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Epidemiological overview of dengue

by Alfonso Vallejos-Paras

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Dengue prevention: a vector-focused strategy

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During the 20th century, significant technological advances occurred, which had a major impact on human demographic development. Never had the population changed so rapidly and radically in its behavior. There were massive migrations of capital, resources, and people, leading to rampant urbanization.

All of this has had various repercussions, some of which have become problems affecting humanity. One example is the ease with which diseases spread, through the introduction of new biological species, either intentionally or unintentionally. Considering that this type of phenomenon has always existed but now occurs on a much larger scale in terms of time and space, it should not be surprising that a virus can, at any time, get out of control worldwide. Obviously, many factors that cause this situation are still unknown, which makes it unpredictable when and where a pandemic will emerge, thus hindering the implementation of effective preventive measures. However, in other types of diseases, this uncertainty is related to the knowledge of another factor in the transmission chain, such as vector-borne diseases. In this case, the most important factor will be controlling the vector. Therefore, the Aedes mosquito is of utmost importance for controlling diseases such as dengue, chikungunya, and yellow fever, especially in urban areas.

Despite the recognition by international health organizations, such as the World Health Organization, of the importance of eliminating the Aedes mosquito since the mid-20th century, sustained efforts to eradicate it have not been made. On the contrary, there has been a constant increase in cases of diseases like dengue worldwide, especially in the last two decades. Furthermore, other diseases such as chikungunya and Zika have appeared in countries where they had not been previously recorded, and yellow fever remains latent in the Amazon.

Therefore, it is necessary to reconsider the factors that have caused preventive measures for controlling the Aedes mosquito to be ineffective. These factors

can be listed as follows: 1) Greater importance has been given to treating diseases than to preventive measures, as a consequence of a persistent curative paradigm. 2) The elimination of the mosquito has become solely the responsibility of the vector control departments under the authority of the ministries of health. This has resulted in a lack of shared social responsibility, which the vector has exploited effectively. It is worth remembering that Aedes aegypti is a completely domestic species, and this is probably the key factor in its success as a species. Therefore, it is necessary for humans to act as predators, since otherwise, there will be no competition in the domestic environment to limit its growth. Now, how can we transform two species into enemies? Undoubtedly, the answer for humans lies in education. However, here, education must be understood as a basic process of socialization, from which we expect behaviors that promote the elimination of the vector. This has probably already been understood by those responsible for vector-borne disease control at the WHO, as well as the ministries of health in each country, as evidenced by the efforts to create educational materials and the recommendations in dengue control operational plans, which include education as a strategy. Unfortunately, when it comes to implementing these educational plans, they often end up being merely informational or are not implemented at all. The reasons are varied, ranging from a lack of human resources to the perception that they are unnecessary because control of insecticides is already being carried out. This usually ends up being a mistake because, within 5 or 10 years, the situation returns to square one with a dengue outbreak, and the informational and educational process begins again, without achieving any long-term impact.

Due to these reasons, it is necessary to rethink educational techniques for controlling the Aedes mosquito to make them more effective and achieve their objective. Within this context, an educational strategy should be developed that fosters community participation, and which should be an economic and safe option for eradicating the Aedes mosquito.

To achieve this goal, various forms of information should be used, as well as educational games that reinforce the most effective actions to combat the vector. An important component should be self-evaluation, such as a reporting platform for Aedes mosquito sightings, which would encourage greater participation.

Although the strategy would be directed at schools, universities, businesses, churches, etc., individuals can also participate by joining special groups focused on vector control; in fact, the participation of the entire population is essential.

This method should not, in any way, be intended to replace the activities carried out by health ministries, but rather to serve as a complement to a common goal: the elimination of the Aedes mosquito.

It is necessary to reevaluate the current approaches to combat dengue, chikungunya, and other vector-borne diseases, and to focus more on eradicating the vector itself. Community participation will undoubtedly be very helpful, but it is important to have a multi-pronged approach against the vector, which opens the possibility of conducting more research on safe mosquito control devices for use in environments where human intervention is not possible, especially for Aedes albopictus. It will also be essential to continue exploring various teaching methods that can influence public behavior.

Finally, we must look to the future, where we can make decisions about the existence of certain species, which must be done with the utmost objectivity, since any mistake could also affect us, and ultimately, what we seek is the survival of the human species.

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Clinical overview and epidemiological factors of dengue

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Abstract

Introduction: Dengue is a vector-borne viral disease transmitted through the bite of female Aedes albopictus and Aedes aegypti mosquitoes. It is an RNA virus belonging to the Flaviviridae family and the Flavivirus genus and is considered the most important and prevalent arboviral disease due to its significant epidemiological impact.

Objective: The aim of this study is to understand the clinical picture and epidemiological factors of patients hospitalized with a diagnosis of dengue fever during the outbreak in Ciudad Obregón, Sonora, Mexico.

Materials and methods: This was an observational, descriptive, retrospective, single-center study conducted at the General Regional Hospital No. 1 of the Mexican Institute of Social Security in Ciudad Obregón, from September 2022 to February 2023. The findings were described using descriptive statistics, and an analysis of association was performed using odds ratios and 95% confidence intervals.

Results: A total of 218 patients were included in the study: 12 with severe dengue fever (6 of whom died), and 206 with dengue fever with warning signs. Of these, 85 were female and 133 male, with a mean age of 33.73 years. 135 patients were from urban areas and 84 from suburban areas. The most common clinical manifestations were fever (218 patients, 100%), headache (214 patients, 98%), myalgia (208 patients, 95%), arthralgia (199 patients, 91%), retro-orbital pain (139 patients, 64%),). All patients tested positive for dengue virus serotype DENV-2.

Conclusions: The study of clinical and epidemiological factors allowed us to identify the behavior of the disease within our beneficiary population during the 2022 dengue outbreak. These findings reveal the main demographic characteristics and clinical presentation of the disease, particularly in severe cases.

Keywords: Dengue, clinical characteristics, epidemiological factors, outbreak, hospitalization.

INTRODUCTION

Dengue is an important vector-borne disease, acquired through the bite of female Aedes albopictus and Aedes aegypti mosquitoes, which need to feed on human blood to lay their eggs; the latter being the primary vector worldwide and in our country.1 The dengue virus (DENV) is an RNA virus, belonging to the Flaviviridae family and the Flavivirus genus. It is considered one of the most important and prevalent arboviruses, with four identified serotypes (DENV 1-4).2 The World Health Organization has classified dengue fever according to its clinical presentation, allowing for stratification and targeted care, focusing on the signs and symptoms that indicate warning signs, thus facilitating timely hospitalization for close monitoring. The current classification remains that defined in 2009, which divides dengue into Dengue without warning signs, Dengue with warning signs, and Severe Dengue. The course of the disease has three clinical stages: febrile, critical, and recovery. In the febrile phase, the patient presents with fever lasting 2-7 days, associated with general malaise, headache, retro-orbital pain, rash, anorexia, nausea, vomiting, and generalized myalgia and arthralgia. Neutropenia, leukopenia, and lymphocytosis are common in the complete blood count; in the critical phase, the fever subsides, and leukopenia and thrombocytopenia worsen, along with increased capillary permeability, leading to plasma leakage and a proportional increase in hematocrit. Uncorrected shock, along with thrombocytopenia, can lead to disseminated intravascular coagulation and massive hemorrhage, increasing mortality. 3.

To conduct epidemiological surveillance of dengue infection in Mexico, the General Directorate of Epidemiology has adopted a classification system for dengue disease, categorizing it as Non-Severe Dengue, Dengue with Warning Signs, and Severe Dengue. The latter two categories require priority referral to hospital care. 4

For the confirmatory diagnosis of dengue, specific laboratory tests are available. The first is nucleic acid amplification using quantitative reverse transcriptase polymerase chain reaction (RT-qPCR). This test is performed within the first 5 days after symptom onset using a blood serum sample. During this same period, the NS1 non-structural protein antigen can also be detected. After the fifth day of symptom onset, following the host's immune response, antibody production begins, with IgM immunoglobulin being used in this stage for the confirmatory diagnosis of dengue. 3,4,5

Among the epidemiological factors identified in countries where dengue is a public health problem is that the most affected age group is adolescents and young adults, people who perform outdoor work or occupational activities, and those who live in areas without public drainage systems or regular garbage collection. 7

The presence of the disease in almost all continents worldwide is linked to the expansion, proliferation, and spread of the vector, population growth, and unplanned urbanization. The countries most vulnerable to dengue outbreaks or re-emergences are those that lack efficient implementation of programs to control vector proliferation, do not guarantee a continuous water supply, lack community involvement in waste management, and have weak political commitment.1 Dengue fever is a disease present worldwide; Southeast Asia and the Western Pacific are hyperendemic areas, according to Verma (2023). His study indicates that approximately 75% of all dengue cases worldwide originate in these regions. India is considered the epicenter of dengue, contributing approximately 34% of all cases.9

Regarding the Americas, according to the latest epidemiological situation bulletin on arboviral diseases, by epidemiological week 40 of 2022, 2,781,316 cases of arboviral diseases had been reported, of which 89.9% were dengue cases. According to data from the Pan American Health Organization, there was intense transmission of the dengue virus during 2022, likely due to the fact that, following the COVID-19 pandemic and related social activity restrictions in the previous year, there was a 165% increase in dengue virus transmission. In Mexico, up to epidemiological week 40, 36,926 cases were reported, representing 1.5% of all cases in the Americas. 13

The presence of dengue infections and outbreaks is not new; it has been circulating in our country since the 1970s. Since then, the DENV-2 serotype was identified, followed by DENV-4 and DENV-2 in the 1990s, as shown in the study by Hernández et al. (2020), which investigated the implications of dengue serotype diversity in Mexico. 11

In Mexico, dengue is the most common arboviral disease. Prior to the COVID-19 pandemic, in 2019, Mexico experienced a dengue outbreak, with more than 41,000 cases, a 226% increase compared to previous years. There was a decrease in cases in subsequent years, likely due to the COVID-19 pandemic in 2020, as mentioned in the study by Fonseca et al. (2020), which examined risk factors for hospitalization and mortality due to dengue in the Mexican population. 12

Currently, dengue fever has become an important public health problem, persisting and increasing in several countries worldwide. Among the factors that have perpetuated its presence are demographic, social, and biological aspects. The objective of this study is to understand the clinical picture and epidemiological factors of patients hospitalized with a diagnosis of dengue fever during the dengue outbreak at General Regional Hospital No. 1 in Ciudad Obregón.

MATERIALS AND METHODS

An observational, descriptive study was conducted using hospital records for confirmed dengue cases generated by the epidemiological surveillance unit of the General Regional Hospital No. 1 in Ciudad Obregón, Sonora, obtained from the SINAVE platform, during the period from September 2022 to February 2023. Inclusion criteria were patient records of any age and gender, included in the SINAVE platform and reported by the unit with a confirmed diagnosis of dengue, during the dengue outbreak in the municipality of Cajeme, from September 1, 2022, to February 28, 2023. Records in the SINAVE platform were incomplete, those related to outpatient care, or those lacking confirmatory test results from laboratories accredited by InDRE were excluded. Data on clinical and epidemiological factors of dengue were collected, including age, sex, municipality of residence, town/village of residence, neighborhood, occupation, hospitalization, initial diagnosis, comorbidities, pregnancy, number of days from symptom onset to presentation, warning signs, fever, headache, myalgia, arthralgia, retro-orbital pain, nausea, vomiting, rash/petechiae, fluid accumulation, severe abdominal pain, mucosal bleeding, gingival bleeding, epistaxis, decreased platelet count, elevated liver enzymes, signs of shock, date of laboratory sample collection, RT-PCR Triplex, ELISA IgM, discharge to home or transfer, and discharge due to death. Qualitative variables were summarized using absolute and relative frequencies and percentages; quantitative variables were summarized using measures of central tendency (mean, median, mode) and measures of dispersion (range, standard deviation, and variance). The data were entered into SPSS version 2.0. Bivariate analysis was performed using the Chi-square test for categorical variables and the student's t-test or Mann-Whitney U test for parametric variables. Additionally, a bivariate analysis was performed according to the type of variable. The odds ratio, or prevalence ratio, was used as a measure of risk, with a 95% confidence interval considered valid, and a p-value of <0.05 was considered statistically significant. This research study complied with the ethical guidelines and general principles established in the

Regulations of the General Health Law regarding health research (published in the Official Gazette of the Federation on February 7, 1984) and was approved by the local health research ethics committee; furthermore, it posed no risk to the participants.

RESULTS

From the data obtained, 12 cases were identified as severe dengue and 206 as dengue with warning signs, with a ratio of 1:17. Of the total cases, 6 deaths were recorded, all of which were classified as severe dengue. The epidemiological characteristics of the cases included demographic aspects, such as gender: 85 (38.9%) were male and 133 (61%) were female. (Table 1) The average age of the cases was 33.73 years, with a minimum of 2 years and a maximum of 89 years, and a standard deviation of ±19.35 years. (Table 2) Regarding the location of the patients, the distribution between urban and suburban areas was analyzed. The results showed that 135 patients came from urban areas, specifically Ciudad Obregón (114, 85%), Navojoa (12, 9%), Huatabampo (8, 6%), and Mexicali (1, 0.7%). The remaining 84 patients came from suburban areas, mainly San Ignacio Rio Muerto (8, 9.5%), Villa Juárez (8, 9.5%), and Etchojoa (4, 4.8%). (Table 1.1) The distribution of patients by municipality of residence showed that 128 (58.7%) resided in Cajeme, 31 (31%) in Navojoa, 13 (6%) in Etchojoa, 13 (6%) in Huatabampo, 11 (5%) in Benito Juárez, 8 (3.7%) in San Ignacio Rio Muerto, 6 (2.8%) in Bacum, 4 (1.8%) in Rosario Tesopaco, 2 (0.9%) in Guaymas, 1 (0.5%) in Álamos, and 1 (0.5%) in Mexicali. According to the occupational distribution of the patients, 62 (28.4%) were students, 60 (27.5%) were homemakers, 54 (24.8%) were employed, 12 (5.5%) were retired/pensioners, 6 (2.8%) were engaged in agricultural, forestry, hunting, and fishing activities, and 5 (2.3%) had other occupations. (Table 1). Regarding the clinical presentation of the studied cases, 218 (100%) had fever, 214 (98%) had headache, 208 (95%) had myalgia, 199 (91%) had arthralgia, 139 (64%) had retro-orbital pain, 136 (62%) had nausea, 109 (50%) had vomiting, 26 (12%) had rash, 39 (18%) had petechiae, 2 (1%) had fluid accumulation, 51 (23%) had severe abdominal pain, 24 (11%) had mucosal bleeding, 44 (20%) had gingival bleeding, 38 (17%) had epistaxis, 192 (88%) had decreased platelet count, 3 (1.4%) had elevated AST or ALT levels, and 12 (5%) had signs of shock. (Table 2). Among the patients' comorbidities, 16 (7.3%) had systemic arterial hypertension, 12 (5.5%) had type II diabetes mellitus, 2 (0.9%) had chronic kidney disease, 14 (6.4%) had other diseases, no patient had immunosuppression, and 174 (79.8%) had no comorbidities.

Table 1. General Characteristics of the Population

Variables	n	%
Gender		
Male	85	39%
Female	133	61%
Occupation		
Students	62	28%
Housework/Homemaker	60	28%
Employees	54	25%
Retired/Pensioner	12	6%
Workers in agricultural, forestry, hunting, and fishing activities	6	3%
Other	5	2%
Retail workers, salespersons, and sales agents	4	2%
Unemployed	4	2%
Tradespeople (carpenter, plumber, mail carrier, electrician, mechanic)	3	1%
Manual laborers	2	1%
Other healthcare workers	2	1%
Nurses	1	1%
Managers or business owners	1	1%
Place of Residence		
Urban	135	62%
Suburban	84	39%
Final Diagnosis		
Dengue with warning signs	206	95%
Severe dengue	12	6%
Laboratory Tests		
PCR	162	74%
IgM	54	25%
NS1	2	1%
Pregnancy		
No	186	85%
Yes	32	15%
Comorbidity		
Hypertension	16	7%
Other	14	6%
Diabetes mellitus	12	6%
Chronic kidney disease	2	1%
Immunosuppression	0	0%
None	174	80%
Discharge Status		
Discharged to home or transferred	212	97%
Died	6	3%

Nominal scale data are presented as frequencies and percentages. Research protocol conducted in 2023, Ciudad Obregón, Sonora

Among other significant conditions in the patients, one patient had bone marrow aplasia, one had rheumatoid arthritis, one had asthma, one had epilepsy, one had fibromyalgia, one had hypothyroidism, one had lupus and antiphospholipid syndrome, one had severe preeclampsia at 30 weeks of gestation (resulting in maternal death), and two were in the postpartum period. During the study, 32 (14.7%) pregnant women were identified. Regarding discharge status, 212 (97.2%) were discharged in stable condition to their homes or transferred to another medical facility, while 6 (2.8%) died. In the analysis of cases according to the confirmatory test for classification, 162 (74.3%) underwent real-time PCR, 54 (24.8%) had IgM antibody testing, and 2 (0.9%) had NS1 antigen detection. The serotype identified in 100% of the cases was Serotype 2. The time elapsed from the onset of dengue symptoms (based on the operational definition of a suspected dengue case) to the onset of warning signs that led to hospitalization was studied, finding a mean of 3.9 days, a median of 4 days, a standard deviation of 1.8, a minimum of 0 days, and a maximum of 10 days (Table 3). A bivariate analysis was performed to examine the risk relationship between pregnancy and the dengue diagnosis, finding a risk of 1.892 for severe dengue, 95% CI (0.253–14.159) with a p-value of 0.523. The fatality rate for dengue fever was calculated according to its classification, and it was found that there were no deaths among patients with dengue fever with warning signs, while there were 6 deaths among patients with severe dengue, resulting in a fatality rate of 2.8%.

Table 2. Clinical manifestations

Variable	n	%
Fever	218	100.00%
Headache	214	97.70%
Myalgia	208	95.40%
Arthralgia	199	91.30%
Decreased platelet count	192	88.10%
Retro-orbital pain	139	63.80%
Nausea	136	62.40%
Vomiting	109	50.00%
Severe abdominal pain	51	23.40%
Gingival bleeding	44	20.20%
Petechiae	39	17.90%
Epistaxis	38	17.40%
Rash	26	11.90%
Mucosal bleeding	24	11.00%
Elevated AST or ALT	3	1.40%
Fluid accumulation	2	0.90%
Shock	2	0.90%

The nominal scale data is presented in frequencies and percentages. Research protocol conducted in 2023, Ciudad Obregón, Sonora.

Table 3. Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Standard deviation
Age	218	2	89	33.7	19.351
Number of days elapsed from the onset of symptoms to the onset of warning signs	218	0	10	3.96	1.82

Quantitative data are presented as mean and standard deviation (SD), along with the minimum and maximum values. Source: Research protocol conducted in 2023, Ciudad Obregón, Sonora.

DISCUSSION.

This study found that the main epidemiological factors of patients hospitalized during the dengue outbreak at Regional General Hospital No. 1 were a predominance of females (61%), an average age of 33.73 years, with students being the most common occupation (28.4%), followed by domestic workers (27.5%) and other employees (24.8%). Most patients were from urban areas (61.9%). There were 6 deaths from severe dengue, resulting in a fatality rate of 2.8%.

The behavior of dengue disease has been changing over the past 60 years, as human populations have evolved, and so have infectious diseases, since dengue is closely linked to social and demographic changes, such as disproportionate population growth, increased population movement, urbanization, and inadequate public health infrastructure to control the spread of the vector, as argued by Varsha et al (2021). 19

According to Durand et al (2022), in their study measuring the frequency of severe dengue cases during an epidemic in Peru, they found that the average age was 23.8 years, males were predominant, and there were no deaths during the study. 20 Meanwhile, in India, Abhijit et al. found in their study that dengue cases were more prevalent in suburban areas due to patients' exposure to agricultural activities, as well as a higher incidence among males than females. 6

Sahidur et al. (2021) identified no significant differences between age, gender, or location of the cases. Carhuamaca et al (2021), in their dengue prevention study, found no association between age, sex, marital status, or employment status and dengue prevention. 8

Fonseca et al (2021) found that among the comorbidities with the highest risk of hospitalization were cirrhosis (OR: 8.8), renal failure (OR: 6.6), immunosuppression (OR: 5.6), diabetes (OR: 4.6), and hypertension (OR: 3.1), while those associated with a higher risk of mortality were renal failure (OR: 11.4), diabetes (OR: 3.1), and hypertension (OR: 2.4). Pregnancy was associated with both, with an OR of 7.6 for hospitalization and an OR of 6 for mortality. In this study, 79.8% of the population had no comorbidities; the most frequent comorbidity was hypertension (7.3%), which is reflected in the 1:17 ratio of severe dengue cases to dengue with warning signs. 12

Villamil et al (2022) described that dengue resolves within a week, with complications such as shock or bleeding occurring between days 3 and 5 after the onset of fever. 21 On the other hand, in India, it was found that patients with confirmed dengue presented to the hospital on average 4 days after the onset of symptoms (Prasad 2022). 6 This study analyzed the time elapsed from the onset of symptoms to the appearance of warning signs, with an average of 3.96 days, coinciding with the time when patients seek hospital care.

Regarding the clinical picture of dengue, Echeverria et al (2022) found that the most frequent warning sign was pleural effusion, and for severe dengue, it was shock, with a mortality rate of 2%. No associated factors were found. They confirmed that vital signs were early indicators for detecting severe forms of dengue, and that 75% of all patients had a decrease in platelets. 22

In this study, a decrease in platelets was also predominant, occurring in 88% of patients, followed by severe abdominal pain and gingival bleeding, which were the most frequent warning signs. As Prasad et al. (2022) mention, all patients showed thrombocytopenia, which they consider an important laboratory parameter for establishing a clinical diagnosis of dengue. 6

In a cohort study conducted in Brazil, the association between severe dengue and pregnancy-related maternal deaths was analyzed from 2007 to 2012. The study found that dengue during pregnancy tripled the risk of maternal death (0.1% 95% CI [1.3-5.8]), and that severe dengue increased the risk of maternal death 450 times (95% CI [186.9-1088.4]). Preeclampsia was the cause of death in 25% of the patients with dengue. The mechanism by which severe dengue is associated with increased maternal mortality is not yet fully understood. However, a possible etiology is the inflammatory process that could affect placental tissue and cause further hemodynamic alterations, in addition to those already present during pregnancy, according to Mulik et al (2021). 19 In this study, one case of maternal death was identified in a woman with a diagnosis of severe dengue at 30 weeks of gestation. She did not

develop preeclampsia, but had a pre-existing comorbidity of chronic nephropathy. The analysis showed a risk ratio of 1.89 (95% CI [0.253-14.159], p=0.523) for pregnancy and severe dengue, compared to women with dengue with warning signs, although this was not statistically significant. Durand et al (2022), when comparing the behavior of the detected serotypes, found that, according to previous outbreaks, the DENV-2 serotype has the capacity to produce severe cases, with approximately one-third of cases requiring hospitalization. 20 The co-circulation of more than one DENV serotype is one of the most important risk factors for the occurrence of severe cases in the population (Mulik, 2021). 19

The prevalence of dengue and the development of outbreaks in different regions depends on various factors such as climate change, weather events, and local infrastructure. In Veracruz, Mexico, cases of severe dengue fever increased following Hurricane Dean in 2007, Hurricane Ida in 2009, and Hurricane Ernesto in 2012, according to Hernández et al (2020). 11

Del Carpio et al. identified that in Veracruz, since 2014, there has been an increase in dengue cases with the DENV-3 serotype, and in 2020, cases with atypical clinical presentations were observed, with patients presenting fever, arthralgia, headache, rash, respiratory symptoms, and liver damage. This serotype has been associated with severe dengue fever.

Currently, the country is experiencing a historically high number of dengue cases. In 2023, 42,203 cases have been confirmed, compared to 9,745 in 2022; 88 deaths have been confirmed, and 67% of the confirmed cases are from the states of Yucatán, Veracruz, Quintana Roo, Morelos, and Puebla. The increase in cases began at the end of 2022 in Quintana Roo and has now spread to the entire peninsula and southern Mexico. All four serotypes are circulating in most of these states, with the DENV-3 serotype predominating at up to 98% in Campeche, 95% in Yucatán, and 93% in Quintana Roo, which could be related to the high number of severe cases and deaths recorded.

According to official data from the General Directorate of Epidemiology, during the dengue outbreak in Sonora in 2022, the circulating serotypes were DENV-1, DENV-2, and DENV-3, with DENV-2 being the predominant serotype at 90%. In the southern part of the state, where the dengue cases began, this serotype was the most frequently identified, which could explain the 2.8% fatality rate of severe dengue cases. 23

Further research into the behavior of dengue fever is necessary, given its nature as a vector-borne disease that is highly adaptable to climate change and urban environments. The potential for a new outbreak remains a latent risk.

The limitations encountered in developing the clinical profile and identifying epidemiological factors were that only hospitalized patients were included, and the characteristics of cases that were treated on an outpatient basis are unknown. This is due to the type of patient population primarily served by the hospital. Future applications could include expanding the scope of research to other healthcare facilities, integrating facilities at all levels to better understand the disease's behavior in all its manifestations.

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Level of knowledge and risk perception of living with the Aedes aegypti mosquito

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Abstract

Introduction: The Aedes aegypti mosquito is currently experiencing a rapid expansion of its geographic range. It is considered the most important vector of disease worldwide due to its ability to transmit four different viruses: dengue, chikungunya, Zika, and yellow fever. This mosquito has been extensively studied; however, this information is not widely available to the public. Therefore, it is essential to understand what information the public already has about this mosquito to develop effective communication strategies.

Objective: To determine the level of knowledge and risk perception regarding coexistence with the Aedes aegypti mosquito among the population served by Family Health Center No. 1 in Ciudad Obregón, Sonora.

Materials and methods: This is a cross-sectional, observational, descriptive, prospective study. A survey instrument consisting of multiple-choice questions will be administered to a randomly selected group of patients from Health Center 1. The responses will be evaluated and assigned a weighted score. The results will be analyzed using statistical software.

Results: A total of 300 people were surveyed. 91.6% had a low level of knowledge (no knowledge at all) about the Aedes aegypti mosquito, while the remaining 8.4% had a moderate level of knowledge (some knowledge). The average score was 47 (SD 8.4). Regarding perceptions of the risk posed by different stages of the mosquito's life cycle, the adult stage was considered very dangerous by 152 people, while the larval stage was considered very dangerous by 11 people.

Conclusions: There is a low level of knowledge about the Aedes aegypti mosquito, which has a significant impact on public health. Effective educational strategies targeting the entire population are needed to reduce the incidence of diseases transmitted by this mosquito.

Keywords: Aedes aegypti, vector, dengue, chikungunya, Zika.

INTRODUCTION

The incidence of diseases transmitted by the Aedes aegypti mosquito has been increasing in recent years. Due to climate change, its distribution has also changed. Currently, it is found not only in tropical or subtropical cities, but also in temperate areas at higher altitudes. In the last two years, there have been outbreaks of chikungunya and Zika, which, together with dengue fever, have significantly increased the morbidity of the Mexican population. Although these diseases have a low mortality rate, they generate high costs due to treatment and the functional impairment they can cause. The remarkable adaptability of the Aedes aegypti mosquito has allowed it to survive even in extreme temperatures. It has adapted so well to urban life that it resides comfortably inside houses, feeding and reproducing. In addition, we believe there is a lack of knowledge about the Aedes aegypti mosquito among the general population. Its elimination can be easy, however, the general population seems unaware of this. Therefore, it is necessary to assess the level of knowledge people have about the Aedes aegypti mosquito, in order to subsequently design educational strategies that address this knowledge gap. This would have a positive outcome: reducing cases of diseases transmitted by this mosquito (dengue, chikungunya, Zika, yellow fever). During the 2009-2010 school year, a study was conducted in 19 public schools in Tapachula, Chiapas, with the objective of identifying knowledge, attitudes, and practices regarding dengue fever before and after an educational intervention. The study concluded that, through the implementation of an educational strategy, children's knowledge, attitudes, and practices regarding self-care in their schools increased, and that they can act as promoters of positive attitude change regarding this disease within their homes. In 2010-2011, the Mexican Ministry of Health conducted a perception survey on dengue fever among the general population and schoolchildren in Mexico. Fourteen states of the Mexican Republic were selected, including the 66 priority municipalities with the highest dengue fever incidence. 94% of the general population knows what dengue fever is, and between 80% and 84% know that the vector is found in stagnant water and how to prevent the disease. 21

Environmental control strategies are based on the elimination or destruction of breeding sites, such as tires, cans, flowerpots, and other containers. 24 These strategies have been very successful, but are difficult to maintain, mainly because they are labor-intensive and require community participation.

It is important that the population have the necessary knowledge about the Aedes aegypti mosquito to be able to contribute to its elimination. However, the dissemination of this information to the public must be planned appropriately, emphasizing the mosquito's life cycle and the places where it breeds, specifically informing people about what constitutes a breeding site.

Therefore, the first step is to assess the current level of knowledge that people have about the Aedes aegypti mosquito. Subsequently, the results must be analyzed to design educational strategies to disseminate information about the mosquito to the population, emphasizing any knowledge gaps identified in the study.

Currently, the prevention programs for diseases transmitted by the Aedes aegypti mosquito are outdated. The communication methods used by the Ministry of Health are no longer appealing to the public.

Therefore, it is important to understand what information people have about Aedes aegypti, in order to find appropriate strategies to disseminate the necessary knowledge to prevent further spread of the mosquito.

The objective of this study was to determine the level of knowledge and risk perception regarding coexistence with the Aedes aegypti mosquito among the population served by Health Unit No. 1 in Ciudad Obregón, Sonora.

MATERIALS AND METHODS

An observational, descriptive, cross-sectional study was conducted at Family Medicine Unit No. 1, belonging to the Mexican Institute of Social Security (IMSS), located in Ciudad Obregón, Sonora, from April 1 to May 30, 2016. Participants included individuals over 12 years of age, of both genders, who were beneficiaries of IMSS and registered with Family Medicine Unit No. 1. Individuals with visual or hearing impairments or those who could not read or write were excluded. Participants who did not complete the entire survey or who decided to withdraw from the study were also excluded. The sociodemographic characteristics of the surveyed population were identified: age, gender, educational level, place of origin, neighborhood of residence, occupation, history of dengue fever, and whether they had a family member with dengue fever. The data collection instrument consisted of six parts. The first part included 14 questions about the respondent's sociodemographic data. The subsequent parts addressed knowledge about dengue, with a total of 49 questions. The second part consisted of 17 multiple-choice questions, some with multiple correct answers. The third part consisted of only 2 fill-in-the-blank questions, where the correct answer was the word "breeding ground"

(singular or plural). The fourth part consisted of 10 questions where participants were shown cards with images of animals presented individually; for each card, they wrote the name of the animal shown. The fifth part consisted of 10 questions where participants were shown cards with images of places or objects presented individually; for each card, they indicated whether the image represented a breeding ground for the Aedes aegypti mosquito. Finally, the sixth section consisted of 10 multiple-choice questions. Participants were shown cards with images of different animals, one at a time, and for each image, they had to choose the word they considered most appropriate regarding their perception of the risk of living alongside that animal, that is, the danger it poses to people. Regarding the evaluation of the survey instrument, each correct answer was worth 1 point, except for the third section, which was a fill-in-the-blank question. For this question, the participant had to write either "breeding ground" or "breeding grounds" to receive credit. The sixth section assessed risk perception, evaluating how dangerous participants considered certain animals to be, with the aim of determining whether the Aedes aegypti mosquito, in its various developmental stages, was perceived as a risk. It is important to note that we define mosquitoes as a health hazard. Therefore, the questions that included images of the mosquito's different stages were worth 3 points only if the answer "very dangerous" was selected. After totaling the correct answers, the score was multiplied by 100 and divided by 49 (the maximum possible score), resulting in a weighted score, which was categorized as follows: >80 = High level of knowledge, 60–79 = Some knowledge, <59 = No knowledge.

The data collection instrument was validated by three experts: a medical epidemiologist, a nurse, and a psychologist. All three reviewed the questions and determined that the survey was appropriate and did not require modifications. Following approval, a pilot test was conducted with 10% of the intended sample size (35 people), using a group of fifth-year medical students from the University of Sonora, Cajeme campus. The survey was administered to this group. The data were then analyzed, and the internal consistency reliability was calculated using SPSS, yielding a Cronbach's Alpha coefficient of 0.785, indicating that the data collection instrument was acceptable. Descriptive analysis of the qualitative variables was performed using frequencies and percentages. Quantitative variables were analyzed using measures of central tendency (mean) and dispersion (standard deviation). A bivariate analysis was conducted, obtaining odds ratios as a measure of association, with 95% confidence intervals. A p-value <0.05 was considered statistically significant. Data analysis was performed using SPSS Statistics version 22 for Windows. The final results are presented in tables and graphs.

After obtaining approval from the Local Health Research Ethics Committee, researchers approached individuals randomly in the waiting areas of Family Medicine Unit No. 1, asking them if they would be willing to participate in a research study by completing a survey. The topic and objective of the study were explained. Upon agreeing to participate, participants were asked to sign an informed consent form, and the survey was then administered to each person in an interview format. Following the multiple-choice and short-answer questions, participants were shown images printed on cards to answer the final three sections. Each of these sections consisted of 10 questions, and participants selected the answer they considered correct for each image. Once the total number of surveys required, based on the sample size, was completed, the data was entered into a data collection form designed in Google Drive using an internet connection. After completion, the database was downloaded to Excel 2016 for Windows. Regarding the survey evaluation, each correct answer received one point; however, the section on perceived risk related to animals was worth 3 points. In total, there were 49 questions, for a maximum possible score of 100. The resulting score was then categorized using a weighted scale (>80 = Good knowledge, 60–79 = Some knowledge, <59 = No knowledge). Subsequently, a statistical analysis was performed using SPSS version 22 (Spanish version) for Windows. This research protocol complied with ethical principles according to the Regulations of the General Health Law on Health Research, specifically articles 13, 14, 20, 21, and 22 of Title II, Chapter I, regarding Ethical Aspects of Research on Human Subjects. "In any research involving human subjects, the principles of respect for their dignity and the protection of their rights and well-being must prevail." This research, according to Article 17 of the Regulations of the General Health Law on Research, was considered low-risk research: These are studies that use retrospective documentary research techniques and methods, and those in which no intentional intervention or modification of the physiological, psychological, or social variables of the participants is performed. Examples include questionnaires, interviews, and review of medical records, provided that no sensitive aspects of their behavior are identified or addressed.

RESULTS

Data were collected through structured interviews using a 49-item questionnaire, administered by a third-year epidemiology resident to a total of 300 people. Of these, 199 (66.3%) were women and 101 (33.7%) were men. The average age of the study population was 39 years (SD 13.2). Regarding educational level, 7 (2.3%) had incomplete primary education, 33 (11%) had completed primary school, 120 (40%) had completed secondary school, 95

(31.7%) had completed high school, 40 (13.3%) had a university degree, 4 (1.3%) had postgraduate studies, and only 1 (0.3%) had a master's degree. Regarding length of residence in Ciudad Obregón, 7 (2.3%) had lived there for < 1 year, 12 (4%) between 1 and 5 years, 10 (3.3%) between 6 and 10 years, 36 (12%) between 11 and 20 years, 75 (25%) between 21 and 30 years, and 135 (45%) for more than 30 years. 25 (8.3%) lived in locations other than Ciudad Obregón. They were asked if they had dengue fever; 57 (19%) said yes and 243 (81%) said no. Regarding preferred mass media, 51.7% (n=155) chose television, 18% (n=54) the internet, 16.3% (n=49) social media, 10% (n=30) radio, and only 4% (n=12) chose newspapers (Table 1). Respondents were asked what kind of animal Aedes aegypti is. 39% (n=115) knew it was a mosquito, 60% (n=181) did not know, and 1% (n=3) thought it was a flea. Regarding the diseases transmitted by the Aedes aegypti mosquito, 46.7% (n=140) mentioned dengue fever, 11.7% (n=35) mentioned Chikungunya, 5.7% (n=17) mentioned Zika, and only 10.7% (32) mentioned all three diseases (Yellow fever was not an option). They were also asked in what type of water Aedes aegypti mosquitoes breed; only 33% (n=100) knew it was in clean water, while the remaining 67% (n=200) did not know (mentioning mainly dirty water). Regarding the characteristics of the Aedes aegypti vector, only 27.7% (n=83) knew that the female transmits diseases, while 72.3% (n=217) did not know. Regarding the development time, 178 (59.3%) people said 3 days, 85 (28.3%) said 10 days, 22 (7.3%) said 20 days, and 15 (5%) said 30 days. Regarding the life cycle, 39% (n=117) knew only one stage, 25% (n=75) two stages, 9% (n=28) three stages, 1% (n=3) four stages, and 26% (n=77) did not know any stages (Figure 6). Regarding the life cycle stage at which it is easiest to eliminate the mosquito, 41% (n=123) mentioned the egg stage, 26% (n=78) the larval stage, 4.4% (n=13) the adult stage, 3.3% (n=10) mentioned both the larval and egg stages, only 1 (0.3%) person mentioned the pupal stage, and 26% (n=78) did not mention any of the mosquito's life stages. Regarding the distance a mosquito typically flies from its breeding site, 10% (n=29) mentioned 2000 meters, 27% (n=81) 1000 meters, 38% (n=116) 80 meters, and 25% (n=74) 800 meters.

Regarding the time of day when the Aedes aegypti mosquito bites, 1.7% (n=5) mentioned that it is at dawn, 24.3% (n=73) at dusk, 63% (n=189) throughout the day, 9% (n=27) only at night, and only 2% (n=6) mentioned the correct answer, which is both at dawn and dusk. Regarding the most effective measure to eliminate Aedes aegypti, 37 people (12%) mentioned fumigation, 75 people (25%) cleaning the yard, 96 people (32%) eliminating breeding sites, 25 people (9%) chose all options, and 67 people (22%) two or three options. No one chose the option "pruning trees" alone.

Table 1. General characteristics of the surveyed population.

Variable	Frequency
n = 300	
Age	39 (13.2)*
Age Group (years)	
12 – 19	14 (4.7)
20 – 29	75 (25)
30 – 39	67 (22.3)
40 – 49	75 (25)
50 – 59	43 (14.3)
60 – 69	23 (7.7)
>70	3 (1)
Gender	
Female	199 (66.3)
Male	101 (33.7)
Education Level	
Primary school	33 (11)
Incomplete primary school	7 (2.3)
Secondary school	120 (40)
High school	95 (31.7)
University degree	40 (13.3)
Postgraduate studies	4 (1.3)
Master's degree	1 (0.3)
Preferred communication	
Television	155 (51.7)
Radio	30 (10)
Internet	54 (18)
Social media	49 (16.3)
Newspaper	12 (4)
Length of residence in Cd.	
< 1 y	7 (2.3)
1 – 5 y	12 (4)
6 - 10 y	10 (3.3)
11 -20 y	36 (12)
21 - 30 y	75 (25)
> 30 y	135 (45)
Do not live in Cd. Obregón	25 (8.3)
Have had Dengue fever	
Yes	57 (19)
No	243 (81)

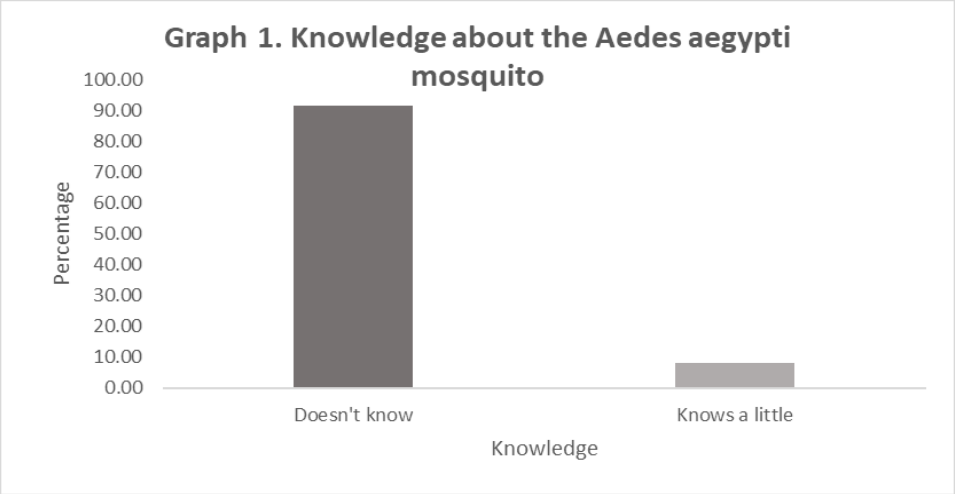
Table 2. Visual identification of the different stages of the Aedes aegypti mosquito

Mosquito Stage	Frequency	p-value*
Pupa		
Yes	1 (0.3%)	0.001
No	299 (99.7%)	0.001
Larva		
Yes	41 (14%)	0.001
No	259 (86%)	0.001
Adult		
Yes	285 (95%)	0.001
No	15 (5%)	0.001

Regarding the identification of mosquito breeding sites, 281 people said that buckets with water are breeding sites, while 19 people disagreed; 265 people said that vases are breeding sites, while 35 people disagreed; 288 people said that water tanks are mosquito breeding sites, while 12 people disagreed; 241 people said that the bases of flowerpots are mosquito breeding sites, while 59 disagreed; 226 people said that plants are mosquito breeding sites, while 74 disagreed; and 264 people said that water channels are mosquito breeding sites, while 36 people disagreed. The respondents were shown images of some animals, including three of the four different development stages of the Aedes aegypti mosquito, for visual identification. The results showed that only 1 person (0.3%) correctly identified the pupa ($p = 0.001$), while 41 (14%) correctly identified the larva and 259 (86%) did not ($p = 0.001$). Similarly, 285 (95%) correctly identified the adult stage, while 15 (5%) did not ($p = 0.001$). Regarding visual identification of breeding sites, 275 people said that flower vases are breeding sites, while 25 disagreed; 201 said that containers with water are breeding sites, while 99 disagreed; 275 said that a pond with fish is a mosquito breeding site, while 25 disagreed; all 300 respondents agreed that a puddle of water is a mosquito breeding site; 291 said that tires are breeding sites, while 9 disagreed; 294 said that plants are breeding sites, while 6 disagreed; 190 said that a lake is a breeding site, while 110 disagreed; 262 said that the base of a potted plant is a breeding site, while 38 disagreed; and 274 said that a vacant lot is a breeding site, while 26 disagreed. Regarding the perceived risk of the different developmental stages of the Aedes aegypti mosquito, only one person identified the pupa, classifying it as not dangerous. Of the 41 people who identified the larva, 9 considered it not dangerous, 3

somewhat dangerous, 18 dangerous, and 11 very dangerous. Regarding the adult stage, 5 considered it not dangerous, 12 somewhat dangerous, 116 dangerous, and 152 very dangerous. Regarding the overall score obtained by the respondents, the mean score was 47 (SD 8.4) with a p-value < 0.001. The lowest overall score was 22, while the highest was 75.

91.6% (n=275) of the surveyed population received a score lower than 59, indicating they lacked sufficient knowledge about the Aedes aegypti vector, while only 8.4% (n=25) scored 60 or higher, which is considered a passing grade (Graph 1).



A bivariate analysis was performed on the level of knowledge. Regarding educational level, primary school had an OR of 3.049 with a p-value of .259, secondary school had an OR of 1.79 with a p-value of .201, high school had an OR of .983 with a p-value of .970, university degree had an OR of .583 with a p-value of .306, and postgraduate studies had an OR of .027 with a p-value < 0.001. According to age group, 20–29 years had an OR of 2.601 with a p-value of .117, 30–39 years had an OR of .718 with a p-value of .477, 40–49 years had an OR of .845 with a p-value of .717, 50–59 years had an OR of .492 with a p-value of .150, and 60–69 years had an OR of .951 with a p-value of .948. Regarding length of residence in Ciudad Obregón, those who had lived there for less than 1 year had an OR of 0.213 with a p-value of 0.050; those who had lived there for 1–5 years had an OR of 0.248 with a p-value of 0.33; those who had lived there for 6–10 years had an OR of 0.812 with a p-value of 0.846; those who had lived there for 11–20 years had an OR of 1 with a p-value of 1; those who had lived there for 21–30 years had an OR of 2.60

with a p-value of 0.117; and those who had lived there for more than 30 years had an OR of 0.736 with a p-value of 0.462. Regarding previous dengue fever infection, those who had dengue before had an OR of 1.75 with a p-value of 0.231 (Table 3).

Table 3. Risk associated with lack of knowledge about the mosquito

Variable	Don't know	Little knowledge	OR	95% CI	p-value
Education Level					
Primary	31	1	3.049	0.398 – 23.33	0.259
Incomplete Primary	7	0	NA	NA	NA
Secondary	113	7	1.794	0.725 – 4.436	0.201
High School	87	8	0.983	0.409 – 2.366	0.97
Bachelor's Degree	35	5	0.583	0.206 – 1.654	0.306
Postgraduate	1	3	0.027	0.003 - 0.268	< 0.001
Master's Degree	0	1	NA	NA	NA
Age (years)					
10 – 19	14	0	NA	NA	NA
20 – 29	72	3	2.601	0.756 – 8.95	0.117
30 – 39	60	7	0.718	0.286 – 1.798	0.477
40 – 49	68	7	0.845	0.338 – 2.109	0.717
50 – 59	37	6	0.492	0.185 – 1.313	0.15
60 – 69	21	2	0.951	0.210 – 4.312	0.948
> 70	3	0	NA	NA	NA
Years of residence in Cd. Obregón					
< 1 y	5	2	0.213	0.39 – 1.159	0.05
1 – 5 y	9	3	0.248	0.63 - 0.983	0.033
6 – 10 y	9	1	0.812	0.99 – 6.683	0.846
11 – 20 y	33	3	1	0.284 – 3.525	1
21 – 30 y	72	3	2.6	0.756 – 8.951	0.117
>30 y	122	13	0.736	0.324 – 1.671	0.462
Does not live in Cd. Obregón	25	0	NA	NA	NA
History of Dengue Fever					
No	225	18	1.75	0.694 – 4.414	0.231
Yes	50	7			

DISCUSSION.

The main objective of the study was to determine the level of knowledge about the Aedes aegypti mosquito. We found that 91.8% of the population affiliated with UMF 1 in Ciudad Obregón scored below 59 (indicating insufficient knowledge), which is considered a failing grade. The remaining 8.4% obtained a passing score (indicating some knowledge), but their scores were below 80. Therefore, according to our classification of knowledge levels, no one had adequate knowledge about mosquitoes. A bivariate analysis showed that having a postgraduate degree was associated with greater knowledge about the Aedes aegypti mosquito (OR 0.27, $P < 0.001$). As observed in our study, most of the surveyed population had less than a university degree. Regarding the overall score, the mean was 47, and there was an increase in scores with higher levels of education, with those with incomplete primary education having a mean score of 44 (SD 4.9) and those with postgraduate degrees having a mean score of 66 (SD 9.0). There were no significant differences in scores by age group. In a 2010 survey on dengue fever in Mexico, between 88% and 95% knew that the disease was transmitted by mosquito bites, but it did not specify whether respondents knew the name of the mosquito. In our study, we asked what kind of animal Aedes aegypti is; only 39% answered that it is a mosquito, while 60% did not know. Regarding the diseases transmitted by the Aedes aegypti mosquito, only 10.7% knew that it transmits dengue, Zika, and chikungunya, despite information campaigns about these diseases. Almost half of the respondents (46.7%) associated the mosquito only with dengue. It is important to note that yellow fever was not included as an option, although it is also a disease transmitted by this mosquito

Villegas-Trecho et al. conducted a study in the state of Morelos in 2011, in which they sampled water containers, finding that 48.5% of the water tanks contained mosquito larvae, 21.3% of various containers (buckets and tubs) contained larvae, and 12.9% of flowerpots contained larvae. 23 In our study, we asked about the identification of mosquito breeding sites; 93.6% correctly identified buckets with water, 88.3% identified vases, 96% identified water tanks, and 80% identified the bases of flowerpots. We observed that the surveyed individuals considered all water containers to be mosquito breeding sites, however, not all of them are, such as rivers, where the water has a constant flow, or ponds with fish, which feed on the aquatic stages of the mosquito, such as the pupa or larva. It is important to mention that the mosquito's ability to develop in different breeding sites is due to its

adaptability to domestic and peridomestic environments, mainly driven by the blood-feeding habit of the females.2

There are several methods for mosquito control: biological, environmental, and chemical. 24 These strategies are effective, but difficult to maintain, mainly because they require community participation. Currently, there are constant efforts to integrate innovative strategies within the ecological-community context. 20 In our research, we asked which measure is considered the most effective for eliminating the Aedes aegypti mosquito; only 32% of the surveyed population said "eliminating breeding sites," 12% said "fumigation," and 25% said "cleaning the yard." The remaining population chose two or more options.

In the survey, participants were shown images of various animals, with the aim of visually identifying the developmental stages of the Aedes aegypti mosquito. 14% identified the larva, 95% identified the adult stage, and only one person (0.3%) correctly identified the pupa. Regarding the perceived risk of these stages, only 11 people considered the larva to be very dangerous. The adult stage of the mosquito was considered dangerous by 152 people. This shows that, although some people can identify the different stages of the mosquito, they do not consider Aedes aegypti to be a dangerous animal. Compared to other animals whose images were shown, they considered the adult stage of the mosquito almost as dangerous as a scorpion, but less dangerous than a tiger or a viper. However, according to statistics, mosquitoes (various types) cause 725,000 deaths per year (due to the various diseases they transmit), while vipers cause 50,000 deaths per year and lions or tigers cause 100 deaths per year (Gates, 2014). In our study, the preferred communication medium was television (51.7%), followed by the internet (18%) and social media (16.3%). There is a trend among younger people towards preferring the internet and social media, unlike older people who prefer television and radio. In the last two years, in our country, in addition to dengue fever, two other diseases transmitted by Aedes aegypti have appeared: Chikungunya and Zika. The latter has garnered more attention due to the complications it causes in pregnant women (babies with microcephaly). However, there is another disease also transmitted by this mosquito, yellow fever, which has a 50% mortality rate, and to which we could be exposed if we do not control the Aedes aegypti mosquito. Strategies to control this mosquito do not depend solely on the Ministry of Health or public institutions; citizen participation is also necessary. It is important to encourage the population to take effective action against the Aedes aegypti mosquito. We need to promote the idea of "eliminating the mosquito" to prevent diseases.

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Impact of a playful strategy to prevent the presence of the Aedes aegypti Mosquito in a primary school

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Abstract

Introduction: Aedes aegypti, the main vector for dengue transmission, is a difficult vector to control, as it has caused numerous outbreaks in all states. The challenges in controlling this vector stem from the scarcity of human, technical, and financial resources to address the growing urban areas and high vector densities.

Objective: To determine the impact of a new Aedes Aegypti mosquito prevention strategy on 5th and 6th grade primary school children attending Family Health Center No. 1, using a playful learning approach.

Materials and methods: This was a quasi-experimental, analytical, prospective, longitudinal study conducted with children in the 5th and 6th grades of primary school. It involved administering a survey on knowledge about Aedes aegypti, providing educational information, and implementing interactive activities (games). Descriptive analysis of quantitative variables was performed using parametric or non-parametric statistical tests, and proportions were used for qualitative variables. For the bivariate analysis, the Student's t-test was used.

Results: A total of 52 schoolchildren were included in the study, with 50% being in 5th grade and 50% in 6th grade, having a mean age of 9 years (range 8 to 11 years). An increase in knowledge was observed after the educational intervention, with p-values <0.05 and 95% confidence intervals, indicating statistically significant results.

Conclusions: This educational strategy proved to be well-received and is a good option for engaging schoolchildren with community health issues, promoting behavioral changes related to disease prevention, and improving quality of life.

Keywords: Aedes Aegypti, breeding sites, interactive learning.

INTRODUCTION

Dengue is an endemic-epidemic disease. The main vector in urban areas is Aedes aegypti, with Aedes albopictus as a secondary vector in the Americas. Its transmission dynamics depend on interactions between the environment, the host population, and the vector.

In the last 50 years, dengue incidence has increased 30-fold, with a growing geographical expansion into new countries and regions. The World Health Organization (WHO) considers it the second most re-emerging infection among tropical diseases and has classified it as a high-priority disease for research.

Therefore, the only way to prevent dengue is through vector control, and four key elements are essential for this: political will, intersectoral coordination in health, strengthening of public health laws, and community participation.

Aedes is the genus of mosquito that transmits diseases such as yellow fever, West Nile fever, and dengue. Dengue is an endemic-epidemic disease, and today it is the most important arboviral disease worldwide in terms of morbidity, mortality, and economic impact. In recent decades, its incidence has increased significantly, with more than 2.5 billion people (more than 40% of the world's population) at risk of contracting it.

The first records of this disease were made in Asia, Africa, and North America in 1780, and by 1970 it had spread throughout Southeast Asia, with reintroduction into the Pacific islands. In that same year, a reduction in cases was observed following an intensive campaign against the yellow fever vector (Aedes) led by the World Health Organization in 1961. However, due to the suspension of the program, the vector not only regained its geographical distribution but also expanded its range of distribution and infection, which led to it being considered a global public health problem.

Dengue affects people of all ages and socioeconomic levels; it is estimated that 2.5 billion people live in at-risk countries and that there are 50 to 100 million cases per year. The American continent is no exception; between 2008 and 2012, more than 1.2 million cases were reported. Furthermore, in 2013, the disease burden was the highest ever recorded, with the largest dengue epidemic in the history of the continent: a total of 2.3 million cases (37,898 severe cases and 1,318 deaths). The estimated economic cost is 2.1 billion US dollars per year.6 The challenges facing disease control stem from the scarcity of human, technical, and financial resources to address the growing urban areas and high vector densities. The public's perception of the risk is often

very low; therefore, it is difficult to gather accurate information on the magnitude of the disease burden, and this leads to dengue fever being recognized only after the outbreak is beyond the reach of control interventions.8 Within the sustainable vector control component, the objective is to ensure that breeding sites are controlled to prevent mosquito reproduction and reduce the mosquito population. This is achieved by involving families in controlling mosquito breeding sites in their homes and by instilling an understanding of the risks they pose, thus improving the quality and effectiveness of vector control activities.6 In 2009 and 2011, in Bucaramanga and Medellín, Colombia, pre- and post-intervention surveys were conducted using workshops, interactive activities, games, songs, puppets, rhymes, stories, role-playing, and videos. The results showed a significant increase in knowledge, in addition to the training of school leaders who demonstrated creativity and ingenuity in modifying family behaviors.11,12 In 2013, a community intervention study was conducted in Quechultenango, Guerrero, with 4th and 5th grade primary school students. Prior to the intervention, a baseline assessment was conducted to identify their level of knowledge. The intervention consisted of activities such as crosswords, word searches, images, and discussions about the characteristics of the vector. The results showed changes in the students' knowledge, indicating that educational interventions can be a strategy that contributes to behavioral changes leading to safer management of Aedes aegypti breeding sites.13.

Finally, in 2014, an educational strategy called "Mosquito-Free School" was implemented in Chiapas. This strategy assessed the level of knowledge, attitudes, and practices regarding dengue fever among primary school students through a pre- and post-test survey and through in vivo observation of biological material. The results showed a great interest among students in learning about the disease, as well as an increase in their level of knowledge.9

Since the introduction of Aedes aegypti into the country, several reemerging diseases have appeared, including yellow fever, West Nile virus, dengue fever, and, in recent years, chikungunya and Zika. This has led to dengue fever being considered a public health problem and a subject of research.

Among the strategies for dengue control, the most impactful disease caused by Aedes aegypti, were the strengthening of epidemiological surveillance and the laboratory network, improved clinical management of patients, vector control (chemical, biological, and environmental), and social communication. This last aspect involved using the media to influence public behavior,

providing information about the vector, and leveraging various information and education techniques to create an effective strategy.

This research project focuses on teaching about Aedes aegypti, the vector of dengue fever, a disease that threatens the health of millions of people living in urban, suburban, and rural areas. Despite the implemented control strategies, last year it was still able to cause outbreaks.

Dengue fever is perceived as "someone else's problem," and responsibility for its control is often shifted to others (neighbors, neighborhoods, communities, municipalities, health institutions, other government agencies, etc.), although ultimately the responsibility lies with the health services. However, due to inaccuracies in morbidity and mortality statistics, the magnitude of the disease as a regional public health problem is underestimated, leading the health sector to consider it a low-priority issue. Consequently, timely actions for its prevention and control are not taken. For this reason, this research protocol proposes a strategy for vector control and prevention through playful learning, evaluating its impact on children. It has been observed that children's enthusiasm significantly motivates adults to implement preventive measures, self-care practices, and learning activities. Since children are the most vulnerable population to this problem, they will be the ones who benefit the most, as their skills, confidence, and understanding will be strengthened, leading to positive changes in their living conditions. The objective was to determine the impact of a new Aedes aegypti mosquito prevention strategy on 5th and 6th grade elementary school students attending Family Health Center No. 1, implemented through playful learning activities.

MATERIALS AND METHODS

A quasi-experimental, analytical, prospective, and longitudinal study was conducted at a primary healthcare facility in Ciudad Obregón, Sonora, which provides outpatient services to 72 neighborhoods. The study population consisted of children in the 5th and 6th grades of primary school, registered at Family Health Unit No. 1, who met the selection criteria. The study was conducted from March 1 to November 31, 2016.

The variables investigated were knowledge levels regarding the Aedes aegypti mosquito, school grade level, sex, age, and the presence of mosquito breeding sites.

The study included children of both genders, in the 5th and 6th grades of primary school, registered at Family Health Unit No. 1, and whose parents had provided written informed consent. Participants who had been surveyed about

dengue fever or the Aedes aegypti mosquito within the previous 3 months were excluded. Children who were expected to move within one month were also excluded. Children whose parents did not consent to their participation or who were unable to participate due to time constraints, as well as children with learning difficulties, were excluded from the study.

A univariate analysis was performed, describing quantitative variables using parametric and non-parametric measures of central tendency, as appropriate. Qualitative variables were described using frequencies and proportions. Bivariate analysis was performed using the Student's t-test as a comparison measure for numerical variables, with 95% confidence intervals (CI), considering statistical significance at a p-value of ≤ 0.05. The statistical software programs Excel and SPSS 24.0 were used for data analysis, and for creating tables and graphs. The recruitment process took place at Family Health Center No. 1, targeting children in the 5th and 6th grades of primary school who were either attending a medical appointment or accompanying a patient. Parents or guardians were invited to a meeting in the center's auditorium to learn about the study's purpose, benefits, activity schedule, and overall duration. The games to be used in the study were explained, including a reading of the instructions for each game (memory game, mosquito-rain game, anti-Aedes war game, bingo, and model demonstration), all of which are included in the appendix. The meeting concluded with parents signing the informed consent form for their child's participation. On the scheduled date, the participants and their families gathered in the auditorium of Family Health Center No. 1. The survey form was then presented and its completion explained. The educational intervention then proceeded as follows: Powerpoint presentation using a projector: 1. Information about the vector, its life cycle, and the diseases it transmits; 2. Signs and symptoms of dengue fever; 3. Vector control and prevention measures (strategy slogan).

Playful learning strategy: Presentation of models created by the researcher, implementation of games with the group divided into subgroups, where the researcher assigned one person to read the instructions (parents) and then proceeded with the activity. Finally, a survey was administered to assess the impact of the strategy.

The data was entered into a Microsoft Excel 2013 database for Windows, for analysis.

A structured survey was used as the data collection instrument, consisting of 15 questions based on the variables of the study "Impact of a New Prevention Strategy for the Aedes aegypti Mosquito in 5th and 6th Grade Elementary

School Students Attending Family Health Center No. 1 through Playful Learning." The survey focused on identifying the vector and its prevention measures, with dichotomous, single-choice answers (Yes or No).

The final instrument was validated by three experts: a psychologist, a family physician, and an epidemiologist. A pilot test was conducted to validate the quality and effectiveness of the questions regarding their clarity, ease of completion, response time, and relevance, as well as the reliability of the instrument. The pilot test showed clear wording, an appropriate time estimate, active participation of the respondents, and a Cronbach's Alpha reliability score of 0.7; therefore, no modifications to the instrument were deemed necessary.

For data analysis, the questions were categorized by indicators: knowledge of the disease, knowledge of the vector, and preventive medical control: A) Knowledge of the disease: 3 questions were addressed, each assigned a numerical value of 1 point. B) Knowledge of the vector: 4 questions were addressed; each assigned a numerical value of 1 point. C) Preventive medical control: 8 questions were addressed, emphasizing activities to eradicate Aedes aegypti, each assigned a numerical value of 1 point. D) For the final evaluation, the following classification was used: "Good" for a score of 11 to 15, "Fair" for a score of 6 to 10, and "Poor" for a score of 5 or lower.

The results were entered into a database and statistically analyzed using SPSS version 24.0 (2016).

The study adhered to the guidelines of the Helsinki Declaration of 1969 and the amendments adopted by the 52nd World Medical Assembly in Edinburgh, which governs biomedical research involving human subjects. Therefore, the study was approved by the Local Research Ethics Committee for Health Research.

RESULTS

A total of 52 schoolchildren were included in the study, of which 26 (50%) were in 5th grade and 26 (50%) in 6th grade. The average age and standard deviation of these students were 9.46 ± 0.753 years, with ages ranging from 8 to 11 years. The predominant gender was male, with 31 students (60%), compared to 21 females (40%) (Table 1). Regarding overall knowledge, at baseline, students had a mostly satisfactory level of knowledge (40, 77%), some good knowledge (8, 15%), and some deficient knowledge (4, 8%). This improved after the intervention, with more students demonstrating good

knowledge (31, 59%), satisfactory knowledge (19, 37%), and less students with deficient knowledge (2, 4%) (Table 3 and Figure 1).

Table 1. General characteristics

Variable	n(%)
Gender	
Male	31 (60%)
Female	21 (40%)
Age (years)	
8	4 (8%)
9	24 (46%)
10	20 (38%)
11	4 (8%)
Grade level	
5th grade	26 (50%)
6th grade	26 (50%)

Table 2. Participants' knowledge before and after the intervention

Question	BI		AI		Value t	p value
	N	%	N	%		
Is the dengue fever mosquito called "Mosquito Grande"?	28	53	35	67	-1.99	0,05
Are the symptoms of dengue fever: sadness, crying, and yawning?	31	60	34	65	-0.72	0,47
Can the dengue fever mosquito transmit other diseases?	46	88	49	94	-1.13	0,26
Does the dengue fever mosquito only bite at night?	32	61	21	40	2.28	0,02
If you have dengue fever, should you take any kind of medication?	44	85	46	89	-0.62	0,53
If you have dengue fever, should you go to the doctor and use insect repellent?	45	87	43	82	0.57	0,56
Do you think dengue fever can kill you?	37	71	41	79	-1.07	0,28
Is cutting the grass one way to eliminate dengue fever mosquitoes?	21	40	18	35	0.68	0,49
If I see a mosquito in my house, should I look for places where dengue fever mosquitoes breed?	30	58	46	89	-4.08	0,00
It just rained... should I eliminate any places where dengue fever mosquitoes breed?	44	84	49	94	-1.69	0,09
Image 1: Flower vase	20	38	38	73	-4.71	0,00
Image 2: River with fish	9	17	29	56	-4.62	0,00
Image 3: Base of a flowerpot	27	51	42	81	-3.87	0,00
Image 4: Empty lot	3	5	11	21	-2.21	0,03
Image 5: Dog water bowl	14	26	37	71	-4.99	0,00

BI: Before intervention, AI: After intervention

P-value calculated using Student's t-test, statistically significant <0.05, CI: 95%

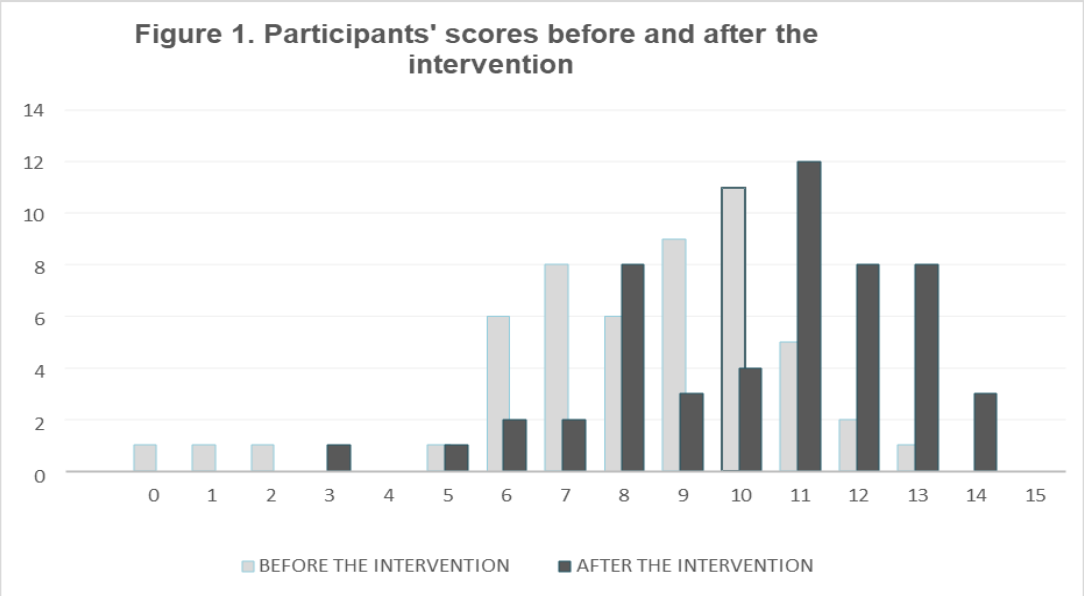
Source: Study protocol conducted from March to November 2016, at UMF No. 1, Ciudad Obregón, Sonora

Table 3. Classification and frequency of scores obtained by participants before and after the intervention.

RANKING (CORRECT ANSWERS)		BI N (%)	AI N (%)
Well			
	15	0 (0%)	0 (0%)
	14	0 (0%)	3 (6%)
	13	1 (2%)	8 (15%)
	12	2 (3%)	8 (15%)
	11	5 (10%)	12 (23%)
Regular			
	10	11 (21%)	4 (8%)
	9	9 (17%)	3 (6%)
	8	6 (12%)	8 (15%)
	7	8 (15%)	2 (4%)
	6	6 (12%)	2 (4%)
Deficient			
	5	1 (2%)	1 (2%)
	4	0 (0%)	0 (0%)
	3	0 (0%)	1 (2%)
	2	1 (2%)	0 (0%)
	1	1 (2%)	0 (0%)
	0	1 (2%)	0 (0%)

BI: Before intervention, AI: After intervention

Source: Study protocol conducted from March to November 2016, at UMF No. 1, Ciudad Obregón, Sonora



Regarding knowledge of the disease's symptoms, 60% of the students could identify them, and 88% knew about other diseases transmitted by Aedes aegypti. Regarding preventive measures, 85% of students avoided self-medication, and 87% recognized seeking medical attention as an important measure; 71% of students understood that the disease can be fatal (Table 2). Furthermore, 53% of the students knew the name of the disease-transmitting vector, 61% knew the time of day when the vector bites, and they also had some knowledge about the vector's life cycle. It was also observed that, although people are aware of preventive measures, only 58% actively search for mosquito breeding sites at home when the vector is present, and 84% eliminate these sites. This is because people are unaware of potential breeding sites for this vector, such as animal water bowls (only 14.26% knew this), flower vases (20.38%), and the bases of potted plants (27.51%). The study also found other locations where this vector does not breed due to unsuitable conditions, but which the schoolchildren considered to be breeding sites, such as vacant lots (43.94%) and rivers with fish (42.83%) (Table 2). It is worth mentioning that after the intervention, an increase in knowledge was observed, primarily regarding the name of the vector and its characteristics (35.67%), preventive measures such as searching for breeding sites at home (46.89%) and eliminating them (49.94%). Similarly, knowledge increased regarding potential breeding sites such as flower vases (38.73%) and the bases of potted plants (42.80%). A Student's t-test was also performed, which yielded the following statistically significant results: knowledge of the vector's name (Aedes aegypti) $p=0.05$; knowledge of the biting times $p=0.02$; preventive measures: searching for breeding sites $p=0.00$ and eliminating breeding sites $p=0.09$; potential breeding sites: animal water bowls $p=0.00$, flower vases $p=0.00$, and bases of potted plants $p=0.00$; and overall scores $p=0.05$ (Table 2)..

DISCUSSION.

This research study aimed to evaluate the effectiveness of an educational intervention using a knowledge survey: an information session with models made of resin and four games (“Anti-Aedes War”, memory game, lottery game, and “mosquito-rain”) as teaching tools for conveying information about the symptoms, mode of transmission, life cycle of the vector, and prevention measures. The results obtained in this intervention were consistent with those of Vesga and Cáceres, as well as Restrepo and Pineda, who conducted interventions in Colombia in 2009 and 2011, where a statistically significant improvement was observed after the intervention.11, 12

Regarding knowledge about the characteristics of the vector (name, biting time, and diseases it transmits), there was an increase from 46% to 67%, as described by Vences and Gallardo in their community intervention in Quechultenango, Guerrero in 2013, where the increase was from 16% to 83%, and also described in the intervention by Torres and Ordoñez in Tapachula, Chiapas in 2014, which was from 30% to 84%.13,9

For prevention measures, the increase in our study was: for identifying breeding sites, from 58% to 89% and for eliminating breeding sites, from 84% to 94%, which corresponds to what was reported in the study by Vences and Gallardo, where the variation was from 20% to 31% and from 20% to 25%.13

Likewise, it was evident that although schoolchildren possess some knowledge about measures to prevent breeding sites, they maintain inappropriate behaviors and practices, a consequence of not recognizing the risk of disease, not changing habits and customs, and not being aware of the magnitude of the problem.10

As seen, vector control must be comprehensive, combining different types of methods with criteria of rationality, safety, effectiveness, adaptability, and acceptability, targeting the different stages of the vector's life cycle. This was observed in our study, as the strategy used had good acceptability, high participation from the schoolchildren, and above all, enthusiasm for learning. Therefore, it is a good option for promoting behavioral changes related to this disease and improving quality of life. This study shows that educational strategies for schoolchildren are an effective tool for understanding concepts and preventing diseases, in addition to being an engaging, stimulating, and rewarding activity. It is important to continue promoting these types of interventions in more locations, as our research showed that in Mexico they have only been implemented in Guerrero and Chiapas. The goal is to evaluate their effectiveness and to help schoolchildren understand the health issues affecting their communities. Furthermore, and as a limitation of our study, it is important to conduct periodic follow-up evaluations of vector control practices to identify strengths and weaknesses and ensure the continuity of these actions, as our study only assessed them at one point in time. Likewise, if adequate control measures are not maintained at all stages of the vector's life cycle, the disease will never be eradicated and will continue to reappear, becoming increasingly difficult to control. On the other hand, it was demonstrated that increased knowledge, positive attitudes, and improved practices promoted self-care among students, school staff, and families, which would lead to a reduction in the use of chemical substances that pollute the environment. This is important, given the growing resistance of the vector's

larvae and adult stages to these chemicals, as has been observed in recent years..

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ERSJ EPIDEMIOLOGICAL RESEARCH AND SURVEILLANCE JOURNAL

Review article

Epidemiological overview of dengue

by Alfonso Vallejos Paras

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Dengue is an infectious febrile illness of viral origin, first identified in 1789 by Benjamin Rush, who named it "breakbone fever" due to the intensity of myalgia and arthralgia.

In recent decades, the incidence of dengue has increased worldwide. The WHO estimates that between 50 million and 100 million infections occur each year, with more than 2.5 billion people (40% of the world's population) at risk of contracting the disease.

It is caused by an RNA virus of the genus Flavivirus, family Flaviviridae. Currently, four serotypes of this virus are recognized: Denv 1, Denv 2, Denv 3, and Deng 4. These possess immunological and antigenic properties characterized by structural antigens (C, M, E) and seven non-structural antigens (NS1 to NS5).

The vectors of the dengue virus are female hematophagous mosquitoes of the Aedes aegypti and Aedes albopictus species. The transmission cycle begins when a healthy mosquito feeds on the blood of a person infected with dengue, thus becoming a vector. The cycle continues when this mosquito, infected with the dengue virus, feeds on the blood of a healthy person, transmitting the virus to that person.

There are several theories about the pathogenesis of dengue; one of the most widely accepted is the immunoamplification theory. This theory states that in a primary infection, specific antibodies are created for a particular dengue serotype, neutralizing the virus. Subsequently, in a secondary infection, these specific antibodies are thought to bind to the Fc region of target cells (monocytes and lymphocytes), triggering viremia and the subsequent release of inflammatory factors, which in turn causes fluid leakage due to tissue damage.

After an incubation period of 3-10 days, it presents with sudden onset of fever, chills, myalgia, arthralgia, nausea, vomiting, headache, retro-orbital pain, and photophobia.

Several definitions have been established for the prompt identification of the disease. These concepts have evolved over time and based on the results of research conducted on the disease. One classification that remains in use for epidemiological purposes is to consider dengue as classic and hemorrhagic. However, several guidelines establish the following concepts.

Probable case of non-severe dengue (NSD): Any person of any age who resides in or has traveled from a region with dengue transmission within the 14 days prior to the onset of signs and symptoms, and who presents with fever and two or more of the following signs or symptoms: nausea, vomiting, rash, myalgia, arthralgia, headache, retro-orbital pain, petechiae, and/or a positive tourniquet test and/or leukopenia.

Probable case of dengue with warning signs (DSA): Any probable case that, in addition to meeting the criteria for dengue with warning signs (DNG), presents one or more of the following warning signs: severe and continuous abdominal pain, persistent or intractable vomiting, fluid accumulation (ascites, pleural effusion, pericardial effusion), mucosal bleeding (epistaxis, gingival bleeding), lethargy or irritability, postural hypotension, hepatomegaly greater than 2 cm, progressive increase in hematocrit, platelet count less than 100,000 platelets per microliter or progressive decrease in platelets and/or progressive decrease in hemoglobin.

Probable case of severe dengue (DG): Any probable case of dengue that presents one or more of the following findings: Shock due to severe plasma leakage, evidenced by: tachycardia, cold extremities and capillary refill equal to or greater than three seconds, weak or undetectable pulse, convergent pulse pressure ≤ 20 mmHg, late-phase hypotension, and fluid accumulation leading to respiratory failure. Severe bleeding, as assessed by the treating physician (examples: hematemesis, melena, heavy vaginal bleeding, central nervous system bleeding). Severe organ involvement, such as: significant liver damage, kidney involvement, central nervous system involvement (altered mental status), heart involvement (myocarditis), or other organ involvement.

Warning signs to consider in a suspected case of dengue include: severe abdominal pain, persistent and intractable vomiting (>5 times a day), clinical evidence of fluid accumulation, active bleeding in mucous membranes (gastrointestinal tract, hematuria), neurological or mental status changes (lethargy, restlessness), hepatomegaly >2 cm (liver failure), and elevated hematocrit coexisting with a decreased platelet count.

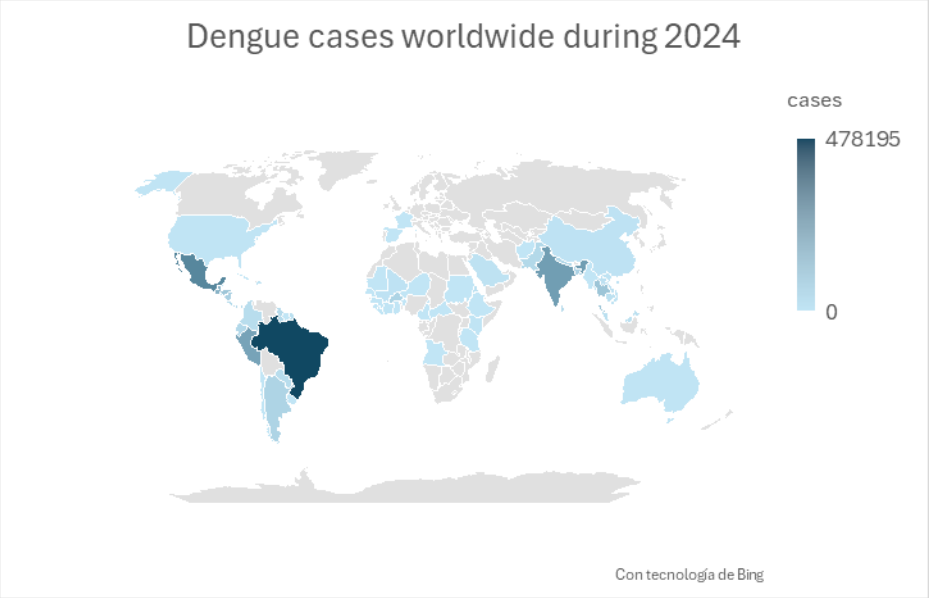
Diagnosis is made with virological tests (within the first few days, i.e., during the febrile phase) and with serological tests (after day 6 of the onset of clinical

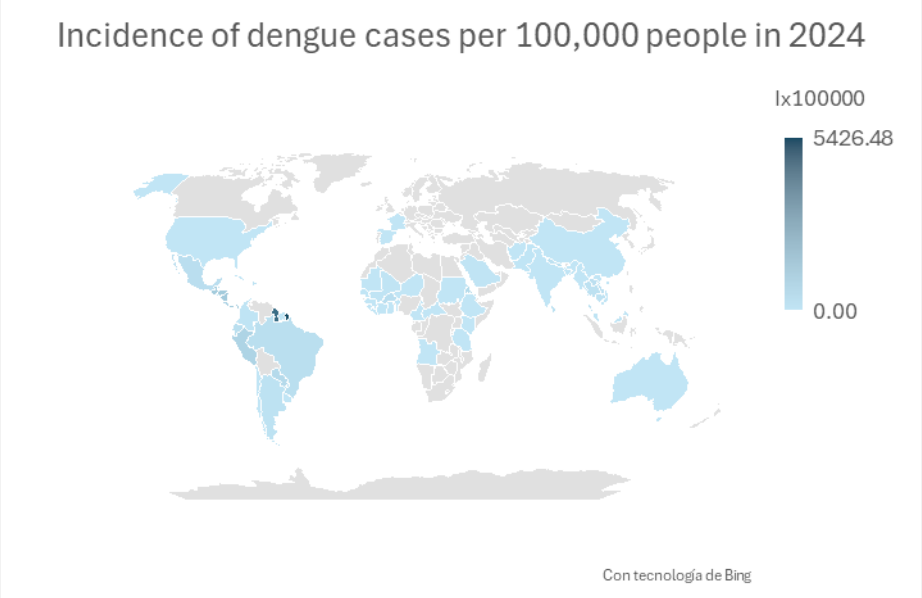
symptoms) through the determination of IgM and IgG antibodies, or the determination of the non-structural antigen of the NS1 virus cell wall, which can be detected in the first five days of the onset of clinical symptoms.

The NS1 antigen is common to all dengue serotypes and is useful for detecting primary or secondary infections. IgM antibodies appear approximately 5 to 6 days after the onset of symptoms, followed by IgG approximately 14 days after onset. Peak IgM levels are reached after 1 to 2 weeks, but can remain elevated for 2 to 3 months after the illness. In secondary infections, IgG rises rapidly within 1 to 2 days after the onset of symptoms.

The differential diagnosis should primarily include rickettsial diseases, typhoid fever, leptospirosis, viral exanthems, and even various hematological disorders. The Americas, through the Pan American Health Organization, have consistently monitored dengue fever. Since 2014, a steady increase in reported dengue cases has been observed, especially in Brazil and Mexico; however, other tropical countries have also experienced periodic outbreaks.

During 2024, reports from the World Health Organization highlighted the large number of dengue cases in India and the Eastern Pacific countries. However, while Brazil had the highest number of cases, the incidence rate per 100,000 inhabitants was significantly higher in French Guiana, with 5,426.48 cases. Brazil also had the highest number of deaths, although the case fatality rate was higher in Niger (20.69%) and Sudan (2.12%).

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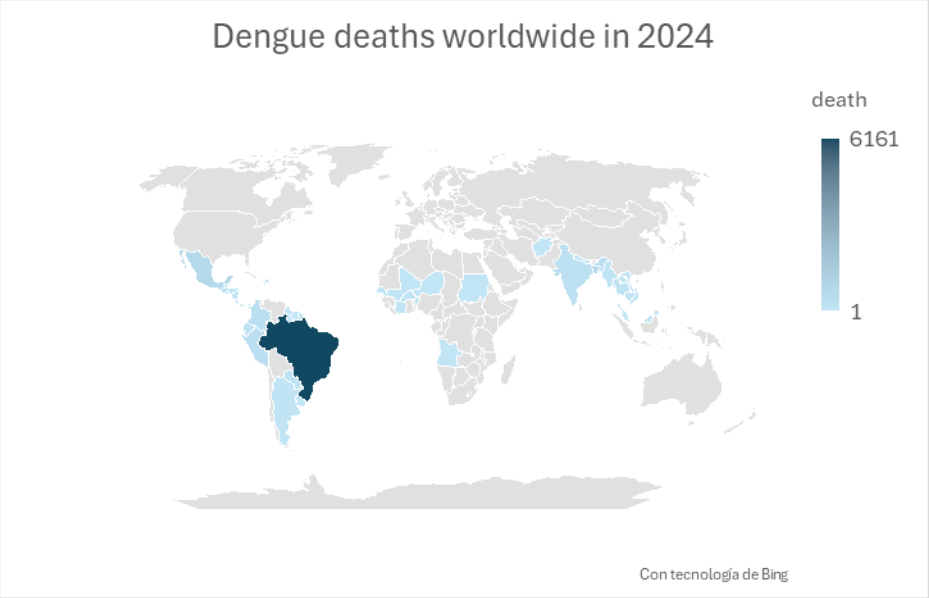
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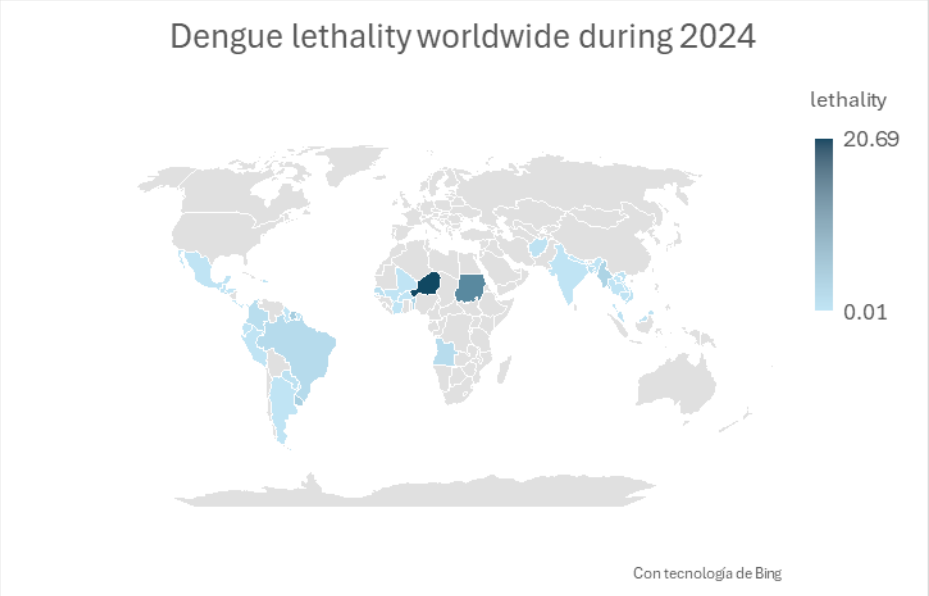
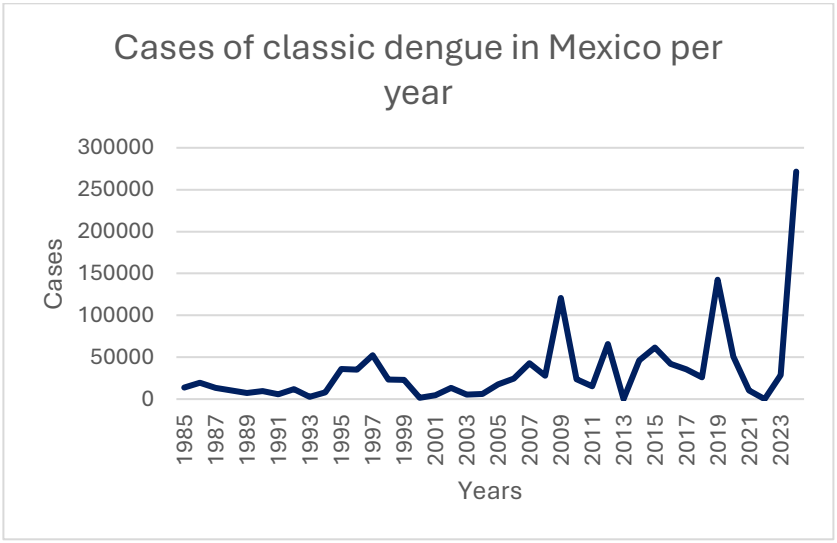
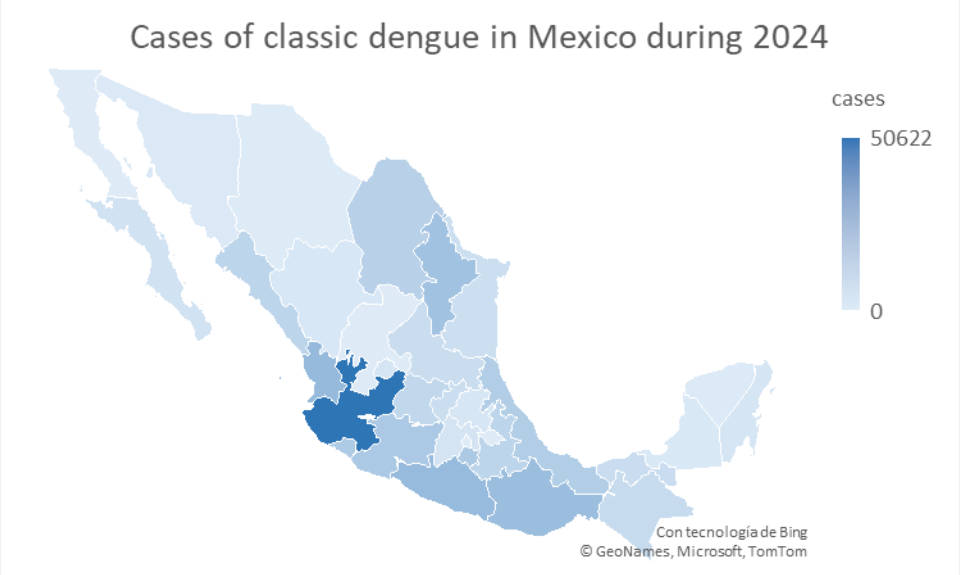


Climate change has created favorable conditions for the expansion of the Aedes aegypti and Aedes albopictus mosquitoes. However, the disease's emergence is subtle until explosive outbreaks occur, after which it remains endemic.

In Mexico, an upward trend has been observed since 1985; however, in 2024, the number of cases far exceeded the historical average (271,588). The cases occurred mainly in the Pacific region, led by the state of Jalisco (50,622), while the state of Nayarit had the highest incidence per 100,000 inhabitants (1,650.87).




Cases of classic dengue in Mexico during 2024
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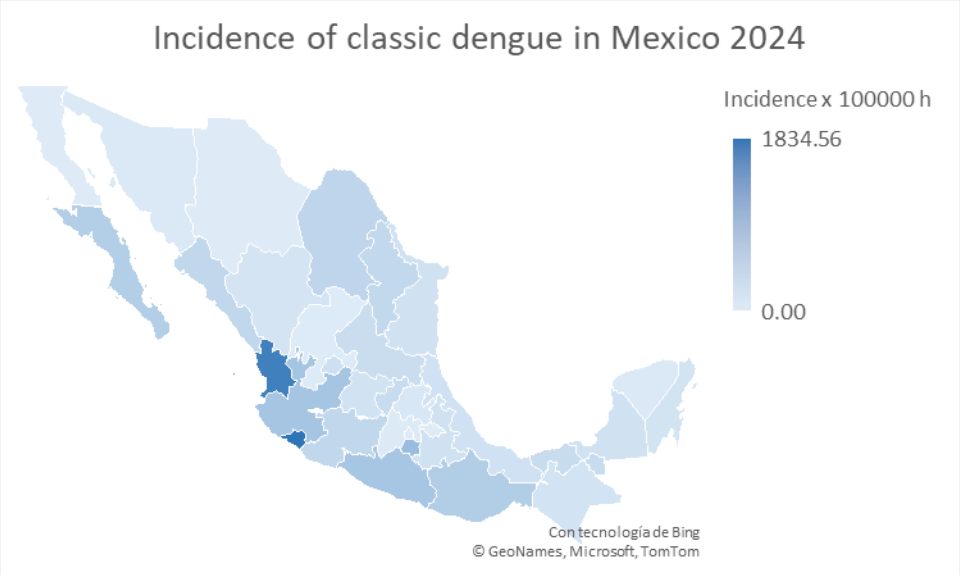
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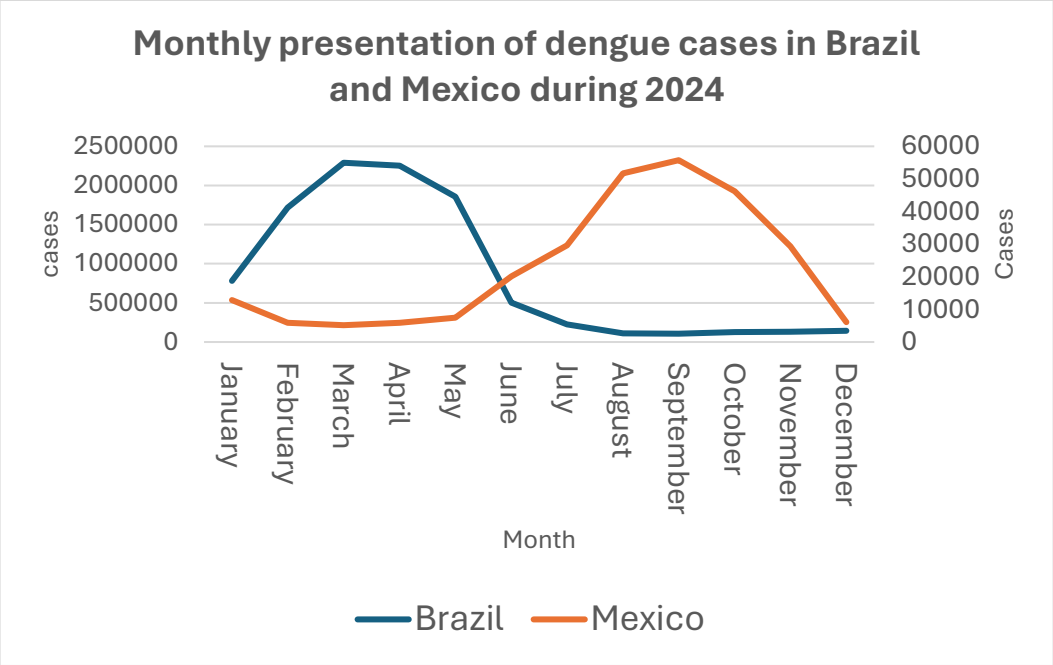
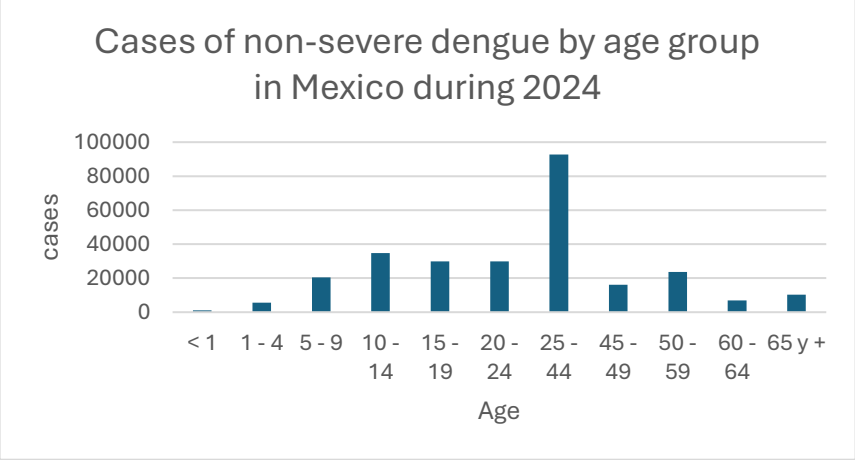
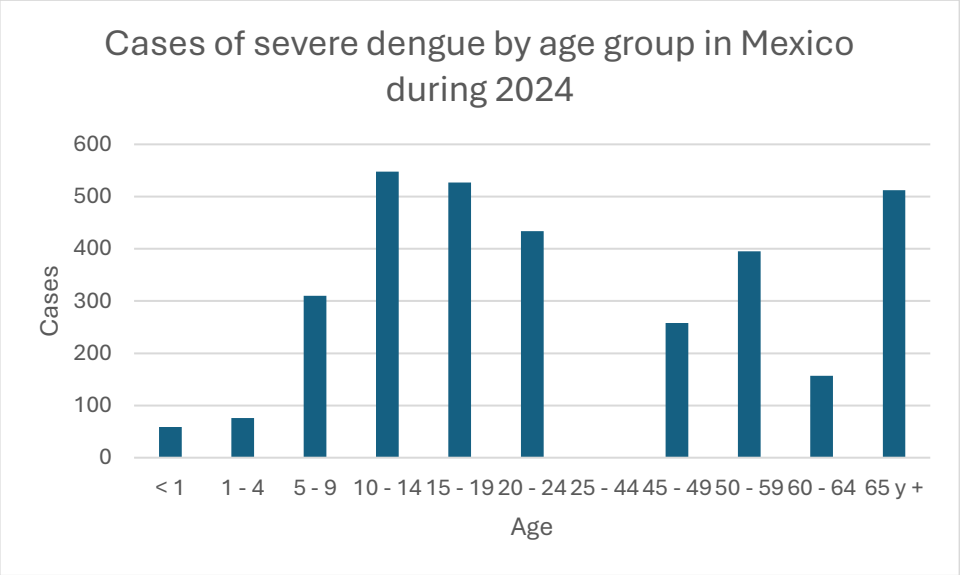
On the other hand, cases of dengue hemorrhagic fever (dengue with warning signs and severe dengue) decreased compared to historical averages, with an incidence of 3.6 per 100,000 inhabitants. Nayarit also had the highest incidence, with 21.81 per 100,000 inhabitants.

In Mexico, the increase in dengue cases begins in June, peaking in September and October, while in the Southern Hemisphere, specifically in Brazil, the peak occurs in March and April, with cases decreasing in June.



The age group with the highest number of dengue cases was 24 to 44 years old, representing the economically active population, while severe cases are concentrated at the extremes of age.





In conclusion, dengue is a disease that continues to spread intermittently throughout the world, especially in tropical areas; however, climate change is causing cases to appear in places that are not considered endemic.

You can consult:

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