mentioned causes of onset. Others claimed that changes in land use were the primary cause of their formation, explaining 26% of all vector-borne zoonotic diseases. These were followed by unknown or unidentified causes and international trade and commerce, which accounted for 11% and 14 percent of cases, respectively. However, it was noted that 10% of the causes of those illnesses were related to the climate and weather (22).

4. External Climate Factors

Vector-borne illness emergence and/or reemergence have been found to be significantly influenced by factors other than climate. Global population growth and urbanization, international trade and travel, intensive livestock husbandry systems, the expansion and modernization of agricultural techniques, the growth of reservoir populations, and the use of antibiotic drugs are a few of the main non-climatic drivers (23–25). Infectious diseases and historical and contemporary socio-political and economic change have a well-established relationship, and complex social and environmental risk factors have been linked to the emergence of new infectious diseases, including vector-borne infections (26). These diseases' emergence and resurgence could be signs of a number of ongoing changes in the human ecology, such as the migration of people from rural to urban areas, which is causing crowded urban peripheries, extensive deforestation, and the disruption of social capitals by war and violence.

A pathogen's genome can alter or mutate as a result of chemical and antimicrobial agent exposure. This can result in gene damage (27) and the creation of drug-resistant pathogen variants that may cause new diseases, in addition to host and environmental variables. Infectious agents can develop and adapt to new hosts for ease of transmission in new ecological niches through specific processes such gene mutation, genetic recombination, or reassortment, as well as factors that encourage microbial pathogens to change reservoir hosts (28).

5. Zoonosis and Infectious Diseases Carried by Vectors

A number of interrelated factors influence the difficult issue of zoonotic disease emergence and zoonosis. In contrast to zoonotic diseases that are spread directly, vector-borne diseases are emerging more frequently. Numerous newly discovered infectious diseases are vector-borne and affect people older than 15 years old, according to earlier research (29). Vector-borne zoonotic illnesses account for 22% of all newly emerging human diseases, despite the fact that 14% of human infectious diseases are vector-borne. This suggests that vector-borne diseases are disproportionately represented in this population. In a similar vein, 60–80% of newly discovered illnesses are thought to have zoonotic origins, meaning that animals first provided a reservoir for the infection's survival (29). According to Jones et al. (29), wildlife that has spread across species is the source of at least 70% of these newly discovered zoonotic diseases.

Even after successful intervention for rising infectious disease, the rate of zoonotic disease development has demonstrated an increasing tendency during the 1940s, as indicated by the rising incidence of emerging infectious disease occurrences (29). According to earlier reports, throughout the last ten years, the global distribution of several zoonotic arbovirus illnesses has increased, including the Japanese encephalitis virus, Dengue virus, Rift Valley fever virus, and Chikungunya virus (30). In a similar vein, WNV is one of the primary zoonotic diseases that pose a threat to public health. By the turn of the century, about a billion people could potentially come into contact with the virus spread by Aedes spp. mosquitoes (31).

6. The Cost of Infectious Diseases Carried by Vectors

Worldwide, vector-borne infectious illnesses are a major cause of morbidity and mortality. These infections disproportionately impact those from lower socioeconomic status and those with little resources. Despite being a global hindrance, the illness and mortality they cause are concentrated in tropical and subtropical regions. Even within the tropics and subtropics, the impoverished population is disproportionately burdened by them. It has been reported that 17% of the estimated worldwide burden of all infectious diseases is caused by vector-borne infections (32).

The ongoing recurrence of previously identified outbreaks as well as the introduction of new ones further exacerbates the worldwide effect of vector-borne diseases. At least thirty novel infectious organisms that impact humans have developed in the last few decades; the majority of these agents are zoonotic, and there has been a substantial correlation found between their origins and socioeconomic, environmental, ecological, and climatic aspects.

Infectious diseases carried by vectors place a significant worldwide cost on public health, exacerbating health disparities. The scourge of recently emerging infectious diseases has long been known about. The most catastrophic pandemic in human history was thought to be caused by infectious diseases carried by vectors. The bubonic/pneumonic plague (10) is a well-known vector-borne disease that has claimed the lives of 25–40 million people.

7. Control Strategies and Vector-Borne Infectious Disease Problems

Diverse instruments and management strategies have been employed to address the emergence and reappearance of vector-borne infectious illnesses. It has been crucial to increase active surveillance, ensure early diagnosis quality, and implement efficient case management. Molecular methods such as phylogenetic tracing investigations and genome sequencing can be crucial in accurately identifying the new pathogens (33).

One of the main obstacles facing the global health program is the control of illnesses spread by vectors. The urgency of employing formal strategic plans that can be created and implemented at both the local and global levels to address these issues has increased because to the current rapid and uncontrolled urbanization. Stakeholders were concerned about the effective control and treatment of victims with linked episodes due to the high prevalence and increasing frequency of endemic vector-borne diseases. As a result, due to advancements in modern medicine, poverty reduction strategies, socioeconomic development, and the application of more effective intervention and control measures, the global burden of infectious diseases, including vector-borne infections, has significantly decreased over the past few decades (34). Using chemical insecticides was one of the most well-liked and effective vector control strategies. Insecticide resistance has surfaced as a significant danger to vector-borne management, which mostly relies on focusing on vector populations, notwithstanding the success stories of chemical pesticides (35). Nonetheless, notable localized achievements are mirrored in global advancements.

It is commonly known that a number of diseases carried by vectors are zoonotic, meaning that wildlife reservoirs increase the frequency of transmission of these diseases in vectors. The issue of vectors and animal reservoir hosts cycling among themselves has created a barrier to vector control and intervention efforts. In the last ten years, the global spread of major zoonotic arbovirus illnesses has expanded significantly, possibly due to the intricate relationship between the vector, pathogen, and host (30).

Even though we now have access to a variety of control and intervention strategies, the majority of control programs continue to face difficulties due to one or more of the following factors: changing environmental conditions, pesticide resistance, population growth, urbanization, and climate change. Therefore, it is urgently necessary to strengthen partnerships and collaboration in order to empower the capacity for monitoring and control new vector control techniques, given the current financing shortfall and insufficient programmatic capacity

(36). Financial limitations also prevent the advancement of innovative pathogen detection tool development and testing.

In summary, vector control has shown to be the most successful weapon in the fight against vector-borne illnesses thus far—that is, if it is widely used. In actuality, it continues to be the only suitable control method we have for a variety of illnesses, including those carried by vectors.

Conclusion

Globally, vector-borne infectious illnesses significantly impact public health. The past few decades have seen an increase in vector-borne emerging disease epidemics, possibly due to a number of factors such as socioeconomic conditions, the environment, global warming, and climate change. In order to address the underlying issues for a long-term plan, collaborative research networks on zoonotic and vector-borne emerging and re-emerging infectious diseases continue to be the most important. Thus, it is important to give priority to the powerful One Health approach that includes entomologists, parasitologists, veterinarians, and public health specialists. Furthermore, proper consideration should be given to the roles played by foreign donors and fund-raising coordinators. Many vector-borne infectious diseases that are currently emerging, reemerging, and stable are becoming well-managed; nonetheless, it appears doubtful what will be done in the future to prevent the emergence of new diseases. This could signal for further efforts to combat newly developing infectious illnesses carried by vectors.

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