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PERMANYER

Rev Inves Clin. 2015;67:372-8 ORIGINAL ARTICLE

Decades of Experience in the Diagnosis of Dengue Fever in the Northwest of Mexico

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ABSTRACT

Background: The State of Baja California Sur is in an arid region of Mexico, the southern half of the Baja California Peninsula. Given its aridity and physical isolation from mainland Mexico, there were no records of dengue fever in the state before 1985. Until now, no data on dengue incidence had been published. **Objective:** To study some epidemiological features of dengue fever in Baja California Sur, Mexico in the last 30 years. **Methods:** Total number of cases, general population, sex, age groups, serotypes, mortality, and incidence data were analyzed. **Results:** There was a 652% increase in reported cases from 2012 through 2014. Age groups mostly affected were adults aged 15-24 and 45-64 years old. **Conclusions:** This study makes a thorough analysis of the incidence of dengue and makes recommendations to face the epidemiological challenge. (REV INVES CLIN. 2015;67:372-8)

Key words: Dengue. Diagnosis. Vector-borne disease. Baja California Sur. Mexico.

INTRODUCTION

Dengue fever is a viral infection transmitted by mosquito bites, which in the last few years has become a national public health priority. Dengue fever, dengue hemorrhagic fever, or its most serious form, dengue shock syndrome, are acute infectious diseases caused by an arbovirus of the family *Flaviviridae,* genus *Flavivirus dengue*[1,2]. Infection can be lethal and is caused by the dengue virus (DENV) group, which includes four serotypes: DENV-1, DENV-2, DENV-3, and DENV-4[3,4]. Dengue virus is transmitted by infected *Aedes aegypti* female mosquitoes[4]. This is one of the most effective vectors, as it is highly anthropophilic and lives and breeds in urban areas. The dengue mosquito has rapidly expanded its geographic distribution, accompanying climate change, poor attention to control and eradication programs, rapid population growth, insufficient municipal infrastructure, and unsanitary habits that promote an increase in the vector and infection in humans.

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The World Health Organization shows that the incidence of dengue has dramatically increased in the last few decades[5]. The number of dengue cases is often poorly documented and many cases are incorrectly classified. According to a recent estimate, 390 million dengue infections occur each year, of which 67-136 million have clinical manifestations, regardless of the impact on victims[6]. In Mexico, the number of deaths caused by dengue in the last few years is 349[7]; in 2014, there were 46,092 confirmed cases of dengue reported and 8,856 confirmed cases of hemorrhagic dengue fever. In 2014, Baja California Sur (BCS) reported 6,641 cases of dengue fever and 95 cases of hemorrhagic dengue[8]. In 2010, to warn the public about dengue, the dengue mortality rates in Mexico from 1980 to 2009 were published[9]. In the Baja California Peninsula, little information had been released, despite the history of dengue cases, its severity and risks, and that the number of dengue cases has greatly increased in the last few years. This data needs to be understood and analyzed to estimate the extent of the public health problem. Our main objective was to assess the incidence of dengue in BCS from 1985 through 2014.

MATERIALS AND METHODS

Study population and data

Information on dengue fever and hemorrhagic dengue fever were obtained from online databases of the Annals of Morbidity from the Ministry of Health of Mexico (Anuarios de Morbilidad, Sistema Nacional de Vigilancia Epidemiológica. Epidemiología. Sistema Único de Información, Dirección General de Epidemiología [DGEPI], Secretaría de Salud) from 1985 through 2014[8]. In relation to the total number of cases, incidence was analyzed for the general population, sex, seven age groups, serotypes, and mortality. All data were confirmed by serological tests (NS_1, IgM, IgG), according to procedures for laboratory diagnosis of dengue fever and dengue hemorrhagic fever included in the Guidelines for the Epidemiological Laboratory Surveillance of Dengue (Lineamientos para la Vigilancia Epidemiológica de Dengue por Laboratorio)[10].

Statistical analysis

Normality tests (Kolmogorov-Smirnov test), and homogeneity of variance (Levene's test) were used, with significance set at $p < 0.05$. Analyses used Statistica 8.0 software (Statsoft, Tulsa, OK) to observe trends in case numbers for each age group in the study period. One-way ANOVA was conducted on data having significant statistical differences, using *post hoc* analysis (Fisher's Least Significant Difference Test) to find data having statistical significance. ANOVA was performed "within" each age group across the years of study and among the age groups.

RESULTS

Table 1 shows cases of dengue fever by month in the last 30 years. Peak years were 1986, 1991, 1997, 2003, and 2010. Starting in 2010, major increases in cases occurred in 2012, 2013, and 2014. This table also shows that the highest number of cases occurred from August through December. Table 2 shows the incidence among females, starting in 2003 when more systematic records were kept. Years 2003, 2010, 2012, 2013, and 2014 had significant peaks. Table 3 shows similar data for males. As in table 1, most cases occurred in August through December. Table 4 shows cases of dengue hemorrhagic fever, number of deaths, and serotypes during the last few years.

The trend over the past 30 years in the state is shown in figure 1. Cyclic outbreaks occurred about every six or seven years (1991, 1997, 2003, and 2010). The cycle disappeared in 2012, when epidemic outbreaks started, which continued in 2013 and 2014. In 2014, the number of cases was 652% higher than in 2012.

The ANOVA was performed for the age groups only for years with peak outbreaks (Fig. 2). 1991 and 1997 showed statistically significant differences among age groups 15-24, 25-44, and 45-64. In 2003 and 2013, the most affected age group was 45-64; in 2010 and 2014, the most affected was 15-24 years old.

DISCUSSION

Occurrence of dengue fever in the State of Baja California Sur has been recorded since 1985. The number of cases has increased more than 75-fold, with higher rates among women in the last 12 years (2003-2014). The most likely cause for higher infection rates among women is that the majority remains at home for more

Table 1. Cases of dengue fever in Baja California Sur by month from 1985 through 2014

Year	Incidence	Total	J	F	M	A	M	J	J	A	S	O	N	D
2014	**896.18**	**6,641**	**117**	**25**	**28**	**14**	**50**	**70**	**176**	**983**	**1,494**	**2,543**	**983**	**158**
2013	**653.17**	**4,691**	**37**	**17**	**15**	**3**	**1**	**4**	**19**	**69**	**527**	**1,659**	**1,764**	**576**
2012	**146.45**	**1,018**	**4**	**0**	**0**	**2**	**4**	**8**	**4**	**16**	**31**	**107**	**476**	**366**
2011	10.63	63	16	4	1	1	0	3	2	2	2	7	22	3
2010	**335.99**	**1,946**	**105**	**48**	**32**	**59**	**64**	**61**	**92**	**137**	**181**	**498**	**491**	**178**
2009	91.79	**519**	**30**	**10**	**43**	**9**	**8**	**9**	**6**	**5**	**30**	**69**	**146**	**154**
2008	37.9	209	1	6	2	1	1	6	2	3	6	73	72	36
2007	6.14	33	2	0	1	1	0	2	1	4	8	10	4	0
2006	17.07	88	0	0	0	0	1	1	0	5	25	39	13	4
2005	1.99	10	1	0	0	0	0	0	0	3	1	0	1	4
2004	0.41	2	0	0	0	0	0	1	1	0	0	0	0	0
2003	**101.96**	**486**	**0**	**0**	**0**	**0**	**0**	**0**	**34**	**70**	**113**	**200**	**65**	**4**
2002	2.16	9	0	0	0	0	0	0	0	0	1	6	2	0
2001	0.24	1	0	0	0	0	0	0	0	0	0	1	0	0
2000	0.25	1	0	0	0	0	0	0	0	0	0	1	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	43.96	185	7	83	3	1	5	5	2	5	10	41	14	9
1997	**385.17**	**1,574**	**5**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**781**	**594**	**192**
1996	9.08	36	5	1	0	0	1	2	2	3	8	8	4	2
1995	8.58	33	2	1	2	4	1	0	0	0	6	8	8	1
1994	8.28	30	7	3	0	1	0	0	0	0	0	0	4	15
1993	43.54	153	1	0	0	1	1	0	0	0	0	1	137	12
1992	23.98	82	17	4	2	2	1	0	2	0	2	8	39	5
1991	**125.1**	**441**	**0**	**1**	**0**	**1**	**0**	**0**	**4**	**3**	**2**	**125**	**249**	**56**
1990	5.3	18	8	2	1	1	4	0	2	0	0	0	0	0
1989	25.05	82	1	0	0	2	1	1	1	4	1	27	33	11
1988	9.21	29	1	3	3	5	6	1	1	1	2	4	2	0
1987	24.8	75	3	20	3	9	8	9	1	4	1	5	6	6
1986	**242**	**675**	**0**	**7**	**0**	**7**	**1**	**7**	**57**	**44**	**96**	**107**	**253**	**9**
1985	10.03	28	0	0	3	2	2	2	5	5	3	1	5	0
	3,266.41	1,9158	370	236	140	126	160	192	414	1,366	2,550	6,329	5,387	1,801

Years with outbreaks are in **bold** typeface. Months with the highest number of cases are underlined.
Source: SUIVE/DGE/Secretaría de Salud/Estados Unidos Mexicanos 2014.

hours each day; mosquitoes breed in larger numbers in residential areas where standing water is common. These results are consistent with a study conducted in the cities of Merida and Tampico, where higher incidence is reported for women[11]. Similar findings occurred in Malaysia from 1973 through 1987[12].

The incidence over the past 30 years peaked every 6-7 years. Starting in 2012, the incidence dramatically increased to epidemic proportions. The viral serotype found in 2010 and 2011 was DENV-1. Serotypes from 2012 through 2014 were DENV-1 and DENV-2[7]. In 2014, the number of cases was 652% higher than in 2012. It is possible that a change in the predominant circulating serotype may have, in some way, contributed to these large and severe epidemics. Some authors mentioned that the DENV-2 serotype is associated with increased pathogenicity in the Americas[13]. Serotypes found in Mexico from 2005 through 2013 were DENV-1, -2, -3, and -4[9,14]. This information is similar to other studies[15,16]. In an effort to identify factors related to transmission, these authors independently published two models that essentially reached the same conclusion: periodicity of dengue transmission depends only on crossed, neutralizing, short-term immunity reactions[15,16]. This would explain why, despite a cyclic period of about three years in dengue transmission, on average, synchrony is observed only in transmission of DENV-2 and DENV-3, while transmission peaks for DENV-4 have a longer periodicity[17].

Table 2. Cases of dengue fever in Baja California Sur among women by month from 2003 through 2014

Year	Incidence	Total	J	F	M	A	M	J	J	A	S	O	N	D
2014	**1,004.25**	**3,656**	**55**	**12**	**13**	**4**	**31**	**46**	**108**	**547**	**816**	**1,379**	**567**	**78**
2013	**653.17**	**2,557**	**14**	**7**	**11**	**3**	**0**	**3**	**12**	**42**	**281**	**930**	**952**	**302**
2012	**146.45**	**552**	**2**	**0**	**0**	**2**	**2**	**4**	**4**	**14**	**17**	**1**	**262**	**184**
2011	10.63	26	9	1	1	1	0	0	1	1	1	0	8	3
2010	**335.99**	**1,032**	**56**	**30**	**16**	**31**	**33**	**36**	**56**	**77**	**97**	**257**	**243**	**100**
2009	91.79	26	9	1	1	1	0	0	1	1	1	0	8	3
2008	46.8	123	1	1	2	1	1	3	1	2	2	43	41	25
2007	6.63	17	2	0	1	0	0	1	0	2	4	5	2	0
2006	19.97	50	0	0	0	0	1	1	0	1	14	23	8	2
2005	2.05	5	0	0	0	0	0	0	0	1	0	0	1	3
2004	0.41	1	0	0	0	0	0	0	1	0	0	0	0	0
2003	**119.26**	**277**	**0**	**0**	**0**	**0**	**0**	**0**	**21**	**46**	**50**	**121**	**39**	**0**
		8,322	**148**	**52**	**45**	**43**	**68**	**94**	**205**	**734**	**1,283**	**2,759**	**2,131**	**700**

Years with outbreaks are in **bold** typeface. Months with the highest number of cases are underlined.
Source: SUIVE/DGE/Secretaría de Salud/Estados Unidos Mexicanos 2014.

Table 3. Cases of dengue fever in Baja California Sur among men by month from 2003 through 2014

Year	Incidence	Total	J	F	M	A	M	J	J	A	S	O	N	D
2014	**791.81**	**2,985**	**62**	**13**	**15**	**10**	**19**	**24**	**68**	**436**	**678**	**1,164**	**416**	**80**
2013	**583.28**	**2,134**	**23**	**10**	**4**	**0**	**1**	**1**	**7**	**27**	**246**	**729**	**812**	**274**
2012	**131.42**	**466**	**2**	**0**	**0**	**0**	**2**	**4**	**0**	**2**	**14**	**46**	**214**	**182**
2011	11.88	37	7	3	0	0	0	3	1	1	1	7	14	0
2010	**300.81**	**914**	**49**	**18**	**16**	**28**	**31**	**25**	**36**	**60**	**84**	**241**	**248**	**78**
2009	75.26	37	7	3	0	0	0	3	1	1	1	7	14	0
2008	29.79	86	0	5	0	0	0	3	1	1	4	30	31	11
2007	5.69	16	0	0	0	1	0	1	1	2	4	5	2	0
2006	14.33	38	0	0	0	0	0	0	0	4	11	16	5	2
2005	1.94	5	1	0	0	0	0	0	0	2	1	0	0	1
2004	0.4	1	0	0	0	0	0	1	0	0	0	0	0	0
2003	**85.51**	**209**	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**24**	**63**	**79**	**26**	**4**
		6,928	**151**	**52**	**35**	**39**	**53**	**65**	**128**	**560**	**1,107**	**2,324**	**1,782**	**632**

Years with outbreaks are in bold typeface. Months with the highest number of cases are underlined.
Source: SUIVE/DGE/Secretaría de Salud/Estados Unidos Mexicanos 2014.

Although it is not fully understood, having all four serotypes present at the same time in one region would increase the possibilities for transmission, i.e., as circulation of all serotypes is established, more frequent epidemic episodes will occur, as in Southeast Asia[17].

We reviewed state fumigation calendars for 2003 through 2014, finding large disparities of application dates in different municipalities; that is, the same application calendar was not followed and changed each year in one or all five municipalities in the state[18].

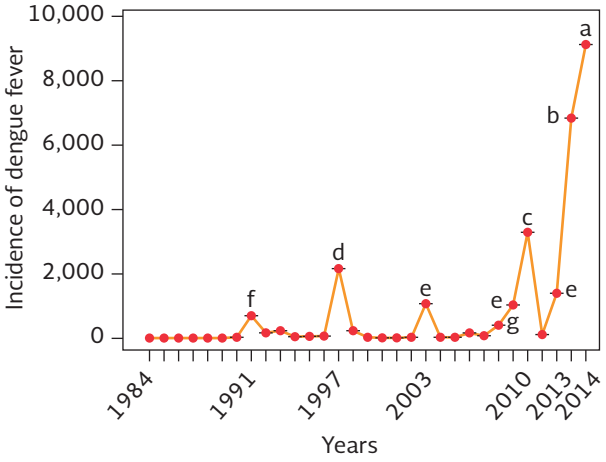
The highest incidence rates reported in this state, starting in 2003, agrees with information provided by the Pan-American Health Organization, where the number of reported cases increased fivefold from 2003 through

Table 4. Cases of dengue hemorrhagic fever, mortality, and serotypes in Baja California Sur, Mexico, from 1995 through 2014

Year	DHF	Mortality	Serotypes
2014	95	4	1, 2
2013	117	3	1, 2
2012	14	0	1, 2
2011	7	0	1
2010	79	1	1
2009	21	0	0
2008	13	1	0
2007	5	NA	NA
2006	27	NA	NA
2005	2	NA	NA
2004	0	NA	NA
2003	441	NA	NA
2002	0	NA	NA
2001	0	NA	NA
2000	0	NA	NA
1999	0	NA	NA
1998	0	NA	NA
1997	1	NA	NA
1996	2	NA	NA
1995	1	NA	NA

NA: data not available; DHF: dengue hemorrhagic fever.
Source: SINAVE/DGE/SALUD/Sistema Especial de Vigilancia Epidemiológica de Dengue.

Figure 1. Incidence of dengue fever for 30 years in the State of Baja California Sur. Different letters on peaks mean significant statistical differences using ANOVA (Tukey, $p < 0.05$).



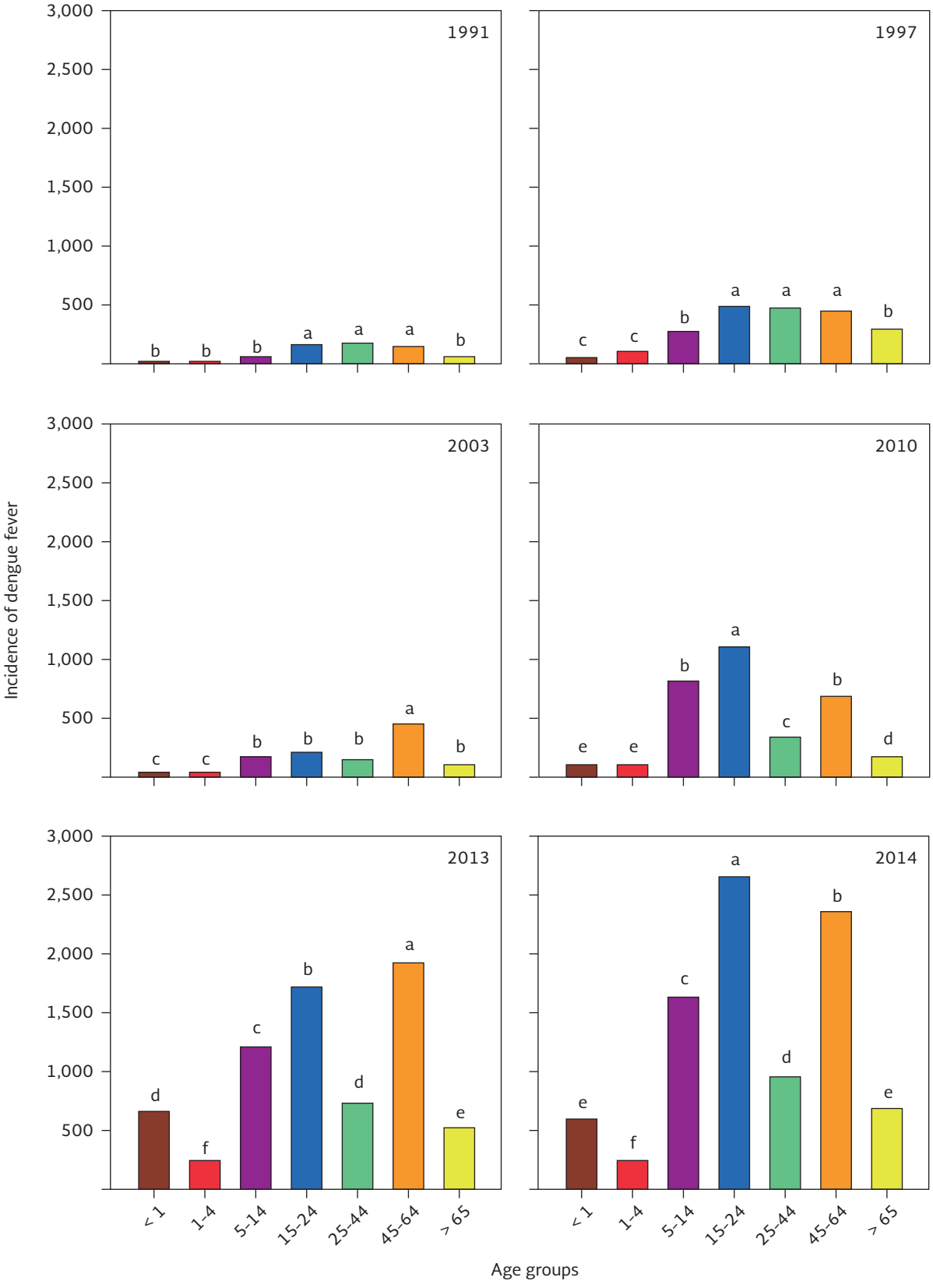
2013[19,20]. The latest report of cases in the state in 2014 is probably related to Hurricane Odile, which devastated the peninsula on 14 September 2014. This was the strongest tropical cyclone ever to hit the Baja California Peninsula, leaving an unprecedented trail of damage, flooding, and large-scale residential destruction, providing very favorable conditions for the development of the vector mosquito. The highest number of reported cases occurred from October through December. This increase is most likely tied to the ecology of the vector; when temperatures decline, larvae maturation time increases. They are smaller adults, and therefore, females must feed more frequently to fulfill nutritional and reproductive requirements, which makes them more efficient vectors[21].

From 2003 through 2014, the highest morbidity occurred in the age groups 15-24 and 45-64. Similar results were seen in Sri Lanka in the last few years, where adult patients had higher morbidity and increased number of deaths[22]. Similar trends of increasing numbers of adult patients occurred in South and Southeast Asia and Latin America[23-25]. In a report that included six cities in Asia, the most vulnerable subset was those over 15 years old[26]. Data from many studies suggest that a greater attention to the adult population may help in reducing a serious loss of financial resources for working adults during their illness. A different age group appears to be more vulnerable in some nations. In the last 10 years, Brazil, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua experienced a higher incidence among children[27]. This has also been reported for Thailand, where most dengue fever and dengue hemorrhagic fever occurs among children[28].

It must be noted that this assessment used only available data. Not all cases are reported, suggesting a larger problem. Also, we recognize the limitations of this study since there is no data by sex from 1985 to 2002 and no positive cases recorded in the official databases.

Today, significant progress has been made in research on the dengue tetravalent vaccine, currently tested in children[29]. As long as the vaccine is not available to the general public, other measures must be implemented, particularly vector prevention and permanent containment of larvae. Measures include elimination of breeding grounds and fumigation. One of the most important actions in the short term is the immediate

Figure 2. Incidence of dengue fever in different age groups in years with outbreaks in the State of Baja California Sur. Different letters on the bars indicate significant statistical differences ANOVA (Tukey, $p < 0.05$).



intervention of public health services to improve mosquito management and control. Current efforts are not enough. Public awareness of the seriousness of this disease needs to be improved, emphasizing that the most effective measure against dengue fever is prevention, particularly eliminating breeding habitats, including removal of trash, old tires, and water-holding containers in backyards. We also recommend a structured fumigation calendar that works throughout the year in all municipalities. Government agencies should provide more resources to scientific efforts attempting to understand the ecology and physiology of the mosquito and transmission of dengue fever.

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