*Nat. Volatiles & Essent. Oils, 2021; 8(5): 8214- 8227*

NVEO
Natural Volatiles &
Essential Oils

# Influence of Socioeconomic, Cultural and Environmental Factors on the Spread of Dengue

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**Abstract**

Dengue is an infectious disease, transmitted by arthropod vectors, considered a priority and growing public health problem. Its vector Aedes aegypti has progressively spread throughout the Ecuadorian territory. It is estimated that 70% of the national territory presents adequate conditions for the transmission of dengue, with a population at risk of more than eight million people. The objective of this research is to study the socioeconomic, cultural, environmental and climatic factors and their relationship with the spread of dengue in Ecuador. A cross-sectional descriptive method was used where the data were obtained using the survey as a technique and questionnaires as an instrument to obtain information on the level of knowledge of the population about dengue, socioeconomic, environmental and climatological conditions. Surveys were carried out using two questionnaires, personal and observational / peridomicilial; both applied to people from older adults to 18-year-olds, with a total of 458 respondents. In the results, 62, 6% declared the use of buckets, gallon jars as places to reserve water; which increases the places to increase the population of the vector insect; 277 respondents affirmed irregular water supply. Knowledge about dengue is scarce, risk practices are adopted that favor the development of the disease; however, a favorable attitude towards control and training is evident. Therefore, it is necessary to promote behavioral changes not only in the community, but also in the way prevention and control programs are being carried out.

**Key words**: Dengue, knowledge, attitudes and practices in health, epidemiological surveillance

## 1. Introduction

Vector-borne diseases have generated a large number of diseases in hot environments such as tropical countries. Latin America and the Caribbean have been at risk from these vector-borne diseases, especially with regard to Dengue.

Dengue is an acute viral disease caused by an arbovirus, defined as arthropod-borne vertebrate viruses or arthropod-borne viruses of the Flaviviridae family. Four antigenically different serotypes have been identified: DENV 1, 2, 3 and 4. The virus is transmitted to humans by the bite of a female blood-sucking mosquito, Aedes aegypti as the primary vector. Dengue is distributed in tropical and subtropical regions of the world [4]. The World Health Organization (WHO) estimates between 50 and 100 million dengue infections worldwide each year and others suggest up to 200 million infections [3]. Arboviruses are distributed throughout the world, presenting a higher prevalence (a number of cases per 10,000 or 100,000 people in) in tropical and subtropical areas. The incidence or number of new cases in a given population, in a given period, are closely associated with climatic conditions.

Dengue belongs to the group of endemic diseases in tropical rain forest areas, and epidemics generally occur in temperate areas after the rains. Its incidence has increased in recent years, in America, it is estimated that 500 million people are at risk. laundry

The year 2013 was an epidemic year with 2.3 million cases and an incidence of 430.8 per 100,000 inhabitants [21] Dengue is highly related to humidity and temperature. The infection increases during the hot and rainy season. It is present mostly in urban and semi-urban areas. The presence of dengue is related to socioeconomic, environmental and behavioral factors [4], [5], [25]. The number of dengue cases in the Americas has increased in the last four decades, going from 1.5 million accumulated cases in the 1980s to 16.2 million in the 2010-2019 decade [23]. Between Epidemiological Week (EW) 1 and EW 52 of 2019, 3,139,335 cases of dengue were reported in the Region of the Americas (incidence of 321.58 cases per 100,000 inhabitants), including 1,538 deaths. Of the total number of reported cases, 1,367,353 (43.6%) were confirmed by laboratory criteria and 28,169 (0.9%) were classified as severe dengue. The case fatality rate was 0.049% [22].

In Ecuador, dengue represents a priority and is a growing problem among all vector-borne diseases. Since the appearance of dengue in 1988, the vector and the disease have progressively spread throughout the territory. Approximately 70% of the Ecuadorian territory is at risk of dengue transition and the four serotypes circulate in this nation [16], [1]. The Ministry of Public Health estimates that around 8,220,000 people are at risk of contracting this disease [1], [19].

Poverty, climate change, and demographics are related to the occurrence of dengue and the great impact on the public health sector. Since dengue does not have a specific vaccine or treatment, control and prevention strategies are based on targeting the vector.

Aedes aegypti tends to remain in or around the houses where it emerged as an adult, and public health authorities are concentrating their efforts on applying chemicals in the areas where cases are reported. The environment, domestic sanitation and water management are important measures that have a direct impact on the presence of the vector. Despite the efforts of the authorities, the application of insecticides is not the only method to prevent the spread of dengue. The individual and collective strategies implemented around the world to fight dengue are rapid diagnosis, case management, outbreak prediction, epidemiological and entomological surveillance; sustainable vector control, education, and vaccine development [23].

For public health authorities and those responsible for formulating policies, it is important to prepare maps in which the geographical distribution of diseases is described, this facilitates the control and prevention of diseases. Mapping is important for tracking threats and targeting prevention and control strategies in high-risk areas [17]. Geographic Information Systems (GIS) provide excellent tools for disease mapping. GIS can be used to manage georeferenced data, display raw data or models based on estimates of disease occurrence, and the creation of spatial statistical models for tropical diseases [20]. Disease clearance requires reliable georeferenced data to be able to accurately predict areas with risk factors such as environmental, climatic, or socioeconomic predictors.

The objective of this research is to study the socioeconomic and cultural, environmental and climatic factors and their relationship with dengue in Ecuador through the socioeconomic, climatic and environmental characteristics that allow predicting potential risk areas, vulnerable communities, selection of strategies for control and prevention in the different provinces of Zone 1.

## 2. Materials and methods

This research was of a cross-sectional descriptive type, in which the population consisted of 458 people. The sampling was probabilistic and random, the unit of analysis being the people of the dwellings. Each person signed the consent to carry out the survey. The population was represented by four provinces of zone 1 in northern Ecuador (Figure 1).


Fig. 1. Research Spatial Delimitation. Provinces of Esmeraldas, Carchi, Imbabura and Sucumbíos.
Source: Google Map

This research was carried out in the northern limit of Ecuador with Colombia, covering the provinces of Esmeraldas, Carchi, Imbabura and Sucumbios (Zone 1). The area includes the towns of San Lorenzo (Esmeraldas), San Juan de Lachas (Carchi), La Carolina y Golondrinas (Imbabura) and Lago Agrio (Sucumbios) (Figure 2).

The analyzes focused on the positive cases confirmed and reported in a period of eight months (January to September 2014), classifying them as positive cases reported by people from households infected with dengue to the Ministry of Public Health (MSP), National Directorate of Epidemiological surveillance, community centers or local hospitals and subsequently confirmed with molecular analysis of positive IgG (Immunoglobulin G) and IgM (Immunoglobulin M) for the virus. The addresses of the positive cases were taken from the epidemiological records, the houses were visited and georeferenced [23].

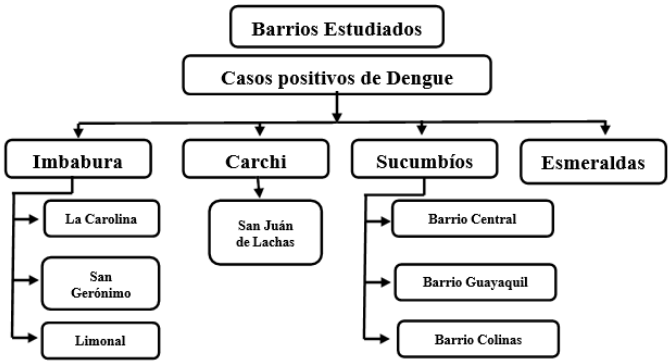


Fig. 2. Neighborhoods where the surveys were applied

Subsequently, a survey of socioeconomic and environmental aspects was carried out, using two questionnaires (personal and observational / peridomicile). Both applied to people from older adults to 18-year-olds, with a total of 458 respondents. In the survey techniques, questionnaires were used as an instrument with which household and peridomiciliary information was obtained: questionnaire 1 offers information on the staff (household information, basic needs, knowledge, dengue fever, symptoms and transmission), practices and attitudes for prevention and awareness towards dengue prevention and questionnaire 2 provided observational / peridomiciliary information (characteristics of the home and access, peridomiciliary characteristics (materials and general conditions) and possible mosquito breeding sites. The objectives of the survey are: 1- Identify the factors that influence the presence of dengue in the sampled areas 2- Evaluate knowledge about dengue and attitudes and awareness towards dengue prevention.

After the identification of the significant environmental and socioeconomic variables, the results were analyzed using the absolute data, the percentages and the probability of occurrence. Through these epidemiological extrapolation models, some hidden / unknown / blind areas were detected. These results can be implemented, after validation, surveillance and decision support in control programs by health agencies.

**3. Results and Discussion**

Dengue is the most important and common arbovirus disease in the world. It is estimated that 40% of the world's population lives in areas at risk of infection, with about 390 million infections (96 million of them symptomatic) and 20,000 deaths from dengue each year in more than 125 endemic countries. Of the 30 countries in the world with the highest reported incidence of dengue, 18 (60%) belong to the Region of the Americas [21].

As long as there is no available vaccine or effective antiviral drug for dengue, the Early Warning Systems (EWS) will continue to be an essential tool to curb the transmission of dengue and reduce the number of cases. However, implementing an EWS can be resource-intensive and labor-intensive, posing an economic burden for resource-limited communities. Given the complex dynamics of dengue transmission, an effective and low-cost EWS requires a multi-component approach that combines 1. environmental monitoring, including climate-based predictive models, 2. entomological monitoring, 3. proactive disease

control strategies vectors, including insecticide uses and reduction of breeding habitat, 4. public awareness and education, and 5. timely response to emergencies and case management [12].

**Bioclimatic Characteristics**

Prolonged warm spells (in which temperatures rarely drop below 18 ° C) promote vector population growth, more rapid amplification of the virus in the larger population, and increased vector feeding, and contact with the human host, leading to an increase in human infections [11]. Conversely, colder periods, when temperatures often drop below 18 ° C, provide an effective and regular brake on vector population growth and viral development, reducing contact with the human host and limiting the number of infections. Major dengue outbreaks generally occur during hot, dry periods with extreme daily temperatures between 18 ° C and 32 ° C C, optimal range for mosquito survival and viral transmission. [7], [10], [15].

As insects are poikilothermic, some of their biological processes such as sexual maturation, copulation and oviposition are affected by environmental temperature [8], so that at appropriate temperatures (between 26 and 28 ° C) the kinetics of the development and survival of all stages of the insect [6], [18]. Ecological factors and seasonal vegetation dynamics can influence vector density at the local scale. Interannual variability in dengue incidence may be related to the turnover of herd immunity (by human hosts) across the four serotypes.

During 2018, 3,094 cases of dengue were reported in Ecuador; of which 2,965 cases (95.83%) are dengue without warning signs (DSSA), 123 cases (3.98%) are dengue with warning signs (DCSA) and 6 cases (0.19%) are severe dengue (DG). The circulation of the serotypes DENV-1 and DENV-4 was identified. [14].

**Potential Mosquito Breeding Sites**

The results of the investigation show the spaces that can become places for mosquito breeding.

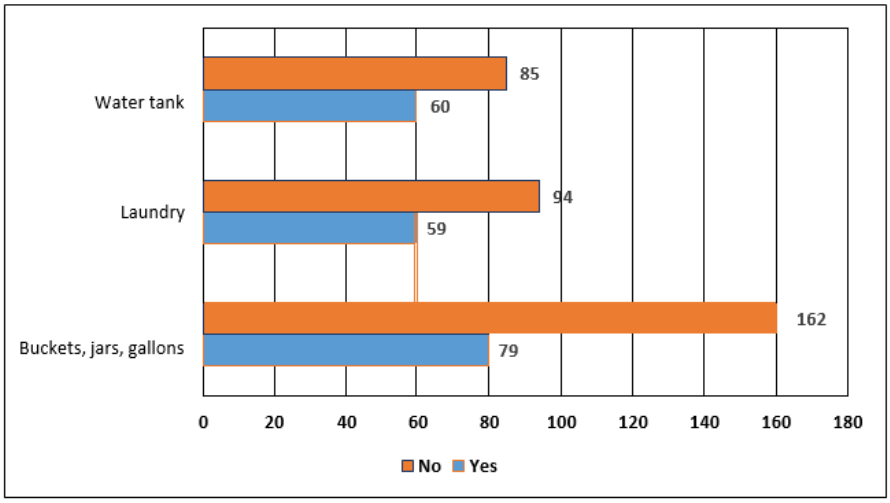


Fig. 3. Potential breeding sites for Aedes aegypti.

It can be seen in Figure 3 the diversity of places that can become places for mosquito breeding. Of the 539 interviewees, 79 (62.2%) declared the use of buckets, gallon jars as places to reserve water; while 60 affirmed the use of tanks as a water reservoir. As everyone knows, tanks (with a lid) are the ideal containers to adequately reserve water; while casual packaging is not recommended as a reservoir for later use. 46.5% of those surveyed affirmed the presence of still water in laundries, which represents a risk area for mosquito breeding.

Some research has associated low socioeconomic conditions with the incidence of dengue, mainly because the risk of transmission is increased by inadequate water supply services, poor solid waste management, poor urbanization conditions, and low level of education. [25]. Hence the importance of training communities on the life cycle of the vector and the forms of transmission of the disease. Other studies carried out in Honduras and Mexico demonstrated a positive relationship between breeding sites positive for A. aegypti and little schooling of mothers [13].

The low educational level of a region could make it difficult to understand the real risk that dengue represents for the inhabitants, at the same time reducing the basic knowledge related to the vector that is necessary for its control [2].

Basic services

Basic services such as the drinking water system and the sewage system of a community are essential to guarantee a healthy life; they are the necessary infrastructure works as sanitary control.

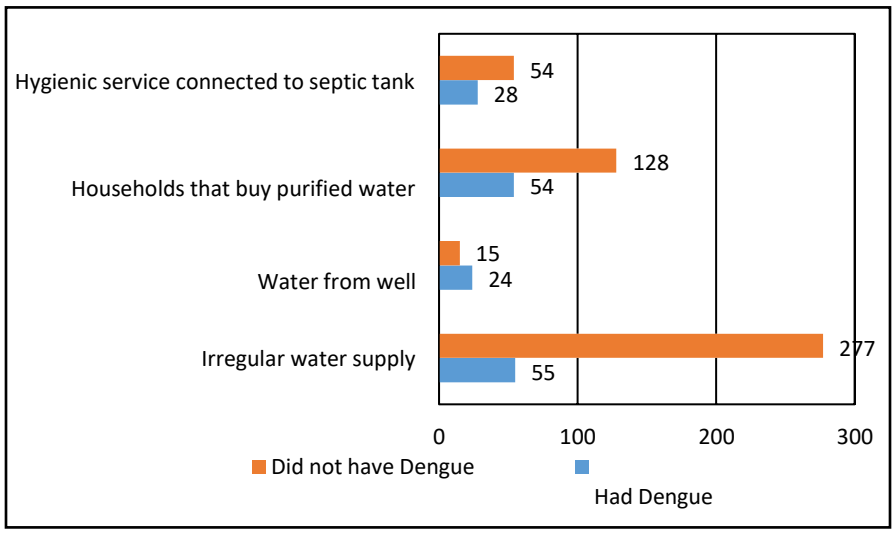


Fig. 4. Basic Services

Figure 4 presents the responses of the communities under study regarding basic services. It can be seen that 128 (36.20%) households that buy purified water were not affected by dengue; while 54 (15.3%) were affected. The use of purified water reduces the risks of contagion. The Figure also shows that the irregular

water supply does not increase the incidence of dengue, this is due to the care in the management of the water reservoir. In the populations surveyed, it can be noted that well water, properly handled and properly reserved, is not a risk factor for contracting the infection.

Knowledge of the population about Dengue.

Figure 5 presents the incidence of dengue and whether respondents have information about dengue.

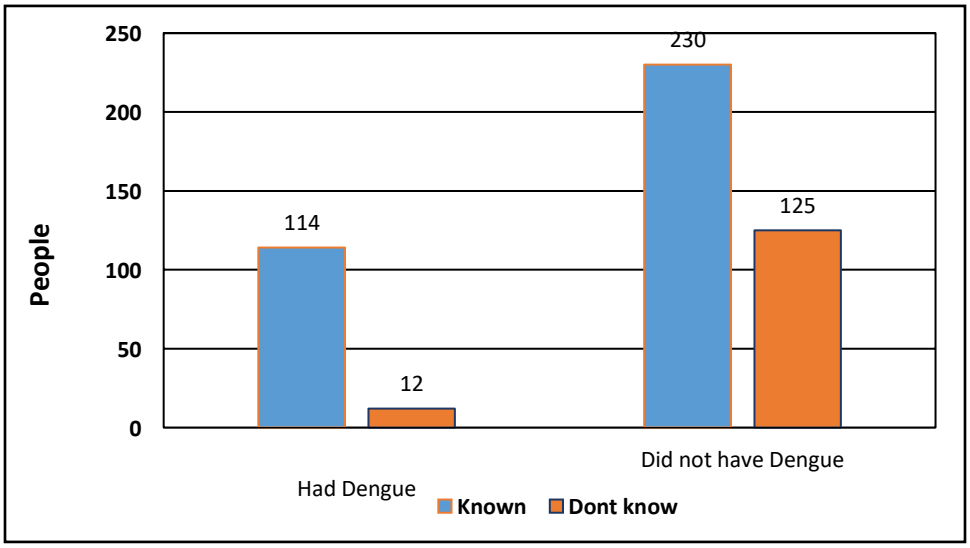


Fig. 5. Knowledge of the population about Dengue

The results (Figure 5) show that the majority of respondents (344) expressed their knowledge about dengue, and of them the number of infected people (126) in whom they had said knowledge was less than the uninfected (355).

It is very important to have the participation of the community for the implementation of programs to control the disease, for this, it is essential to train the communities on the characteristics of the disease and its prevention. this sickness. preventive measures, it is also important to have the participation of community members in prevention, sanitation and control programs for dengue virus infections. [9]

Knowledge Community attitudes and practices for dengue prevention

Most of the respondents expressed the occurrence of dengue cases in their community; However, they also expressed ignorance of the transmission of the infection, which increases the risks of contagion to neighbors and the non-emergence of Dengue prevention, control and sanitation plans.

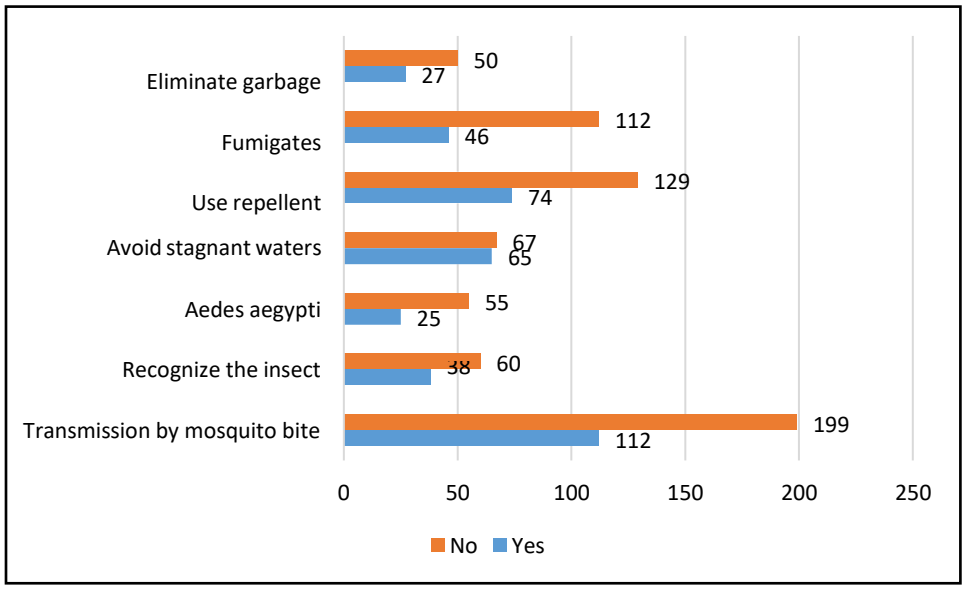


Fig. 6. Community knowledge, attitudes and practices for prevention dengue.

In Figure 6 it can be seen that most of the respondents expressed their ignorance about the relationship between dengue and community knowledge, attitudes and practices for the prevention of dengue virus infection. Regarding the transmission of infection by mosquito bite, 199 (90%) were unaware of such transmission. Of 98 respondents about the mosquito and 98 about its recognition, only 38 and 25 respectively stated that they knew the organism. The results also show that 129 do not use the mosquito repellent and only 74 do.

The communities have shown signs of not knowing the causal agent of Dengue, they are also unaware of the larvae and are unaware that said larvae will become a mosquito; This ignorance means that citizens do not make an effort to eliminate possible mosquito breeding sites because they are unaware of them, nor do they take preventive measures, thus increasing the risk factors for contracting the infection. [9].

Knowledge of Dengue Symptoms

It is very important to know the symptoms that accompany a Dengue infection

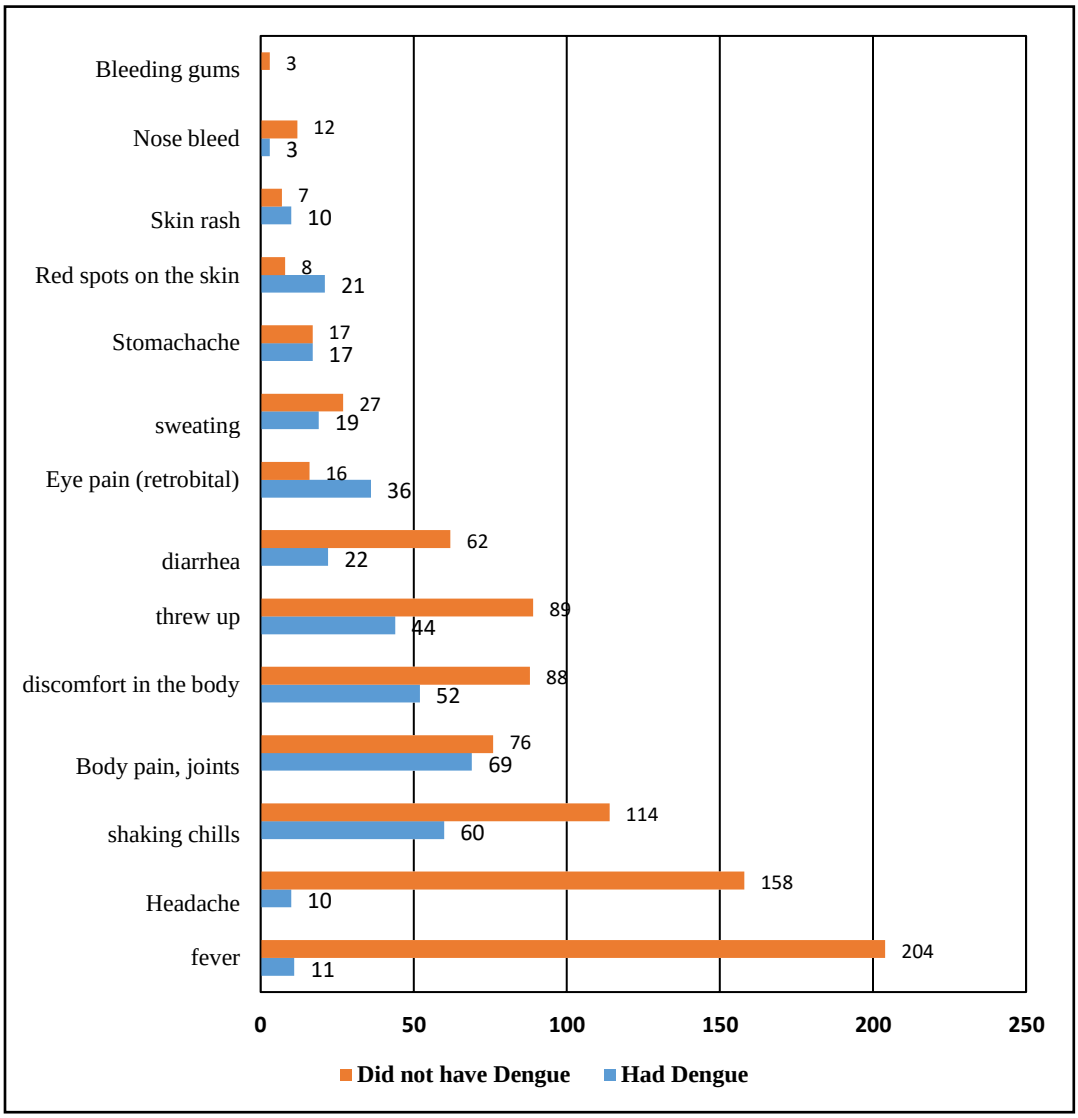


Fig. 7. Dengue symptoms

The results shown in Figure 7 indicate that fever, headache, and chills are the symptoms that responders most associated with the manifestation of a dengue infection, mainly in people who have not had the disease. The recognition of the rest of the symptoms was indicated to a lesser extent.

Recognizing the symptoms of dengue infection is very important. because the identification of the symptoms allows to recognize the infection and thus to apply the necessary measures immediately and to take the precautions to avoid the contamination of the others; besides the recognition of the symptoms also gives the signals about the level for the training; and thus, achieve a prompt and adequate application of preventive measures such as fumigation and risk reduction. [24]

**Campaign**

In Ecuador, among the diseases transmitted by vectors, dengue is one for which the elimination of the transmitter has been quite difficult, which has made it a priority problem in public health due to the large number of cases that occur each ye

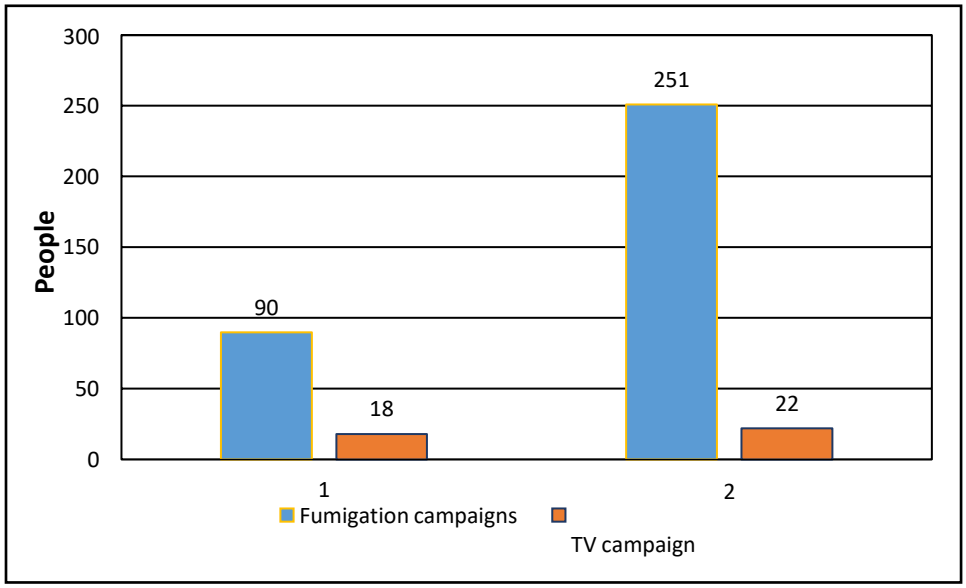


Fig. 8. Campaigns

As can be seen in Figure 8, most of the respondents affirmed the occurrence of fumigation campaigns as a prevention of dengue virus infection. Those who received a fumigation campaign had fewer patients with dengue (90) than without being affected by the infection (251). The number of respondents who received a TV campaign were 40 interviewees of which 18 contracted the disease.

The prevention of diseases such as dengue that have a transmitting agent that is part of the ecosystem, requires the application of permanent measures that control the life cycle of the transmitting agent; for them it is essential to take into account local experts and develop strategies that prevent, control and eradicate the presence of viruses such as DENV. Hence the need to train citizens on infectious diseases such as dengue and give them enough information about the risks of contracting the infection, it is necessary to know the life cycle of the transmitting insect, among others, to be able to exercise true control and efficient prevention; Thus, each citizen can be responsible for the periodic inspection and elimination of infection risks in his home and the surroundings that facilitate the management and control of public health problems such as dengue.

Summary of the data of the investigated provinces

In Table 1 you can see the information on the factors that can influence the spread of Dengue disease collected in the neighborhoods of the provinces of Imbabura, Carchi, Sucumbíos and Esmeralda.

Table 1. Data of the investigated provinces

| VARIABLE | Imbabura | Sucumbios | Esmeraldas | Carchi |
|---|---|---|---|---|
| Dengue awareness | 60% | 80% | 65% | 19% |
| Control campaigns | 93% | N/A | N/A | 52% |
| Home visities | 83% | 54% | 55% | 20% |
| Community campaigns | 16% | 13 | 54 | 40% |
| Television campaigns | N/A | 34% | 10% | N/A |
| Radio campaigns | N/A | 29% | 10 | N/A |
| Campaigns in the press, posters or billboards | N/A | N/A | 4% | 20% |
| Recognize the infection vector | 25 | 26% | 33 | 30% |
| Recognize mosquito bite infection | 75 | 91% | 90% | 80 |
| Know the name of the infection agent | N/A | 20% | 29% | 11% |
| Have or have had dengue | N/A | 50% | 10% | 19% |
| Avoid stagnant waters | 50 | 52% | 84% | 5% |
| Wash basins of water | 0 | 22% | 23% | 5% |
| Use of tent | 37 | 32% | N/A | 17% |
| Daily cleaning | 93 | N/A | N/A | N/A |
| Garbage collection | N/A | 18% | 24% | 21% |
| Fumigate | 50 | 55% | 67% | 64% |
| Existence of buckets and jars of water | N/A | 56% | 4% | 42% |
| Existence of water tanks | N/A | 58% | N/A | N/A |
| Existence of plastic cups | N/A | N/A | 72% | N/A |
| Existence of bottles | N/A | N/A | 73% | N/A |
| Existence of puddles | N/A | N/A | 42% | N/A |
| Existence of logs or pots | N/A | N/A | N/A | 31 |
| Existence of tires | N/A | N/A | N/A | 36 |
| Existence of manual laundry platform | N/A | 54 | N/A | N/A |
| Irregular water supply | N/A | 40 | 93 | N/A |
| Well water for human consumption | N/A | N/A | N/A | 73 |
| Bathroom with septic tank | N/A | N/A | N/A | 78 |
| Fever | 90 | 62 | 90 | 94 |
| Headache | 72 | N/A | 20 | 90 |
| Body aches | 54 | 62 | 20 | N/A |
| Rashes | 27 | N/A | N/A | N/A |
| Body discomfort | 27 | 52 | N/A | N/A |
| Shaking chills | N/A | N/A | 20 | 52 |
| Threw up | N/A | N/A | 20 | N/A |
| Stomach ache | 27 | N/A | N/A | N/A |
| Discomfort in the eyes | 27 | N/A | N/A | N/A |
| Bleeding | 0 | N/A | N/A | N/A |
| Sweating | 0 | N/A | N/A | N/A |

N / A: There was no response

## 4. Conclusions

The results obtained allow to conclude that;

In the neighborhoods where this research was carried out, the people surveyed have declared the high incidence of cases of dengue virus infection, these cases have been registered by local health authorities.

The knowledge of the inhabitants about dengue is scarce, mistakes are made when trying to adopt measures to reduce the risk of infection, which, in many cases, has favored the spread of the disease. The interviewed population showed at all times a willingness to receive training on dengue infection, control and sanitation, which provides a permanent opportunity to develop strategic dengue control and prevention measures.

The increase in dengue serotypes, the increase in population density, the increase in poverty, the problems of public services, the scarcity of medical services, and population mobility have increased the cases of dengue in the investigated regions. These factors have influenced the permanence of the disease throughout the year.

The incidence of dengue in the investigated neighborhoods has been maintained due to socioeconomic, climatic and ecological factors, the storage of water for long periods of time in poorly covered or uncovered containers, buckets, jars, gallons, where they collect rainwater that facilitate the increase in the population density of vector mosquitoes.

Also contributing to the increase in the disease is the lack of protective screens on windows and doors and the failure to use mosquito nets, the absence or deterioration of which facilitate the entry of mosquitoes into homes.

Knowledge of dengue distribution, environmental and climatological variables, as well as its socioeconomic and cultural characteristics are essential for understanding its ecoepidemiology, recognition of risk areas, prediction of outbreaks, planning of interventions, implementation of control strategies, and prevention, resource allocation, personnel.

This research allowed to know the state of the art of the disease of the spread of Dengue, providing important information that facilitates the determination of the recommendations for the prevention and control of the disease, the adequacy of the clinical and epidemiological surveillance, predetermination of the training of the personnel , planning and execution of education campaigns; promote hygiene practices and increase community awareness and capacity for action; according to different social and cultural factors in each region.

Temperature, altitude and the human poverty index (HPI) were the most relevant variables to explain the incidence of D / DH, while temperature was the most significant in the multiple analyzes.

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