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Climate change and diseases: A focus on dengue fever and its surveillance system in Fiji Islands

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Abstract

Dengue is currently one of the most common vector transmitted disease and this is further elevated with climate change. Pacific Island Countries like Fiji are at the forefront of this issue and this puts stress on the already strained public health care system. Therefore, efficient methods need to be employed to better combat and control dengue fever when an outbreak occurs. Attention is drawn to dengue fever in Fiji Islands and the three types of surveillance systems present and their effectiveness. This paper provides recommendations of introducing a climate based and a web-based surveillance are provided to better combat dengue fever under changing climatic conditions.

***Keywords*:** Climate change, disease, surveillance, Dengue Fever, Fiji Islands.

Introduction

Climate change is any significant long-term change in the expected patterns of average weather of a region (or the whole Earth) over a significant period of time. These changes include temperature, precipitation, wind patterns, water salinity and the decline in the size of polar ice caps (1). Changing climate is a natural process that the earth has been undergoing since its beginning however, recently due to human intervention this phenomena has become more of a disaster. Climate research has made it evident that the impacts of climate change will be felt across all continents if this is not already the case and with this the intensity of health risks will also be amplified (2). It has been estimated that global temperatures will rise by about 0.5°C by 2020 (3). The main cause of temperature rise is directly linked to the increasing concentration of carbon dioxide and other gases such as methane and nitrous oxide which have been emitted into the atmosphere as a direct

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result of human activities (4). Worrying trends in climate variability is a major concern for health authorities as research has shown that changes in climate pose a severe threat to the well-being of humans (1).

Different environmental conditions play a role in the occurrence of diseases. An example as such is the incidence of vector-borne diseases where certain climatic conditions can be a driving influence in the spread of these diseases by providing favorable conditions for the vector to breed and thrive. Vector-borne diseases are studied in its association with climate change mainly due to their widespread occurrence and inclined sensitivity to climatic factors (5). Changes observed in the overall rainfall, temperature and humidity will affect the biology and ecology of vectors and their associated hosts which in turn can increase the rate at which diseases are transmitted (6). Pacific Island nations such as Fiji have increased vulnerability to vector borne diseases as seen in the increased occurrence of vector borne diseases such as dengue, Zika virus, Malaria, Lymphatic Filariasis and Chikungunya (6), all of which are transmitted by mosquitoes.

While Fiji and other Pacific Islands have a range of mosquito species such as *Aedesaegypti*, *Anopheles farauti*, *Culex quinquefasciatus* and *Anopheles puntulatus* (6), the species responsible for the spread of dengue and other mosquito borne diseases in Fiji is the *Aedesaegypti*. In an interview with a local Fijian newspaper medical specialist Gary Grant mentioned that climate change will cause an increase in the intensity of vector-borne diseases in Fiji and better measures should be employed to counter it (7).

Dengue is now a common vector-borne disease that has become a serious concern in many parts of the world and while the disease was most prevalent in urban centers it has now also been more recently observed in rural areas of subtropical and tropical countries (8). According to (9), about 390 million people are infected with dengue each year and this rate will most likely increase due to climate variations. In addition, the economic, health and social burdens that are associated with populations that are infected with dengue are will also significantly increase (10). Currently there is no specific treatment or vaccine for this particular disease and with a large number of people living under the risk of being infected it is vital that effective methods be developed (11).

The next best course of action would be ensuring proper case management and clinical care is delivered to infected persons. Surveillance of diseases which are vector-borne are important for controlling an outbreak and minimizing harm. In countries like America both epidemiological and entomological in conjunction with weekly case reporting has proven to be useful in curbing vector-borne diseases (12). For countries in the Pacific such as Fiji, vector-borne diseases such as dengue needs to be reported and assessed in a proper and timely manner (11). This paper provides a general outline on the surveillance systems used in Fiji for dengue fever.

Dengue fever in Fiji Islands

Dengue fever has become one of the most common vector borne diseases globally and more importantly in Fiji and its neighboring Pacific island countries. Vector-borne diseases are infectious diseases that are transmitted between hosts by an intermediate host (vector) such as mosquitoes and ticks. The vector of interest in Fiji's dengue outbreaks is the *Aedesaegypti.* What makes dengue unique in Fiji from the rest of the world is that it is that Fiji is the only country that is home to about six potential mosquito vectors, with only the *Aedesaegypti* being the disease causing vector (13). This vector has been responsible for the various outbreaks that burden Fiji's public health system. According to World Health Organization, 2019, dengue is endemic in over 100 countries worldwide. Fiji is among these statistics with the epidemic showing dynamic changes in the past four decades (6, 13, 15).

Fiji has reported two nationwide outbreaks in 1971 and 1975 after which there was no outbreak for more than a decade. It was only after 1988 that outbreaks have occurred with increasing frequency; an alarming six outbreaks occurring between 1998 and 2017 (16, 17). These major outbreaks have been observed to occur in a 4 to 5 year cyclical pattern. The last major outbreak to strike the Fijian population occurred between 2013

and 2014 in the form of the dengue serotype-3 virus which re-emerged in the South Pacific after an 18 year absence (16). A total of 15,000 cases were reported during this period, 5,249 of which were laboratory confirmed cases. Record total of 48 deaths were reported during this outbreak period (16). These statistics far outnumber any previously reported dengue outbreaks. The 1997-1998 DENV- 2 outbreak which was previously Fiji's worst epidemic reported 24,000 cases, 17,000 hospital admissions and 13 deaths (18).

Generally dengue outbreaks have been observed to coincide with the wet and rainy season. The rainy season in Fiji occurs between November to April and this when high dengue cases have been recorded whereas, transmission of dengue is low during dry season (May to October) (18). Also seen during the 2014 epidemic where majority of cases were reported in the first three months of the year coinciding with high rainfall (16–18). However, the 1997 and 1998 outbreak occurred during the drought period and this illustrates the importance of stored water as breeding sites for these vectors (18). The need to store water in Fiji usually seen in the rural sections, which arises partially during the drought season. Thus, an adaptability can be seen where *Aedesaegypti* populations can increase in both dry and wet conditions. According to a number of studies warmer temperatures influences or is a predictor of dengue fever infection (9, 16, 19). Data collected from Nadi and Suva in Fiji support this and that show that dengue outbreaks are positively related temperature and December, January, February and March are months of high risk (18). Other factors such as microclimates, breeding sites and abundance of vectors are also important as well (18).

A study carried out on modeling the epidemic potential of dengue in the future depicted that due to climate change there will be an overall shift from seasonal patterns to all year around risk of outbreak of dengue (20). The study also mentions that the number of outbreaks can increase with more dangerous forms of dengue in small island nations. Therefore, proper management and surveillance is required as the first line of defense.

Current surveillance system for Dengue in Fiji

Dengue fever is ranked high in the public health priority list. To trigger an investigation in relation to dengue fever the health department needs twice the average number of cases seen in the previous three weeks. An outbreak is declared if the incidence rate is greater than 2 standard deviations above the average for the last 5 non-outbreak years (21).

The medical sector term outbreak refers to an unanticipated increase in the number of patients for a particular disease. According to (21), many factors are considered before an outbreak is declared. Factors include the type of disease, location in which the case was reported, the population in the affected area, season and the approximate number of cases detected. Outbreaks are detected using different approaches which include Surveillance systems, reporting by health professionals and informal reporting from other agencies and individuals. Three different surveillance systems used in Fiji are national notifiable diseases surveillance systems, indicator-based surveillance and event-based surveillance.

National Notifiable Diseases Surveillance Systems (NNDSS)

The NNDSS has been in existence since 1938. The system requires medical officers and laboratories to notify an outbreak to the subdivisional medical officer (SDMO). The SDMO after discussion with the medical officers will inform the divisional medical officer (DMO) who will have to inform the Fiji Centre for Communicable Disease Control (FCCDC). In case of dengue fever the reporting will follow the same channel whereby reporting will be made on a weekly basis by the officers using a NNDSS reporting form. However, in case of an outbreak or an urgent condition the medical officers and the laboratories will have to inform the DMO immediately by phone and submit the NNDSS reporting form within 24 hours.

Syndromic Surveillance: Early Warning Alert and Response System (EWARS)

Syndromic surveillance is intended as an early warning system before an outbreak is declared. The syndromic surveillance conditions require weekly reporting from the clinical officers about the clinical cases to the FCCDC and other agencies (21). An alert will be generated once the FCCDC submits the report to the divisional and subdivisional outbreak response team, who will analyze and confirm the scenario.

Event-based surveillance

The event-based surveillance system is intended to monitor unusual events, not only in humans, but also in birds, animals, and the environment. Events of interest include diseases in humans, clusters of diseases, unusual patterns in diseases, unexpected deaths, high work/school absenteeism, die offs in birds or animals, contaminated food or water, and environmental hazards (21).

Efficiency of the current surveillance system

Despite having different surveillance process, surveillances system used in Fiji is not effective (22). Further, paper based reporting is currently used is not effective and delays in the detection of cases (22). The data which is received may not be sufficient due to poor reporting from medical laboratories and incomplete data from private sector (21). Also, a study conducted by (23) depicted that policies on climate and public health are indirectly related to health. The health impacts that are related to the changing climate are not usually emphasized at the level were policies are made. To declare an outbreak and take corrective actions, accurate and relevant data is required thus Fiji needs to improve on its reporting process which will enable the health authorities to make quality decision, create awareness and prevent cases from rising.

Economic impacts of ill-health on the economy

There are various impacts of mosquito borne diseases such as dengue fever on an individual's physical health as well as economic health of the entire nation. The impact can range from being very mild to very harsh and even incapacitating the economy. The effects felt by the nation depends on various factors such as population immunity, socioeconomic status of its population, the amount of medical and clinical care provided and the level of hygiene present in the affected areas (6). Studies conducted in this area have focused on estimating the cost of specific diseases and dividing these costs into two categories namely direct and indirect costs (24). The direct costs include the medical care bills and travel costs while indirect costs comprise the monetary value of loss in production and income.

In Fiji, no detailed analysis has been undertaken to fully estimate the extent of damage that is caused by vector borne diseases. However, there are estimates such as the 1997/98 outbreak cost the Fiji Government around 6.5 million Fijian dollars (18). Whereas, another report mentioned that the cost was estimated to be 12 million Fijian dollars (25). Moreover, a rise in dengue fever cases in the future will put a pressure on the public health care system's budget as more medicines need to be purchased to cure this disease. Additionally, creating awareness on the prevention and cure of this disease will also increase the expenditure on health care. Thus, leading to an increase in the opportunity costs of this action by the government as the tax payers money could have been put to a more productive use.

The ill effects of an ailing population are varied. It will have a negative impact on the productivity of workers which translates into lower economic growth as the infection may last two weeks. There is not only a loss of output but also a loss of income to the individuals due to this temporary unemployment. The fever may go down within two weeks but the symptoms may last longer especially fatigue and weakness. A loss in income will result in a fall in consumption expenditure which in turn reduces aggregate demand and output. The effect of disease is not restricted to macro level but also has impact on

the individual sectors of the economy such as the households, the firms and the government. The non-market activity such as care-giving for the dengue patient extends beyond financial implications to a loss in economic welfare. It also leads to forgoing leisure activities to provide care for the sickly family member. However, if an individual has to take time off from work to provide this care-giving then there is a direct loss in production and consequently a loss in income which will tend to reduce consumption. The current consumption together with the future consumption of the households is affected since the medical care bills may distort the budget and lead to less savings thus lower future consumption.

Another micro level impact of ill-health is on the business houses. When workers to do not turn up for work due to illness there is a loss in productivity and performance of the firm. Due to this loss in production the firm will experience a loss in its profits thus leading to reduction in the owner's consumption. The firms may be negatively affected as it will not be able to invest its profits to earn higher returns on its investment. The sick population has also negative effects on the government's budget. Firstly, it impacts the productive capacity of the government workers as illness in its workers will lead to lower level of public goods being supplied. Secondly, poor health will impose restrictions on the government spending in the various sectors as more funds would be required to finance the increased health expenditures. Also, redirection of funds from capital expenditure to consumption expenditure do not yield any returns in future as these not one off payments and are not considered investments whereby the government does not receive any goods or services in return (24). It is an extensive task to measure the economic impacts of vector-borne-diseases therefore; very few studies exist in this area.

Recommendations

It has been well established that climate change will enhance the number of outbreaks of dengue in the years to come and this will be very difficult to control especially in small developing states like Fiji. Therefore, better surveillance methods need to be developed and employed in the health system. One such is an interconnected climate based surveillance system. This system provides timely information to the locals about disastrous events, outbreaks of dengue, and most importantly the health care works to better prepare themselves. A database will need to be created between the weather office and health care where data can be shared on extreme weather events which can lead to an outbreak. Fiji is highly sensitive to climate based diseases (26) and creating this system will be beneficial. Studies on climate based surveillance on infectious diseases including dengue and its relationship to climate have been conducted in countries like Brazil and China have proven to be successful (27,28). A study in Fiji has proven to show that cases of dengue fever increased after extreme weather events such as cyclones and frequency of dengue has also been linked with climate unpredictability (29). Therefore, these studies act as a support for implementing a climate based surveillance in Fiji Islands.

Further, health care now in Fiji should move online where reporting and recording of diseases like dengue should be done on apps using mobiles or tablets. An internet based surveillance information entry system can be created which is linked to all the health centers and hospitals throughout the region. Standard forms can be used in this online surveillance so that consistence is maintained in data collection. This method has shown to be effective in some countries (30) however, with some drawbacks. Such as internet in remote areas of Fiji will be a problem and study needs to be conducted on the cost on introducing this method. In addition, health works need to be trained comprehensively to better report these diseases and raise awareness in their local communities.

Conclusion

There is a significant association between environmental variables such as temperature and precipitation and these associations can help in the establishment of a climate based surveillance. This climate based surveillance can be based on changes that occur in the weather patterns which can be linked to the health care system in Fiji. Web-based surveillance is another

method that can be used with proper training provided to the health care workers and together with that standardized reporting procedures can be useful as well. It is also important to educate the public to report any cases to ensure proper treatment is employed before the disease spreads and leads to an outbreak.

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