A2 A preliminary analysis of weekly dengue incidence rate in the Dominican Republic during 2019

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Introduction

Dengue fever is an acute febrile infectious disease caused by the Dengue virus.

Dengue virus is spread by female mosquitoes, mainly of the species Aedes aegypti, through bites on human hosts. Dengue symptoms include fever, severe headache, muscle pain, joint pain and skin rashes, just to name a few [1]. According to the World Health Organization (WHO), there are three categories of dengue disease: dengue without warning signs, dengue with warning signs, and severe dengue [1]. Regardless of the severity level, dengue has become one of the most important vector-borne disease in Africa, the Americas, the Eastern Mediterranean, South-East Asia and the Western Pacific. Currently, it threatens the health of millions of people that live in urban, suburban, and rural areas, especially in tropical countries where environmental conditions favor the production and spread of the mosquito Aedes aegypti. According to [2], the number of dengue cases in the Americas has increased in the last four decades, passing from 1.5 million accumulated cases in the 1980s, to 16.2 million in the decade from 2010-2019.

Clinical and public health services have not been able to reduce the dengue incidence rate. Several causes have been pointed out: the vaccine is only recommended to people aged between 9 to 45 years, with evidence of previous infection; effective medical treatments that avert the development of severe symptoms are still unknown; and no sustainable control measures against the vector that guarantee the protection of affected communities [3,4]. Furthermore, several other social and geographical factors have contributed to this public health problem in some countries, such as uncontrolled urbanization, the increasing population growth, and the proliferation of air traffic [5].

The Dominican Republic is one of the ten Latin American countries and the Caribbean most affected by dengue [6].

This work aims to present a first exploratory analysis of the behavior of the total number of dengue cases attended and notified per week in each of the 32 districts of the Dominican Republic during 2019..

Methods

Count data of new dengue cases reported by epidemiological week, from weeks 1 to 52 during 2019, and accounted by nine age groups (<1, 1-4, 5-9, 10-19, 20-29, 30-39, 40-49, 50-59 and $\geq$ 60 years), were collected from a database from hospitals of the 32 districts of the Dominican Republic.

Additionally, demographical and geographical characteristics per district were considered, such as the average number of people living in each district and each age groups, population density, average altitude, and percentage of people living without water and waste services. Dengue incidence rates per week were also calculated using the number of new cases reported per week during 2019, divided by the local population and multiplied by 100,000 inhabitants. These rates were obtained per district (=local population) and at national level. In the latter case, the "local" population was the total number of people living in the Dominican Republic and the annual rate represents the National Incidence Rate (NIR).

For a better overall understanding of dengue impact in the country, both types of rates under study, the long-week rate and the annual rate (per district and at a national level) were categorized into three levels of dengue incidence: low, medium, and high. Concretely, a rate has (i) a high incidence level whenever its value is equal to or higher than the NIR; (ii) a medium incidence level whenever its value is between the 1st quartile of the incidence rates and the NIR; and (iii) a low level whenever its value is lower than that 1st quartile.

For data visualization, statistical graphs were constructed: line graph to show trends over time, and bar graph and points graph to show the distribution of the rates. All analyses were carried out using the R Studio version 4.0.4 software.

Results

In the Dominican Republic, during the period between epidemiological weeks 1 and 52 of 2019, 20,230 dengue cases were reported with a national incidence rate of 195.3 cases per 100,000 inhabitants considering a population of 10.3 million, according to the National Statistical Organization. During this year, the weeks with the highest numbers of reported cases were from week 27 to 41 (months from July to September, see Figure 1) with a total of 7,022 cumulative cases and a rate of 101.8 cases per 100,000 inhabitants.

Regarding the incidence rates by age, the highest rates were observed under 19 years old, with a total of 461.3 cases per 100,000 inhabitants. For the remaining ages, a total of 38.9 cases were observed per 100,000 inhabitants. Figure 2 clearly shows that the age groups with the highest incidence rates were "<1", "1-4", and "5-9".

Figure 3 depicts, from the highest to the lowest, the annual incidence rate of the 32 districts of the Dominican Republic. A map with the three discretized levels of these annual incidence rates is also presented. For thirteen districts, the annual incidence rates are higher than the NIR, with San José de Ocoa having the highest rate with 655 per 100,000 inhabitants. Samaná has the lowest rate of 72.8 per 100,000 inhabitants.
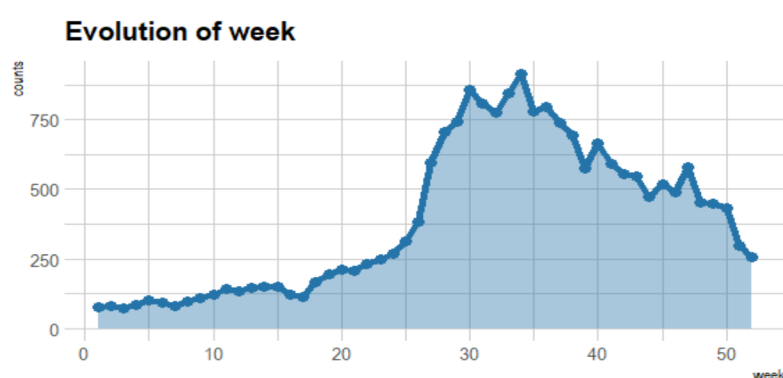

Figure 1 – Evolution of the total number of dengue cases over the 52 epidemic weeks of 2019.
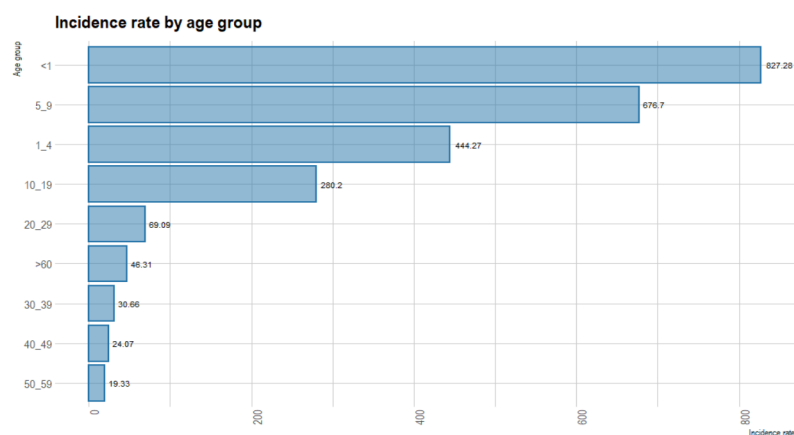

Figure 2 – Dengue incidence rates by age group in 2019.

Comparing the distribution of the dengue incidence rate over the 52 weeks of 2019 and among the 32 districts (Figure 4), different behaviors are observed. While most districts present higher rates of incidence in the second half of the year, the districts of Barahona, Independencia, Monte Cristi, and San Jose de Ocoa tend to exhibit higher incidence rates throughout the year, and Peravia district shows more concentration of higher rates in the second trimester. Moreover, in general, the situation with less dengue cases occurs during the first half of the year. Further analyzing demographical, geographical, and water and waste conditions of the 32 districts, patterns seem not to be highlighted related to the distribution of incidence rates, in particular with the thirteen districts that present the highest incidence rates (see table at the bottom in Figure 4)..
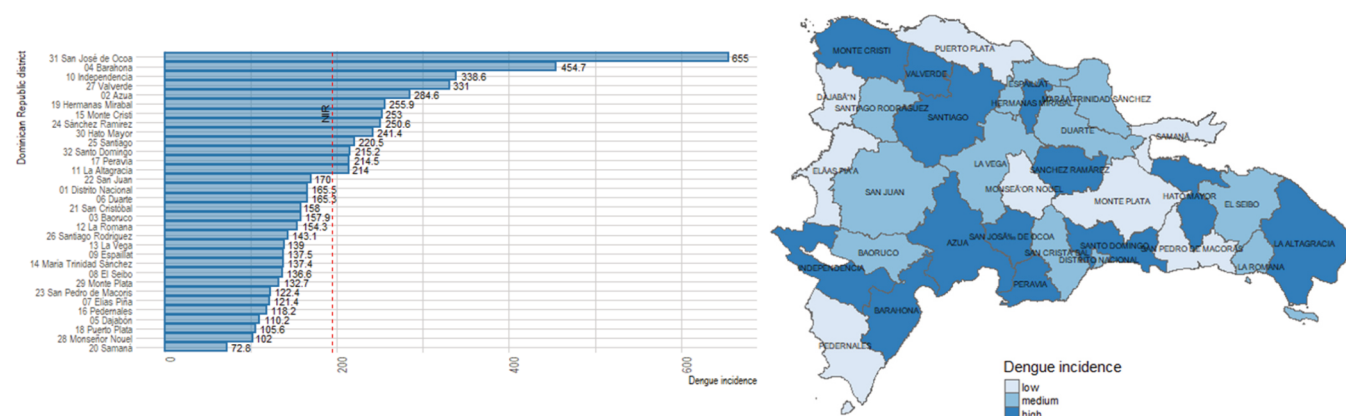
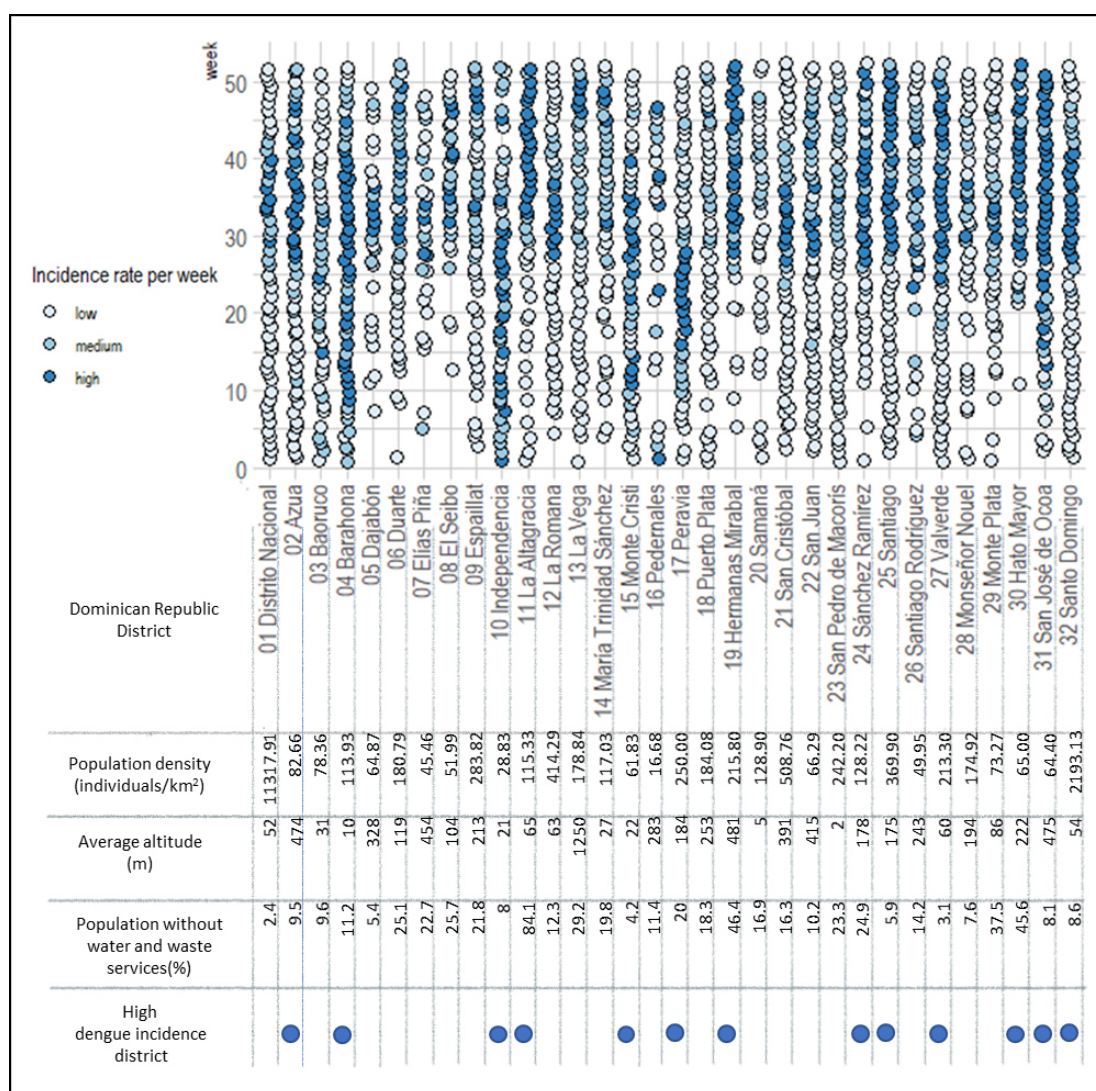**Figure 3 –** Distribution of dengue incidence annual rate by district in 2019 (NIR – National Incidence Rate).

Figure 4 – Weekly distribution of dengue incidence rate and geographical and demographical characteristics per district in 2019.

Discussion

As compared to other Latin American and Caribbean countries, the year 2019 was the most affected for the Dominican Republic in the last five years, with the country ranking eighth in the notification of dengue cases to the Health Information Platform of the Americas in 2019 [6]. The dengue incidence rate in 2019 (NIR=195.3 cases per 100,000 inhabitants) was very close to the incidence registered in the previous endemic period that occurred in 2015 [2].

Regarding age, the age groups below 19 years old were the most affected, presenting a higher incidence rate than the older age groups. In the age groups "1-4", "5-9" and "10-19" years, there were respectively 21.23%, 31.96%, and 26.47% of cases, representing almost 80% of the total number of dengue cases reported in 2019. This age distribution is similar to that observed in [7], in which the studied population has a predominance, represented by 75%, aged 8-16 years.

Except for Canada, all countries in the American continent are infested with the mosquito Aedes aegypti, and Latin America accounts for 60% of all cases registered to WHO [6]. The mechanism of recurrent dengue epidemics in this area has been largely explained by urbanization. Furthermore, epidemics are expected to intensify in middle and low-income countries, where the urban population is expected to double by 2050 [8]. Studies carried out in Latin America have shown that the transmission of the disease describes a cyclical behavior, varying between high and low incidences during the epidemiological weeks of the year [8].

Epidemic peaks coincide with rainy seasons, and an important risk factor observed is living or moving in areas where cases of the disease are occurring. Similar conditions seem to be related to the data herein analyzed: peaks of incidence rates are more concentrated around weeks 27-41 corresponding to the months July - September, which has ideal conditions for the Aedes mosquito reproduction.

Although climatic features, such as rainfall, humidity, or temperature, are relevant as indicators in dengue transmission, they have not been explored in this paper. Nevertheless, the findings presented in this analysis contribute to improving the understanding of the dengue dynamics in the Dominican Republic. Concretely, the behavior of the incidence rate showed that there is no single pattern among the 32 districts suggesting district clustering. More studies with robust designs should be performed to investigate individual and environmental factors that could influence the substantial increase of dengue cases in some regions of the Dominican Republic.

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