Knowledge, Attitudes, and Preventive Practices Regarding Dengue in Maracay, Venezuela

Jelte Elsinga,^{1†} Masja Schmidt,^{1†} Erley F. Lizarazo,^{1,2} Maria F. Vincenti-Gonzalez,^{1,2} Zoraida I. Velasco-Salas,^{1,3} Luzlexis Arias,² Johannes G. M. Burgerhof,⁴ and Adriana Tami^{1,5*}

¹University of Groningen, University Medical Center Groningen, Department of Medical Microbiology, Groningen, The Netherlands; ²Instituto de Investigaciones Biomédicas, Universidad de Carabobo, Maracay, Venezuela; ³Departamento de Biología, Facultad Experimental de Ciencia y Tecnología, Universidad de Carabobo, Valencia, Venezuela; ⁴Department of Epidemiology, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands; ⁵Departamento de Parasitología, Facultad de Ciencias de la Salud, Universidad de Carabobo, Valencia, Venezuela

Abstract. Dengue, a viral mosquito-borne disease currently affects more than 2.5 billion people living in endemic areas worldwide. In vector control, social mobilization and community behavioral changes are of crucial importance. Here, we identified the factors influencing community dengue preventive practices in a high-transmission urban area in Venezuela. Between September 2013 and February 2014, a cross-sectional study at the household level was carried out in Maracay city, Venezuela. A precoded questionnaire was used to obtain information on people's knowledge, attitudes, and use of preventive practices in relation to dengue. Concomitantly, entomological data was collected from households. In 80% of the 105 included households, 1–5 preventive practices (e.g., repellents, insecticides) against mosquito bites were used. However, 57% of the examined houses had potential *Aedes* breeding sites indoors and/or outdoors, most of which positive for *Aedes* spp. larvae/pupae. Preventive practices were associated with a previous dengue infection ($P = 0.030$) and a better knowledge on dengue symptoms and transmission route ($P = 0.020$). In turn, knowledge was associated with feeling at risk ($P < 0.001$), a previous dengue infection ($P = 0.010$), and reported exposure to information sources of dengue ($P = 0.011$). Even though the knowledge level of the community over transmission ways was high, and most of the individuals took measures to avoid mosquito bites, potential mosquito breeding sites were present in almost two-thirds of the examined properties. Health promotion activities in Venezuela should aim at raising awareness at the community level on the importance of combining mosquito bite prevention with removal of breeding sites in and around the households.

INTRODUCTION

Dengue is a viral vector-borne disease spread by the day-biting mosquitos *Aedes aegypti* and *Aedes albopictus*. The global number of people infected in 2010 was estimated to be 390 million, of which around 14% occurred in the Americas.¹ Venezuela is one of the countries with the highest burden of dengue in the region,² where severe disease and recurrent epidemics on a background of perennial transmission are a major public health problem.³ Maracay city has become one of the most important endemic urban areas of the country with the co-circulation of all four dengue serotypes.⁴

No vaccine or specific antiviral treatment against dengue is widely available yet. Therefore, the most effective way to prevent and control the spread of dengue continues to be the reduction or elimination of human–vector contact.^{5,6} Effective vector control strategies include community-based larvae control, adult mosquito management, and the use of personal protection.⁷ Community-based larvae control consists of environmental management, that is, alterations in the environment to minimize vector breeding, especially in close proximity with humans, and source reduction by application of chemical larvicides in possible breeding containers before the dengue season or during outbreaks in densely populated areas.⁶ Adult mosquito management currently comprises chemical insecticide spraying in areas where dengue cases are reported, to reduce transmission by lowering the adult vector population.⁸ In addition, the spread of the disease can be reduced by using personal protection against mosquito

bites, for example, insect repellents or adult reduction devices, such as mosquito-repelling vaporizing tablets. Individual and community contributions to dengue control are of importance for the success of dengue control programs; studies show that community involvement in environmental management can reduce the *Aedes* larval infestation indices in domestic areas.^{9,10}

However important, social mobilization in dengue control is often difficult to achieve. It is challenging to motivate people to prioritize dengue among other acute health and environmental concerns, especially during interepidemic periods or when vector breeding continues unabated in neighboring households or other sites such as informal dumps.^{6,11} By revealing characteristics of the community knowledge, attitude, and practices (KAP), a KAP study can offer valuable information for the development of health promotion approaches and suggest intervention strategies that are specific to the sociocultural context in which they have to take place.¹²

Studies on KAP, mosquito breeding sites, and possible associations between these components related to dengue are not abundant in the Americas. Although most people in Venezuela are aware of dengue as a disease, preventive measures to avoid mosquito breeding sites are not always taken.¹³ To our knowledge, there are no previous studies published on KAP and mosquito breeding sites for dengue in Venezuela.

To improve dengue control of communities exposed to endemic dengue transmission, we aimed to 1) describe KAP concerning dengue, and 2) investigate determinants of a) personal protection against mosquitos and b) mosquito breeding site elimination.

MATERIALS AND METHODS

Study site. The study was conducted in three neighborhoods in Maracay city, Aragua state, Venezuela: Candelaria,

* Address correspondence to Adriana Tami, Department of Medical Microbiology, University Medical Center Groningen, Hanzplein 1 (Mailcode HPC EB80), Groningen 9713, The Netherlands. E-mail: a.tami@umcg.nl

† These authors contributed equally to this work.

Caña de Azúcar, and Cooperativa. These neighborhoods were selected owing to their high dengue incidences. With a population of 1,300,000,¹⁴ Maracay is one of the largest cities in Venezuela where dengue is hyperendemic.^{4,15}

Study design. A cross-sectional study was carried out to gather data on KAP related to dengue at the community level. This study was performed within one of the annual surveys (September 2013–February 2014) of a running community-based prospective cohort study. A detailed description of the study setup was published earlier.¹⁶ Briefly, in August 2010, a total of 2014 individuals aged 5–30 years in 840 randomly selected households within the study sites were enrolled after written informed consent through house-to-house visits.¹⁶ A subsample of 260 households of the cohort study was randomly selected for the cross-sectional KAP survey that is described here. However, individuals from 105 households were finally interviewed because violence during anti-governmental protests in February and March 2014 in the country^{17–19} precluded the enrolment of further individuals.

Study population. In each household, one individual was interviewed. The intention was to interview an equal number of adults and parents or guardians of children (< 18 years old) who were already participating in the cohort study, following the selection criteria described elsewhere.²⁰ Briefly, this selection was made to investigate health seeking behavior (HSB) of dengue and fever, comparing HSB of parents or guardians referring to their children and HSB of adults referring to themselves.²⁰ Adults (18 years and older) were randomly chosen from all present adults at the moment of visiting the selected households.

Data collection. A structured individual questionnaire was developed containing pre-coded and open questions on sociodemographic details, knowledge of dengue symptoms and transmission, and risk perception. Data on socioeconomic variables and preventive practices were collected from a household questionnaire which was applied as part of the annual survey of the overarching cohort study. The questionnaires were prepared in English, translated to Spanish, pretested, and adapted in a pilot study. Data on sociodemographic characteristics included age, place of residence (neighborhood), educational level, occupation, and religion. To assess the level of familiarity with dengue, individuals were asked if they had heard about dengue and from which source. In addition, people were asked if they or, if applicable, their child had a dengue infection in the past. To measure the general dengue knowledge of the community, people were asked about dengue transmission routes and symptoms in open questions. Answers were used to calculate a knowledge score by adding the number of dengue symptoms that the individual correctly mentioned. Symptoms marked as correct included fever, headache, eye pain, body pain, red face/rash, muscle pain, abdominal pain, vomiting, diarrhea, malaise, nausea, bleeding, itching, sore throat, dizziness, and fainting. In addition, one point was added if the individual mentioned the correct transmission mode (“the bite of a mosquito” or similar utterances). We assessed the perceived severity of dengue in the community by asking people if they thought someone can die when infected with dengue. In addition, people were asked whether they felt at risk of acquiring dengue, and why. Questions about risk perception referred to a child when a parent/guardian was interviewed, and to the individual in question when it concerned the adult questionnaire. To gain insight in the use of personal protection against

dengue in the community, people were presented with a list of possible mosquito-bite preventive practices at the household level. Individuals were asked which of the following preventive measures were used in their household: door and window screens, mosquito nets, spraying of insecticides indoors, application of repelling creams or oils on the skin, mosquito repelling plants, mosquito repelling oils, and herbal infusions. Additional preventive methods mentioned spontaneously by the interviewees were recorded under “other” and later classified accordingly. A score was developed by counting the number of reported preventive measures (Table 1) per household, assigning one point per measure mentioned. To obtain an estimate of the degree to which mosquito larvae control measures were taken at the household level, we examined the indoor and outdoor areas of the residence for the presence of potential *Aedes* breeding sites. Samples of larvae and/or pupae were collected from every breeding site available (natural or artificial) in the household and were transported to the laboratory for further taxonomic identification.^{21–23}

Data analysis. Information collected in the questionnaires was entered into a database using the Epi Info™ (version 3.5.4; Centers for Disease Control and Prevention, Atlanta, GA) software. Data were checked for consistency and analyzed anonymously using SPSS (version 20.0; SPSS, Inc., Chicago, IL). Differences in proportions were analyzed with Pearson’s χ^2 test or Fisher’s exact test if appropriate. Continuous variables were analyzed using the Student’s *t*-test if data were normally distributed (in that case the mean and standard deviation [SD] were provided), otherwise using the Mann–Whitney *U* test accompanied with median and quartiles (Q1, median, and Q3). Associations between continuous variables were assessed using the Pearson correlation or the Spearman’s rank correlation coefficient. Socioeconomic data were analyzed using principal component analysis^{24,25} to obtain a relative measure of socioeconomic status. Based on these data, individuals were divided into groups with a low, average, and high socioeconomic status.²⁰ Binary logistic regression analyses were performed to examine the effects of several variables on the “number of preventive practices” and “presence (or not) of mosquito breeding sites,” respectively. Variables with an association of $P < 0.20$ in the univariate analyses were included in the multivariate regression analyses. Variables were stepwise backward removed until only significant variables (selected using univariate analyses) remained. A dichotomized variable was used (cutoff point: median) when analyzing preventive practices in the binary logistic regression analyses.

TABLE 1
Number of preventive measures and number of mosquito breeding sites per household

No.	Preventive measures taken* (N = 91)		Mosquito breeding sites† (N = 72)	
	n	(%)	n	(%)
0	17	(18.7)	31	(43.1)
1	34	(37.4)	14	(19.4)
2	16	(17.6)	14	(19.4)
3	16	(17.6)	5	(6.9)
4	4	(4.4)	7	(9.7)
5	4	(4.4)	1	(1.4)

* Households with information on preventive practices.

† Households searched for breeding sites.

Ethical statement. The study was approved by the Ethics Review Committee of the Biomedical Research Institute, Carabobo University (Aval Bioetico #CBIB[UC]-014), Maracay, Venezuela; the Ethics, Bioethics and Biodiversity Committee of the National Foundation for Science, Technology and Innovation of the Ministry of Science, Technology and Innovation, Caracas, Venezuela; and by the Regional Health authorities of Aragua State (Corposalud Aragua). All participants signed a written informed consent at the start of the cohort study.

RESULTS

In total, 105 individuals participated in this study. Of these, 54 individuals answered questions on risk perception and previous experiences of dengue referring to themselves (the adult questionnaire), and 51 respondents referred for these questions to their child (the child questionnaire). In addition, 92 socioeconomic questionnaires were applied. The sociodemographic characteristics of the study population are fully described in a previous study.²⁰ Briefly, most of the respondents were women ($N = 91$, 86.7%), and the median age was 36 years (interquartile range [IQR] = 25–53 years). More than 80% of the people had a secondary school or higher level of education. Half of all respondents were housewives or domestic workers ($N = 52$, 49.5%). Most individuals lived in the neighborhood Candelaria ($N = 72$, 68.6%), followed by Caña de Azúcar ($N = 22$, 21.0%) and Cooperativa ($N = 11$, 10.5%). Seventy-six socioeconomic questionnaires provided information about the household's monthly income, resulting in a median of bolívar fuerte (VEF) 7,500, with an IQR of VEF 5,000–10,000 (Minimum wages at the time of the study ranged between VEF 2,703 and VEF 3,270).

Community dengue knowledge and past dengue infection. Almost all people had heard of dengue ($N = 103$, 98.1%), the reported information sources are listed in Table 2. Participants

mentioned up to six different sources of information (mean = 2.5; SD = 1.1). More than 30% ($N = 33$, 31.4%) referred that they or their child had had dengue in the past.

The majority of respondents knew dengue is transmitted by the bite of a mosquito ($N = 100$, 95.2%). Eight people (7.6%) responded that stagnant water was the source of dengue infections and one (1.0%) thought that dengue could be transmitted by kissing an infected person. With respect to the knowledge of dengue symptoms, almost all individuals (97.1%, $N = 102$) referred to fever as a symptom of dengue. Symptoms mentioned by the interviewees are listed in Table 2. Participants mentioned up to eight different, correct dengue symptoms (mean = 3.9, SD = 1.7).

People achieved a mean knowledge score of 4.8 (SD = 1.8) based on their responses to the questions about dengue symptoms and transmission routes. We explored the attitudes and sociodemographic factors influencing the knowledge score. Individuals professing a religion (Catholics and other Christians) had a higher mean knowledge score (mean = 4.9; SD = 1.7) than nonreligious individuals (mean = 2.7; SD = 1.6; $P = 0.002$). Income was negatively associated with knowledge. People with a lower monthly income (< VEF 7,000) had on average more knowledge of dengue symptoms and transmission than those with a higher income (mean = 5.3 versus 4.3, respectively; $P = 0.013$). Feeling at risk of dengue was associated with knowledge (feeling at risk: $N = 73$, mean knowledge score = 5.2; SD = 1.8 versus not feeling at risk: $N = 30$, mean knowledge score = 3.7; SD = 1.4; $P < 0.001$). People that reported a previous dengue infection had more knowledge about dengue ($N = 33$, mean knowledge score = 5.5; SD = 1.8) than people without this experience ($N = 69$, mean knowledge score = 4.5; SD = 1.7; $P = 0.010$). The dengue knowledge score was in turn found to be correlated with the reported number of different dengue information sources (Pearson correlation: $r = 0.247$, $P = 0.011$). The other KAP and sociodemographic characteristics: gender, age, education,

TABLE 2
Dengue information sources and knowledge on dengue symptoms

	<i>n</i>	(%*)		<i>n</i>	(%*)
Responses on question: where did you hear about dengue? ($N = 105$)					
TV	59	(56.2)	Radio	11	(10.5)
Health center	46	(43.8)	Dengue project	5	(4.8)
Friends/family/neighbors	35	(33.3)	Leaflets	5	(4.8)
School/university	34	(32.4)	Internet	4	(3.8)
Newspaper	32	(30.5)	Other†	7	(6.7)
Campaigns from the regional Ministry of health	29	(27.6)	–	–	–
Responses on question: what are the symptoms of dengue? ($N = 105$)					
Fever	102	(97.1)	Nausea	7	(6.7)
Headache	60	(57.1)	Abdominal pain‡	7	(6.7)
Malaise	41	(39.0)	Sneezing/coughing§	6	(5.7)
Muscle pain	36	(34.3)	Sore throat	3	(2.9)
Red face/rash	35	(33.3)	Running nose§	3	(2.9)
Vomiting‡	31	(29.5)	Itching	3	(2.9)
Body pain	24	(22.9)	Dizziness	2	(1.9)
Bleeding‡	19	(18.1)	Fainting	1	(1.0)
Diarrhea	19	(18.1)	Other	6	(5.7)
Eye pain	13	(12.4)	–	–	–

* The percentage corresponds to the number of individuals that mentioned each dengue information source/symptom. Because most individuals mentioned more than one dengue information source/symptom, the total does not add up to 100%.

† Other: work, mass media, pharmacy, (personal) experience.

‡ Dengue warning symptoms for developing severe dengue.

§ Not symptoms of dengue (not included in knowledge score).

|| Low platelets, red eyes, flu, heavy eyes, weight loss (all not included in knowledge score).

TABLE 3
Reasons for (not) feeling at risk for a dengue infection

Reasons for feeling at risk	Total N = 73		Reasons for not feeling at risk	Total N = 30	
	n	(%)		n	(%)
Mosquitos in the household	46	(63.0)	No (uncovered/stagnant) water around	10	(33.3)
Presence of stagnant/stored water	27	(37.0)	We protect ourselves against mosquitos	9	(30.0)
Dengue cases in the vicinity	21	(28.8)	No rubbish nearby†	9	(30.0)
Mountains/hills nearby	14	(19.2)	No dengue cases nearby	7	(23.3)
Rubbish nearby†	14	(19.2)	No mosquitos in the household	6	(20.0)
Rain	5	(6.8)	No breeding sites around	6	(20.0)
Canal/river nearby	5	(6.8)	Other§	4	(13.3)
Other‡	15	(20.5)	—	—	—

* Proportions within the population who felt (N = 73)/did not feel (N = 30) at risk of dengue.

† Rubbish was perceived as a risk factor for dengue, because mosquitos might breed in rain water that accumulates in, for example, plastic bottles, cups, or any concave surface that can hold water.

‡ "There are mosquitos at school," "presence of dark places," "the necessary measures to fight dengue are not being taken," "children are not bothered by mosquitos," "dengue is in the environment."

§ "I am immune to dengue," "I scare mosquitos," "There are no mountains near," and "I don't have a garden."

occupation, neighborhood, and socioeconomic status were not significantly associated with dengue knowledge.

Community perceptions of risk and severity. Almost all participants (N = 102; 98.1%) thought a dengue infection is potentially deadly and more than 70% (70.9; N = 73) of the participants thought they themselves were, or that their child was, at risk of contracting dengue. The reasons for people (not) to feel at risk of contracting dengue are listed in Table 3. Interestingly, for seven of 12 people (58.3%) who stated not to feel at risk of dengue because there were no breeding sites in and around their households, one or more breeding sites were found.

Preventive practices against mosquito bites. In 74 (81.3%) of the 91 households where data on preventive practices were collected, people reported to use at least one measure to avoid contact with mosquitos. Up to five preventive measures (median = 1; IQR = 1–3) were reported per household (Table 1) and these are presented in Table 4. The most frequently mentioned preventive measure was the application of personal repellents followed by the use of spray insecticides within the house, the use of a fan, using mosquito nets, and repellent tablets or insecticide coils. Although almost 70% (N = 62) of the households had an air conditioner (mainly in the sleeping rooms), only individuals from six households reported this as a preventive method against mosquito bites. Plants or other natural elements, such as plant or animal oils/herbal infusions, to repel mosquitos, were reported to be used in 8 (8.8%) households.

Aedes mosquito breeding sites. Seventy-two households in Caña de Azucar and Candelaria were searched in- and outdoors for *Ae. aegypti* or *Ae. albopictus* breeding sites. In these households, up to five mosquito breeding sites were found (median = 1; IQR = 0–2) (Table 1). Breeding sites were identified in 41 (56.9%) of the households, and in almost all of these (N = 39; 95.1%) at least one of the breeding sites was positive for *Aedes* spp. larvae or pupae. Overall, there were 90 breeding sites found in the 72 households (Table 1). Most of these (N = 78; 86.7%) were found outdoors (garden, patios) whereas 12 (13.3%) were identified indoors. Sources of mosquito breeding sites found are listed in Figure 1. Almost all (93.3%) of the breeding sites were positive for *Ae. aegypti* or *Ae. albopictus* larvae and/or pupae.

Factors related to preventive practices and presence of mosquito breeding sites. Preventive measures taken by people in the community to avoid mosquito–man contact, and presence of mosquito breeding sites at participant premises

were tested for their relation with general characteristics, dengue risk perception and dengue knowledge of the study population using univariate analyses (Table 5). A higher knowledge score ($P = 0.020$) and a previous dengue infection ($P = 0.030$) were associated with preventive practices (Table 5). Because the variable of "preventive practices" was not suitable for a linear logistic regression—the residuals did not show a normal distribution—this variable was dichotomized based on the median. The individuals performing a lower number of preventive practices (zero or one preventive practices; N = 51) were compared with the individuals performing a higher number of preventive practices (two or more; N = 40). The final model of the binary logistic regression of the preventive practices showed no significant associations with the knowledge score (odds ratio [OR] = 1.17; 95% confidence interval [CI] = 0.91–1.50; $P = 0.229$) or with a previous dengue infection (OR = 1.83; 95% CI = 0.72–4.70; $P = 0.207$). No variables were (independently) associated with the presence of mosquito breeding sites. The significant results of the univariate analyses of determinants for knowledge and preventive practices were visualized in a KAP-framework in Figure 2.

DISCUSSION

In an effort to elucidate the determinants of community behavior in relation to mosquito preventive practices, we performed a cross-sectional KAP survey in three neighborhoods

TABLE 4
Measures mentioned by individuals to avoid mosquito–man contact

Measure (households: N = 91)	n	(%)
Repellents	44	(48.4)
Insecticides	39	(42.9)
Fan	11	(12.1)
Mosquito nets	11	(12.1)
Mosquito repellent tablets/coil	11	(12.1)
Burning cardboard	7	(7.7)
Air conditioning	6	(6.6)
Door and window screens	5	(5.5)
Repelling plants	5	(5.5)
Herbal infusions/repelling oils	3	(3.3)
Other†	8	(8.8)

* The percentage corresponds to the number of households mentioning the use of the preventive measure. Because more than one answer was possible, the total does not add up to 100%.

† Mosquito annihilation lamps; electric racquets; incense; close doors; "we lock ourselves in the house."

FIGURE 1. Sources for mosquito breeding sites found. Proportion of breeding sites of the total sample size ($N = 90$). Other breeding sites included: discarded toilet; gutter; puddle, ponds. This figure appears in color at www.ajtmh.org.

in Maracay City, Aragua State, Venezuela. We found that although one or more preventive practices against mosquito bites were reported in 80% of the households, almost 60% of these had potential mosquito breeding sites in their premises with most of them positive for *Aedes* larvae or pupae. A higher knowledge on dengue transmission and symptoms and having had a previous dengue infection were associated with performing a higher number of preventive practices, based on univariate analyses.

The use of preventive measures was widespread in the community with four of five households reporting at least one method to avoid contact with mosquitos. Repellents and insecticide sprays were the most popular among the different anti-mosquito methods reported, in agreement with a study in Jamaica²⁶ and Puerto Rico.²⁷ Contrary to our results, studies in Sri Lanka,²⁸ Pakistan,²⁹ and Laos³⁰ found that mosquito nets were a popular method of protection against dengue. However, this may not always be effective because mosquito nets are used at night whereas *Ae. aegypti* feeds at daytime.²⁸ Interestingly, not all preventive measures were recognized as such by the interviewees: even though almost every household had an air conditioning in one or more of the rooms, only a few stated that staying in the room with air conditioning was a way to avoid mosquito bites.

Despite that interviewees seemed to put effort in protecting themselves against dengue, more than half of the examined households contained potential *Aedes* spp. breeding sites. This suggests that community awareness of the importance of identifying and eliminating breeding sites within their houses (indoors) and gardens/patios (outdoors) may not be high. No associations were found between the number or presence of *Aedes* breeding sites in people's households and any of the variables studied. Several previous studies found an association between presence of mosquito breeding sites and dengue knowledge,^{31,32} whereas others found no association, such as the present study.³³ It should be noted that the studies differ in

their ways of determining knowledge on dengue and the methods used to explore the relation between knowledge and practices.³⁴

Several barriers for mosquito breeding site elimination have been identified among which are misconceptions about dengue, invisibility of dengue compared with other (chronic) diseases and the lack of acceptance of responsibility for dengue prevention.²⁷ Others found that a lack of self-efficacy, lack of perceived benefit, and a low or unsure perceived susceptibility play a role as barriers for dengue larvae control.³⁵ Interviewees who stated to feel at risk because they are convinced that the mosquitos come from mountains, hills, rivers, or canals nearby (see Table 3), might not see the benefit of removing breeding sites from their premises. The same accounts for those expressing a low perceived susceptibility ("*I am immune to dengue*," "*I scare mosquitos*," see Table 3). In Puerto Rico, it was found that although most people recognized the need to eliminate breeding sites, some perceived it as a useless effort because mosquitos are always present. Instead they used repellents, insecticides, and screens to protect themselves from dengue.²⁷ In our study, mosquito breeding sites were mainly found outdoors with the most frequent being small plastic or metal containers, and buckets or containers from 10 to 20 L (see Figure 1). Living in a dwelling where water was stored, long-lasting deficits in public services such as frequent and prolonged interruptions in water supply and electricity, and irregular garbage collection have been associated with higher dengue incidence and persistence in Maracay.^{18,36} Shortage of piped-water supply has worsened in recent years in Venezuela, prompting people to store water intra-domiciliary maintaining adequate breeding conditions for dengue vectors during the dry season and throughout the year.^{17,18,36,37} The relationship between irregular water supply, water storage in the community, and an increase in *Ae. aegypti* habitats has been described before.^{38–40}

Almost everyone had heard of dengue through on average two different sources. Television and information received at health centers were, next to word-of-mouth, the most frequently reported dengue information fonts, in agreement with a study in Laos.³⁰ Information received via television was also found to be the most prominent source in studies in Jamaica and Sri Lanka,^{28,41} suggesting this medium is well suited for informing communities about dengue. Media coverage is important to inform the community about dengue prevention. In a focus group study on dengue in Puerto Rico, women defined the concept of an "important problem" as a situation that is presented in the newspapers and on television news programs. Limited presence in the media might cause people to minimize the importance of the disease and its prevention.²⁷

With regard to the individual's risk perception of the disease, almost everyone was aware of the potential lethality of a dengue infection and the majority (70%) of the people felt that they or their child were at risk of acquiring dengue. Apart from risk perception, we attempted to measure people's general dengue knowledge by assessing both knowledge about dengue transmission and dengue symptoms. The results point out that the interviewees had an average knowledge about dengue symptoms but a good understanding about its transmission route. Almost everyone knew that dengue is transmitted by mosquitos. A few people additionally mentioned that dengue is transmitted by stagnant water; however, it is likely that in general this was meant as a source of mosquitos rather than

TABLE 5
Univariate analyses of preventive practices and presence of mosquito breeding sites

	Number of preventive practices taken*			Presence of mosquito breeding sites†			
	n	Quartiles	Mean (SD)	No		Yes	
				n	(%)	n	(%)
Age							
18–30	35	1–1–3	1.60 (1.26)	9	(30.0)	14	(34.1)
31–50	29	1–1–2.5	1.72 (1.22)	9	(30.0)	16	(39.0)
> 50	25	0–1–3	1.60 (1.58)	12	(40.0)	11	(26.8)
P value		0.787‡			0.492§		
Gender							
Females	79	1–1–3	1.68 (1.37)	25	(80.6)	36	(87.8)
Males	12	1–1–2	1.42 (1.00)	6	(19.4)	5	(12.2)
P value		0.697			0.513¶		
Place of residence							
Candelaria	60	1–1–3	1.68 (1.38)	22	(71.0)	31	(75.6)
Cooperativa	11	1–1–2	1.27 (1.01)	0	(0.0)	0	(0.0)
Caña de Azúcar	20	1–2–3	1.75 (1.33)	9	(29.0)	10	(24.4)
P value		0.631‡			0.658§		
Education							
Illiterate/pre- or primary school#	14	0–1–2	1.36 (1.50)	6	(20.0)	8	(19.5)
Secondary school	49	1–1–2.5	1.67 (1.28)	14	(46.7)	17	(41.5)
University/university polytechnic	27	1–1–3	1.81 (1.33)	10	(33.3)	16	(19.0)
P value		0.437‡			0.877§		
Occupation							
Student	14	0.75–1–2.25	1.57 (1.40)	5	(16.7)	4	(9.8)
Labor: housewife/domestic worker/ manual worker	48	1–1–3	1.77 (1.43)	17	(56.7)	19	(46.3)
Nonlabor: merchant/employee/office worker/professional/university staff	28	1–1–2	1.54 (1.10)	8	(26.7)	18	(43.9)
P value		0.848‡			0.333¶		
Religion							
No religion	5	0.5–2–2.5	1.60 (1.14)	2	(6.7)	2	(5.0)
Catholic	66	1–1–2.25	1.61 (1.39)	23	(76.7)	29	(72.5)
Other christian/protestant/evangelist**	16	1–2–3	1.88 (1.20)	5	(16.7)	9	(22.5)
P value		0.645‡			0.813¶		
Monthly income (VEF)††							
≤ 7,000 VEF	38	1–2–3	1.89 (1.41)	9	(42.9)	17	(48.6)
> 7,000 VEF	38	1–1–3	1.68 (1.38)	12	(57.1)	18	(51.4)
P value		0.501			0.678§		
Socioeconomic status							
Low	38	0.75–1–3	1.68 (1.45)	8	(36.4)	15	(40.5)
Average	30	1–1–2.25	1.60 (1.40)	7	(31.8)	12	(32.4)
High	22	1–1–3	1.68 (1.04)	7	(31.8)	10	(27.0)
P value		0.847‡			0.917§		
Previous dengue infection							
No	61	1–1–2	1.41 (1.20)	22	(71.0)	29	(70.7)
Yes	27	1–2–3	2.15 (1.51)	9	(29.0)	12	(29.3)
P value		0.030			0.983§		
Risk perception							
Not feeling at risk	24	1–1–2	1.46 (1.14)	12	(38.7)	11	(27.5)
Feeling at risk	65	1–1–3	1.68 (1.39)	19	(61.3)	29	(72.5)
P value		0.662			0.317§		
Knowledge score‡‡ P value		0.020§§ correlation coefficient: 0.243			0.682		

SD = standard deviation. P values in bold are statistically significant.

* Statistical tests were performed using a standardized variable.

† P values were derived from the comparison of proportions/means between presence of mosquito breeding sites or not.

‡ P values were derived from a comparison of mean preventive practices taken using Kruskal–Wallis test.

§ P values were derived from the comparison of proportions/means between presence of mosquito breeding sites or not using a Chi-square test.

|| P values were derived from a comparison of mean preventive practices taken using Mann–Whitney U test.

¶ P values were derived from the comparison of proportions/means between presence of mosquito breeding sites or not using a Fisher's exact test.

One person was illiterate.

** One person was a Jehovah's witness.

†† Minimum wages at the time of the study ranged between VEF 2703 and VEF 3270.

‡‡ Range knowledge score: 1–9 correct answers.

§§ P values were derived from a correlation with the amount of preventive practices taken using a Spearman's Rho.

||| P values were derived from the comparison of proportions/means between presence of mosquito breeding sites or not using a Student's t-test.

the actual source of infection. The good understanding about dengue transmission and the potential risk of infection originated by breeding sites is also reflected in the reasons people gave for (not) feeling at risk, such as the alleged absence or presence of uncovered stored water in the vicinity. As for the symptoms of dengue, people were able to name on average

four correct symptoms and almost everyone mentioned the most important symptom of dengue, which is fever. Similar levels of dengue knowledge were found in Costa Rica and Cuba.^{34,42} However, studies in Jamaica found a much lower symptom knowledge level.^{41,42} These differences and similarities might be explained by variations in dengue endemicity

FIGURE 2. Factors related to knowledge and preventive practices. This model was drafted based on the knowledge, attitude, and practices framework. Associations with $P \leq 0.05$ are displayed. All relations are positive relations, based on univariate analyses where either “knowledge” or “preventive practices” were considered to be the dependent variables. If an arrow has two arrowheads, we assumed that causality could go either way.

in other geographical areas and/or the nature and frequency of national dengue campaigns.

Thus, even though most individuals had heard of dengue and felt at risk, and had a good knowledge of dengue transmission and of the risk factors involved, more than half of the examined households contained mosquito breeding sites. This suggests that dengue prevention in Maracay, Venezuela, is predominantly focused toward avoiding mosquito bites rather than elimination of their breeding sites. In our study, the number of preventive practices related to personal protection against mosquitos was associated with a higher level of dengue knowledge, suggesting that a gain in knowledge might lead to changing practices. Similar results were found in Laos³⁰ and Puerto Rico,⁴³ but not in Thailand.³²

Preventive practices were also associated with a previous dengue infection. Concomitantly, we found a positive relation between a past dengue episode and dengue knowledge (Figure 2). Other studies provide possible explanations for these interrelations. First, people with a previous dengue episode might be more inclined toward seeking information about the disease and its prevention, as was suggested in a study in Pakistan.⁴⁴ Second, in Costa Rica people with a previous dengue infection perceived preventive practices as more important.⁴² In the same study, interviewees considered that education and having had a previous dengue infection were the most effective ways to convince others to perform more preventive practices.⁴²

In our study, we found no association between dengue risk perception and the number of preventive practices reported, contrary to a study in Cuba.³⁴ The positive relationship between knowledge about dengue and risk perception was previously described in Cuba too.³⁴ In Venezuela, there is a high awareness about dengue given the current perennial transmission and the co-circulation of the four dengue serotypes, which increases the incidence of severe disease.⁴ Notwithstanding, people tend to expect the Ministry of Health and the government to take action with respect to the

elimination of mosquito breeding sites and protective measures against dengue such as insecticide fogging of the community.⁴⁵ Similar attitudes are reported in other countries such as Cuba,⁴⁶ Yemen,⁴⁷ Curaçao,⁴⁸ Pakistan,²⁹ and Puerto Rico.²⁷

Because of anti-governmental protests in early 2014 in Venezuela,^{17–19} we were not able to carry out all the 260 intended interviews, resulting in a smaller sample size of 105. This reduced the possibility of detecting associations that are small or moderate in magnitude. The variable measuring preventive practices was not suitable for a linear logistic regression. We therefore decided to perform a binary regression with a dichotomized variable. This probably reduced the statistical power and could be the reason for not finding independent significant relations in the multivariate analyses. Furthermore, the interviewed individuals were mainly women, which may have implications for the generalizability of our results to the whole population in Maracay. However, it is important here to note that in Venezuela mainly women take the responsibility for running the household or are actually the household heads, therefore, we assume that they are the main decision-makers with regard to dengue prevention and health care in general. We therefore believe that the results of this study are representative of the population of Maracay city, and to a lesser extent also of other urban areas of Venezuela. A strength of the study was that the interviews were conducted in people’s own homes, providing a safe and familiar environment. Because the overarching cohort study, there was a large amount of data available from the sample used in this particular study, which was used to interpret the results. In the cohort study, spatial analyses were performed to reveal hotspots of dengue transmission.⁴⁹ The proposed vector-control policies can be optimized if these are implemented using this geographic information system-based study site map.⁴⁹ Therefore, we believe that our study offers valuable insights in the KAP regarding dengue in this community.

Clarifying determinants of dengue related practices provides input for developing effective community mobilization and communication strategies to promote behavioral change as part of routine vector-control programming.⁵⁰ Further research has to identify communities' knowledge on the vector and prevention of dengue and how this knowledge is put into practice. In addition, possible barriers for elimination of potential mosquito breeding sites in this community should be identified. This would be valuable in the process of designing evidence-based programs to achieve community involvement in the combat against dengue in Venezuela and possibly other similar populations in Latin America.

Received July 3, 2017. Accepted for publication April 2, 2018.

Published online May 29, 2018.

Acknowledgments: We are very grateful to the study participants who gave their time to participate in the study. We would like to thank the nurses Iris Alfonsina Liendo and Mery Suheylis Tortolero for their support in the data collection, and Gloria Sierra and Guillermo Comach and the Laboratorio Regional de Diagnóstico e Investigación del Dengue y otras Enfermedades Virales, Instituto de Investigaciones Biomédicas de la Universidad de Carabobo (Maracay, Venezuela) for hosting Jelte Elsinga during the data collection in Venezuela.

Financial support: This work was supported by the Fondo Nacional de Ciencia y Tecnología e Innovación (FONACIT) of the Ministerio del Poder Popular para Ciencia, Tecnología e Industrias Intermedias (MPPCTII, Venezuelan Ministry of Science, Technology and Intermediate Industries), Venezuela (201100129, 201300201) and by the University Medical Center Groningen (UMCG), University of Groningen, Groningen, The Netherlands. J. E. received a grant from the UMCG, University of Groningen, Groningen, The Netherlands.

Disclaimer: The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Authors' addresses: Jelte Elsinga, Masja Schmidt, Erley Lizarazo, and Maria F. Vincenti-Gonzalez, Department of Medical Microbiology, University Medical Center Groningen, Groningen, The Netherlands, E-mails: j.elsinga.research@gmail.com, schmidtmasja@gmail.com, e.f.lizarazo.forero@umcg.nl, and m.f.vincenti.gonzalez@umcg.nl. Zoraida I. Velasco-Salas, Departamento de Biología, Facultad Experimental de Ciencia y Tecnología, Universidad de Carabobo, Valencia, Venezuela, E-mail: zvelasco@hotmail.com. Luzlexis Arias, Instituto de Investigaciones Biomédicas "Dr. Francisco J. Triana Alonso", Maracay, Venezuela, E-mail: luzdv.arias@gmail.com. Johannes G. M. Burgerhof, Department of Epidemiology, University Medical Center Groningen, Groningen, The Netherlands, E-mail: j.g.m.burgerhof@umcg.nl. Adriana Tami, Department of Medical Microbiology, University Medical Center Groningen, Groningen, The Netherlands, and Departamento de Parasitología, Facultad de Ciencias de la Salud, Universidad de Carabobo, Valencia, Venezuela, E-mail: a.tami@umcg.nl.

REFERENCES

- Bhatt S et al., 2013. The global distribution and burden of dengue. *Nature* 496: 504–507.
- San Martin JL, Brathwaite O, Zambrano B, Solorzano JO, Bouckennooghe A, Dayan GH, Guzmán MG, 2010. The epidemiology of dengue in the Americas over the last three decades: a worrisome reality. *Am J Trop Med Hyg* 82: 128–135.
- Brathwaite Dick O, San Martin JL, Montoya RH, del Diego J, Zambrano B, Dayan GH, 2012. The history of dengue outbreaks in the Americas. *Am J Trop Med Hyg* 87: 584–593.
- Barrera R, Delgado N, Jiménez M, Villalobos I, Romero I, 2000. Estratificación de una ciudad hiperendémica en dengue hemorrágico. *Rev Panam Salud Publica* 8: 225–233.
- Morrison AC, Zielinski-Gutiérrez E, Scott TW, Rosenberg R, 2008. Defining challenges and proposing solutions for control of the virus vector *Aedes aegypti*. *PLoS Med* 5: e68.
- Chang MS, Christophel EM, Gopinath D, Abdur RM, Malaria, Vectorborne O, Diseases P; World Health Organization Regional Office; Western Pacific, 2011. Challenges and future perspective for dengue vector control in the Western Pacific Region. *Western Pac Surveill Response J* 2: 9–16.
- Gubler DJ, 2011. Dengue, urbanization and globalization: the unholy trinity of the 21st century. *Trop Med Health* 39 (Suppl): 3–11.
- Luz PM, Vanni T, Medlock J, Paltiel AD, Galvani AP, 2011. Dengue vector control strategies in an urban setting: an economic modelling assessment. *Lancet* 377: 1673–1680.
- Leontsini E, Gil E, Kendall C, Clark GG, 1993. Effect of a community-based *Aedes aegypti* control programme on mosquito larval production sites in El Progreso, Honduras. *Trans R Soc Trop Med Hyg* 87: 267–271.
- Sanchez L, Perez D, Perez T, Sosa T, Cruz G, Kouri G, Boelaert M, Van der Stuyt P, 2005. Intersectoral coordination in *Aedes aegypti* control. A pilot project in Havana City, Cuba. *Trop Med Int Health* 10: 82–91.
- Spiegel J, Bennett S, Hattersley L, Hayden MH, Kittayapong P, Nalim S, Wang DNC, Zielinski-Gutiérrez E, Gubler D, 2005. Barriers and bridges to prevention and control of dengue: the need for a social–ecological approach. *EcoHealth* 2: 273–290.
- Gumicio S, Merica M, Luhman N, Fauvel G, Zompi S, Ronsse A, 2011. *The KAP Survey Model (Knowledge, Attitudes & Practices): Médecins du Monde*.
- Barrera R, Avila J, Gonzalez-Tellez S, 1993. Unreliable supply of potable water and elevated *Aedes aegypti* larval indices: a causal relationship? *J Am Mosq Control Assoc* 9: 189–195.
- Instituto Nacional de estadística (INE), 2013. *XIV Censo Nacional de la Población y Vivienda. Resultados por Entidad Federal y Municipio del Estado Aragua*. Available at: http://www.ine.gov.ve/index.php?option=com_content&view=category&id=95&Itemid=26#. Accessed January 5, 2014.
- Comach G et al., 2009. Dengue virus infections in a cohort of schoolchildren from Maracay, Venezuela: a 2-year prospective study. *Vector Borne Zoonotic Dis* 9: 87–92.
- Velasco-Salas ZI, Sierra GM, Guzman DM, Zambrano J, Vivas D, Comach G, Wilschut JC, Tami A, 2014. Dengue seroprevalence and risk factors for past and recent viral transmission in Venezuela: a comprehensive community-based study. *Am J Trop Med Hyg* 91: 1039–1048.
- Oletta JF, Orihuela RA, Pulido P, Walter C, 2014. Venezuela: violence, human rights, and health-care realities. *Lancet* 383: 1967.
- Tami A, 2014. Venezuela: violence, human rights, and health-care realities. *Lancet* 383: 1968–1969.
- Acquatella H, Rodríguez L, Michelena HI, 2014. Venezuelan unrest increases pressure on health services. *Lancet* 383: 1969.
- Elsinga J, Lizarazo EF, Vincenti MF, Schmidt M, Velasco-Salas ZI, Arias L, Bailey A, Tami A, 2015. Health seeking behaviour and treatment intentions of dengue and fever: a household survey of children and adults in Venezuela. *PLoS Negl Trop Dis* 9: e0004237.
- González R, Darsie RF Jr., 2011. Clave ilustrada para la determinación genérica de larvas de Culicidae de Colombia y el Nuevo Mundo. *Bol Mus Entomol Univ Del Valle* 4: 21–37.
- Rossi GC, Almirón WR, 2004. Clave ilustrada para la identificación de larvas de mosquitos de interés sanitario encontradas en criaderos artificiales en la Argentina. Publicaciones Mundo Sano. *Serie Enfermedades Transmisibles* 5: 53.
- Salamanca M, Londoño B, Urquijo L, Díaz A, Padilla J, 2013. *Gestión para la Vigilancia Entomológica y Control Para la Transmisión del Dengue*. Bogotá, Colombia: Plan Nacional de Salud Pública.
- Vyas S, Kumaranayake L, 2006. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy Plan* 21: 459–468.
- Krishnan V, 2010. *Constructing an Area-Based Socioeconomic Index: A Principal Components Analysis Approach*. Edmonton, Alberta: Early Child Development Mapping Project.
- Stoler J, Brodine SK, Bromfield S, Weeks JR, Scarlett H, 2011. Exploring the relationships between dengue fever knowledge and *Aedes aegypti* breeding in St. Catherine Parish, Jamaica: a

- pilot of enhanced low-cost surveillance. *Res Rep Trop Med* 2: 93–103.
27. Pérez-Guerra CL, Zielinski-Gutierrez E, Vargas-Torres D, Clark GG, 2009. Community beliefs and practices about dengue in Puerto Rico. *Rev Panam Salud Publica* 25: 218–226.
28. Gunasekara TDCP, Velathanthiri VGNS, Weerasekara MM, Fernando SSN, Peelawattage M, Guruge D, Fernando S, 2012. Knowledge, attitudes and practices regarding dengue fever in a suburban community in Sri Lanka. *Galen Med J* 17: 10–17.
29. Syed Met al., 2010. Knowledge, attitudes and practices regarding dengue fever among adults of high and low socioeconomic groups. *J Pak Med Assoc* 60: 243–247.
30. Mayxay M, Cui W, Thammavong S, Khensakhou K, Vongxay V, Inthasoum L, Sychareun V, Armstrong G, 2013. Dengue in peri-urban Pak-Ngum district, Vientiane capital of Laos: a community survey on knowledge, attitudes and practices. *BMC Public Health* 13: 434.
31. Sanchez L, Perez D, Cruz G, Castro M, Kouri G, Shkedy Z, Vanlerberghe V, Van der Stuyft P, 2009. Intersectoral co-ordination, community empowerment and dengue prevention: six years of controlled interventions in Playa Municipality, Havana, Cuba. *Trop Med Int Health* 14: 1356–1364.
32. Koenraadt CJ, Tuiten W, Sithiprasasna R, Kijchalao U, Jones JW, Scott TW, 2006. Dengue knowledge and practices and their impact on *Aedes aegypti* populations in Kamphaeng Phet, Thailand. *Am J Trop Med Hyg* 74: 692–700.
33. Rosenbaum J, Nathan MB, Ragoonanansingh R, Rawlins S, Gayle C, Chadee DD, Lloyd LS, 1995. Community participation in dengue prevention and control: a survey of knowledge, attitudes, and practice in Trinidad and Tobago. *Am J Trop Med Hyg* 53: 111–117.
34. Castro M, Sánchez L, Pérez D, Sebrango C, Shkedy Z, Van der Stuyft P, 2013. The relationship between economic status, knowledge on dengue, risk perceptions and practices. *PLoS One* 8: e81875.
35. Wong LP, AbuBakar S, 2013. Health beliefs and practices related to dengue fever: a focus group study. *PLoS Negl Trop Dis* 7: e2310.
36. Barrera R, Delgado N, Jiménez M, Valero S, 2002. Eco-epidemiological factors associated with hyperendemic dengue haemorrhagic fever in Maracay City, Venezuela. *Dengue Bull* 26: 84–95.
37. Pham HV, Doan HT, Phan TT, Minh NN, 2011. Ecological factors associated with dengue fever in a Central Highlands province, Vietnam. *BMC Infect Dis* 11: 172.
38. Caprara A, Lima JW, Marinho AC, Calvasina PG, Landim LP, Sommerfeld J, 2009. Irregular water supply, household usage and dengue: a bio-social study in the Brazilian Northeast. *Cad Saude Publica* 25: S125–S136.
39. Swaddiwudhipong W, Chaovakiratipong C, Nguntra P, Koonchote S, Khumklam P, Lerdlukanavong P, 1992. Effect of health education on community participation in control of dengue hemorrhagic fever in an urban area of Thailand. *Southeast Asian J Trop Med Public Health* 23: 200–206.
40. Schmidt W et al., 2011. Population density, water supply, and the risk of dengue fever in Vietnam: cohort study and spatial analysis. *PLoS Med* 8: e1001082.
41. Shuaib F, Todd D, Campbell-Stennett D, Ehiri J, Jolly PE, 2010. Knowledge, attitudes and practices regarding dengue infection in Westmoreland, Jamaica. *West Indian Med J* 59: 139–146.
42. Egedus VL, Morales Ortega J, Alfaro Obando A, 2014. Knowledge, perceptions, and practices with respect to the prevention of dengue in a mid-Pacific coastal village of Costa Rica. *Rev Biol Trop* 62: 859–867.
43. Winch PJ, Leontsini E, Rigau-Perez JG, Ruiz-Perez M, Clark GG, Gubler DJ, 2002. Community-based dengue prevention programs in Puerto Rico: impact on knowledge, behavior, and residential mosquito infestation. *Am J Trop Med Hyg* 67: 363–370.
44. Itrat A, Khan A, Javaid S, Kamal M, Khan H, Javed S, Kalia S, Khan AH, Sethi MI, Jehan I, 2008. Knowledge, awareness and practices regarding dengue fever among the adult population of dengue hit cosmopolitan. *PLoS One* 3: e2620.
45. Camacho DE, Alvarez M, Rodriguez-Henriquez F, de Quintana M, Soler M, Chiarello A, Sierra G, Comach G, 2003. Laboratory diagnosis of dengue virus infections in Aragua State, Venezuela: October 1997–December 1998. *Invest Clin* 44: 91–103.
46. Toledo-Romani ME, Baly-Gil A, Ceballos-Ursula E, Boelaert M, Van der Stuyft P, 2006. Participación comunitaria en la prevención del dengue: un abordaje desde la perspectiva de los diferentes actores sociales. *Salud Publica Mex* 48: 39–44.
47. Saied KG, Al-Taiar A, Altaire A, Alqadsi A, Alariqi EF, Hassaan M, 2015. Knowledge, attitude and preventive practices regarding dengue fever in rural areas of Yemen. *Int Health* 7: 420–425.
48. Elsinga J, van der Veen HT, Gerstenbluth I, Burgerhof JG, Dijkstra A, Grobusch MP, Tami A, Bailey A, 2017. Community participation in mosquito breeding site control: an interdisciplinary mixed methods study in Curaçao. *Parasit Vectors* 10: 434.
49. Vincenti-Gonzalez MF, Grillet ME, Velasco-Salas ZI, Lizarazo EF, Amarista MA, Sierra GM, Comach G, Tami A, 2017. Spatial analysis of dengue seroprevalence and modeling of transmission risk factors in a dengue hyperendemic city of Venezuela. *PLoS Negl Trop Dis* 11: e0005317.
50. Department of Control of Neglected Tropical Diseases; World Health Organization, 2009. *Dengue: Guidelines for Diagnosis, Treatment, Prevention and Control*. Geneva, Switzerland: World Health Organization.