Dengue Fever in China

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Dengue fever, one of the most prevalent viruses in the world, occurs in tropical and subtropical regions globally. Historians have theorized that Panama's first suspected dengue outbreaks were in 1635. In modern times, however, it is considered an emerging disease and is endemic to China (Martin et al., 2012). Dengue fever is a vector-borne illness, and it is spread through the bites of infected Aedes mosquitos, the same that are also known to spread Zika and chikungunya viruses. The transfer of the host occurs through the skin, which is the portal of entry.

Approximately half of the world's population is at risk for dengue fever. Scientists have estimated that 100 to 400 million infections occur each year, specifically in urban and semi-urban areas (World Health Organization, 2023). Furthermore, the Centers for Disease Control and Prevention have estimated that 40,000 people die annually as a result of severe dengue. Likewise, in China, dengue fever is concerningly common. From 2005-2020, there were 81,653 indigenous dengue cases reported. Despite the very high morbidity in China, the mortality is relatively low, with 13 deaths occurring in the same 15-year period (Yue et al., 2022).

Additionally, there are some groups that are more likely to fall ill with dengue fever globally. For instance, those living in low-income communities lacking medical supplies, treatment, and intervention are more likely to get sick and die from dengue. Also, the most severe cases were reported in children under 15 years of age throughout hyperendemic areas in Asia, including China (Tantawichien, 2012). There is currently no specific antiviral for dengue, but the symptoms can be managed, substantially decreasing mortality rates. Despite this, one vaccine available in the United States is the Dengvaxia dengue vaccine (Centers for Disease Control and Prevention, 2019). This vaccine is effective, with an efficacy of approximately 80 percent. It is, however, only administered to individuals from 12 to 45 years old who have previously had a documented case of dengue fever. This is due to the fact that the vaccine poses a high risk of giving someone severe dengue if they did not have it previously.

In China specifically, research has proven that socioeconomic factors (defined as interactions between social and economic factors) significantly affect how damaging dengue can be. For example, population density, urbanization, and gross domestic product (GDP) can alter the devastation caused by the virus. Additionally, extreme weather conditions are known to impact dengue incidence. In spite of this, it is shown that there are some interventions that are proven to be effective, including vector control and early treatment. As mentioned previously, low-income communities are particularly at risk. As such, funding is necessary to study dengue further and implement effective preventative interventions.

Throughout China, various socioeconomic factors influence the risk and damage caused by dengue fever. Specifically, the work by Qu et al. (2018) examined the effects of six exploratory variables. The researchers conducted this study using administrative data from the Chinese Centers for Disease Control and Prevention and space-time scan statistical analyses. Four out of the six variables – population density, gross domestic product per capita, normalized difference vegetation index, and road density – are examined. The data concluded that a higher population density comes with a higher conditional probability of the risk of disease incidence. This higher risk can result from the fact that with more people in each area, there is a higher likelihood for infected mosquitos to bite people. On the other hand, with GDP per capita, the evidence showed the opposite. With less GDP, a region is at higher risk for dengue incidence. Since a lower GDP is associated with lower income, corresponding areas are less likely to have interventions in place or the required resources for treatment, increasing risk. Higher NDVI, which quantifies the presence of vegetation in a given area, was shown to decrease disease incidence. This conclusion seemingly goes against preconceived notions. One would think that more forests and vegetation correspond with more mosquitoes and, therefore, incidence. This was not the case, however. Finally, the data on higher road density shows an increase in the risk of disease incidence. An area with more roads indicates higher accessibility for that area, meaning more people can travel there. As discussed previously, more people leads to higher incidence.

In further support of these ideas, another research article studied the effects of natural and socioeconomic factors on dengue fever in two cities in China, intending to identify the key factors affecting dengue fever's spatial and temporal distribution (Chen et al., 2020). The two provinces were Foshan and Guangzhou, areas known to have had severe dengue outbreaks in the past. Using a variety of analysis methods, including temporal trend and spatial distribution, as well as negative binomial regression, among others, relative risk was calculated. Experimenters heavily scrutinize population density. In this 12-year period, Chen and company examine the relative risk of disease incidence in the two provinces. Areas with higher population density, those being central Guangzhou, Eastern Foshan, and the borders between the two areas, are shown to have a higher risk for dengue incidence.

After considering both studies, it is clear that higher population and density correlate with a higher relative risk for dengue disease and incidence. The most vulnerable groups in China include those living in areas with high traffic, low-income areas with a lack of vegetation. It is essential to take these factors into consideration for limiting incidence in the future since a large portion of China consists of heavily populated cities, with a multitude of low-income communities scattered throughout. These groups are particularly vulnerable and need as much funding as possible to limit dengue incidence and mortality.

In conjunction with socioeconomic factors, environmental constituents also play an integral role in shaping how damaging dengue can be in China. To start, the work by Cheng et al. (2021) looks at extreme weather conditions and their relation to dengue outbreak. The study utilizes conditional modeling and focuses solely on Guangdong, China, another region known to have flare-ups of dengue fever. Although it is common knowledge that mosquitos are more plentiful during breeding seasons with high temperatures and precipitation, the work done in this study is critical to consider for China specifically. In the study, scientists found a statistical significance that both extremely high temperatures and rainfall had a positive association with dengue incidence in the Guangdong province. This information is vital for China due to its incredibly varied climate. China is a region known to have devastating monsoons between May and September, along with cyclones and typhoons that peak between July through October (Met Office, 2020). These periods are known to have extremely high rainfall, precipitation, and temperature. Since these periods span so much of the year, the fact that dengue is positively associated with high rainfall and temperature is particularly concerning for China as the population is at risk for dengue for most of the year. Furthermore, dengue fever, in conjunction with catastrophic monsoons, typhoons, and cyclones, can lead to a concerningly high number of mortalities as resources may be limited because of these extreme natural disasters. Due to this shortage of resources and compounding disasters, money must be plentiful to purchase essential supplies that can help treat the symptoms of dengue as well as limit incidence.

After considering all of this, it is clear that dengue is incredibly damaging, and its exceptionally high virulence is especially harmful to low-income communities. Furthermore, dengue is continuously evolving, with its incidence and mortality having increased substantially both globally and in China particularly. Yang et al. (2021) examine the global burden of dengue and its evolution over the past 30 years by compiling data from the Global Burden of Diseases, Injuries and Risk Factors Study 2019 (GBD 2019). This study examines four areas of interest: the age-standardized incidence rate (ASIR) or disease incidence, the age-standardized death rate (ASDR) or mortality, and age-standardized disability—adjusted life years. (DALYs) The last of these is the estimated number of years of life lost from dengue. China had exceptionally high levels of ASIR and DALYs, with a value of approximately three to six (in units of 100,000) for the former and a value of four to eight years of life lost for the latter. Likewise, the same study reported that East Asia, which includes China had the fastest rise of ASIR

with an estimated annual percentage change (EAPC) of 4.57 or a 95% increase from 1990 to 2019. With this massive increase in dengue incidence in China, securing funding to combat this devastating disease is essential. Correspondingly, those with disabilities are at significant risk in China. A condition that is otherwise incapable of causing death in China (usually) can remove up to eight years of life from someone with disabilities.

On a more positive note, despite the fact that dengue is so catastrophic, there are a variety of interventions that have been proven effective. Several studies examined control measures and their effectiveness in relation to limiting dengue or vector incidence. One such study assessed the degree to which early rigorous control intervention could reduce dengue outbreaks and magnitude by analyzing data from surveillance systems and reports from local public health departments (Liu et al., 2018). Focusing on Chaozhou, China, the study compared a variety of different factors. Notably, the effects of varying levels of control interventions are compared. Additionally, the study compares the impact of no-control measures to practical control interventions. Unsurprisingly, the predicted number of cases with control models in place was reported to be substantially lower than those without. The study also compares the effects of different reductions in effective contact rates (ECR). Essentially, this compares the different levels of intervention intensity. It concluded that the highest intensity of 15% percent was most effective, showing the most significant reduction in incidence. The study compares different levels of daily reduction of mosquito density. Once again, relating to intensity, the highest intensity of 15% daily reduction was the most effective. Finally, the study compares both daily reduction in mosquito density and ECR, restating the fact that higher intensity causes the most significant decrease in cases.

Together with the research completed by Liu et al. (2018), researchers evaluate the effects and effectiveness of control interventions while estimating the inapparent infections of dengue in Hangzhou, China. Similar to the previous study, this study compares the impact of different levels of case isolation with the effect of implementing vector control. This study also concludes that a higher-intensity form of vector control is more effective. It also adds that starting vector control as early as possible is the most effective, reducing incidence the most.

Summarizing the two studies, each conclude that high-intensity intervention is most effective at limiting disease incidence. Moreover, early implementation of vector control measures is vital in stopping and limiting dengue epidemics. Although these conclusions certainly provide hope that these measures can mitigate the damage caused by dengue, implementing control measures is only sometimes feasible. For example, socioeconomic factors impact the availability, implementation, and effectiveness of interventions. Since money is needed for intense and early interventions, low-income areas with a lack of surveillance are more likely to be overlooked. They may also need more resources to put intense, early vector control into effect. Considering this fact, it is therefore essential to secure funding for these at-risk communities.

In conclusion, due to how virulent dengue is, it is an especially prevalent disease globally, as well as in China in particular. Throughout China, there are certain groups or areas that are at much higher risk for being infected with dengue fever. These consist of sites with a lack of vegetation with lots of traffic as well as high population density. Further, regions with extremely high temperatures and precipitation are at considerably higher risk than other places. On top of devastating cyclones, typhoons, and monsoons, this risk creates higher temperatures and rainfall, making dengue even more devastating due to a lack of resources and general devastation to an area caused by these natural disasters. Despite the grave nature of dengue in China, the region does have some successes. For instance, several studies report that control measures that are implemented as quickly as possible with high intensity have high efficacy. Specifically, vector control in the form of pesticides or anti larval treatment has dramatically reduced the incidence of dengue, effectively limiting outbreaks.

Nevertheless, these interventions cost substantial amounts of money. Moreover, as highlighted previously, dengue is particularly ruthless in low-income regions where more funding is required. In order to remedy this dilemma, increased funding is necessary for these areas, both for further surveillance, along with the implementation and development of vector control methods. Doing so will limit the spread and mortality of dengue in China, with the aim to save as many people as possible.

Future research on dengue is equally important. Currently, there is no specific cure for dengue. As such, more research in this field could prove vital to cure dengue as quickly as possible. Further, there is only one vaccine for dengue fever. Although it is effective, it has two considerable limitations: it can only be used in those that have previously been infected with dengue fever, and it has a limited age range of 12-45, alienating a large portion of people. Developing a better vaccine that is usable in those who have not been sick with dengue in the past, along with including a more extensive age range, could also be immensely beneficial in limiting the havoc dengue wreaks. Besides cures and vaccinations, experimental technologies concerning control measures need further testing to evaluate their effectiveness. These include genetic strategies and human odor-based bait blends (Wu et al., 2020). Two field trials proved successful in controlling mosquito populations by utilizing experimental genetic sterilization techniques of insects. Also, scientists used a human odor bait mixture device to trap mosquitos. One trial utilized this technique in urban environments, proving its effectiveness. With the proper funding, officials can use and fully explore these new research areas and experimental control technologies, providing even more hope for the future control and mitigation of dengue epidemics in China.

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