Health & Place 63 (2020) 102339

Contents lists available at ScienceDirect

Health and Place

journal homepage: http://www.elsevier.com/locate/healthplace

Knowledge, attitudes, and practices regarding dengue, chikungunya, and Zika in Cali, Colombia.

M.R. Desjardins [a,*], I. Casas [b], A.M. Victoria [c], D. Carbonell [d], D.M. Dávalos [c], E.M. Delmelle [e]

[a] Department of Epidemiology & Spatial Science for Public Health Center. Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, 21205, USA
[b] Department of Social Sciences, Louisiana Tech University, Ruston, LA, 71272, USA
[c] Department of Public Health and Community Medicine, Universidad Icesi, Cali, Colombia
[d] Department of Health Sciences, Universidad Libre Seccional Cali, Cali, Colombia
[e] Department of Geography and Earth Sciences & Center for Applied Geographic Information Science. University of North Carolina at Charlotte, Charlotte, NC, 28223, USA

ARTICLE INFO

Keywords:
Vector-borne disease
Community surveys
Dengue
Chikungunya
Zika

ABSTRACT

Dengue fever (DENF), chikungunya (CHIK), and Zika are responsible for the majority of the burden caused by vector-borne diseases (VBDs); which are produced by viruses primarily transmitted by the *Aedes* mosquito. *Aedes* have become prolific in urban areas due to a combination of climate change, rapid urbanization, increased human mobility, and globalization, causing the three VBDs to emerge in novel regions. Community knowledge can provide detailed insights about the spatial heterogeneity of disease risk and rates within a particular region, improving public health interventions. Knowledge, Attitude, and Practice (KAP) surveys are used to shed light on at-risk communities' understanding of the vector, the pathogen, prevention and treatment strategies. Little is known how KAP varies among diseases, and among neighborhoods within a city. Understanding KAP variation among co-circulating VBDs at a fine-level, especially differences between endemic and emerging diseases, can improve targeted interventions, education programs, and health policy. We administered KAP surveys to 327 individuals in healthcare centers and selected neighborhoods in Cali, Colombia in June 2019. We utilized generalized linear models (GLMs) to identify significant predictors of KAP. Our findings suggest that knowledge is related to community characteristics (e.g. strata), while attitudes and practices are more related to individual-level factors. Access to healthcare also forms significant predictor of residents participating in preventative practices. The results can be leveraged to inform public health officials and communities to motivate at-risk neighborhoods to take an active role in vector surveillance and control, while improving educational and surveillance resources in Cali, Colombia.

1. Introduction

Dengue fever (DENF), chikungunya (CHIK), and Zika are three vector-borne diseases (VBDs) transmitted by the *Aedes aegypti and Ae. albopictus* mosquitos (Harrington et al., 2001; Chouin-Carneiro et al., 2016). In general, VBDs are responsible for approximately 1 billion infections and 1 million deaths per year globally (World Health Organization, 2014); DENF, CHIK, and Zika cause the majority of mosquito-borne diseases (Wang et al., 2016). While CHIK and Zika first emerged in the Americas in 2013, DENF has been endemic in the region for decades.

There are five known serotypes of the DENF virus, the fifth variant follows the sylvatic cycle and the first four follow the human cycle (Mustafa et al., 2015). Approximately 80% of infected dengue individuals are asymptomatic. An infection from one serotype will result in lifelong immunity to that serotype, however, a secondary infection with another serotype can lead to severe forms of DENF, such as dengue hemorrhagic fever and dengue shock syndrome. Between 50 and 97% of those infected with CHIK will be symptomatic (Nakkhara et al., 2013), and chronic complications after the acute infection subsides are common. Symptoms of chronic CHIK may include polyarthritis and polymyalgias, which can persist for months and even several years, resulting in mobility issues (Sissoko et al., 2009; Hoarau et al., 2010; Simon et al., 2011). An estimated 80% of individuals infected with the Zika virus are asymptomatic (Duffy et al., 2009). Non-vector-borne modes of transmission are also possible for Zika, including sexual contact, blood

* Corresponding author. 627 N Washington Street, Floor 2, Baltimore, MD, 21205, USA.
E-mail address: mdesjar3@jhmi.edu (M.R. Desjardins).

https://doi.org/10.1016/j.healthplace.2020.102339
Received 31 October 2019; Received in revised form 5 March 2020; Accepted 6 April 2020
Available online 21 April 2020

transfusions, and vertically via pregnant mother to child (Calvet et al., 2016). Furthermore, congenital disorders are associated with Zika, especially microcephaly and Congenital Zika Syndrome (Guilland, 2016). In rare cases, Zika has been linked to neurological disorders, including Guillain–Barré Syndrome, acute myelitis, and meningoencephalitis (Araujo et al., 2016; Calle-Giraldo et al., 2019).

It is critical to implement surveillance strategies that can improve the understanding of DENF, CHIK, and Zika transmission. VBD surveillance can facilitate the timely reporting of disease cases, reduce underreporting, inform policymakers, increase disease awareness, define funding and research priorities (Toan et al., 2015); ultimately reducing the economic and public health burden in at-risk locations around the world (Shepard et al., 2016). For example, improved VBD surveillance can reduce viral transmission by reducing available vector habitats, influencing behavioral changes (Gubler and Clark, 1994; Healy et al., 2014) to improve bite prevention techniques (i.e. repellants, clothing, and community control programs).

For this study, we evaluate local familiarity with DENF, CHIK, and Zika transmission and intervention and preventative strategies in Cali, Colombia using the Knowledge, Attitude, and Practice (KAP) surveying approach. The KAP survey approach was first used in 1950s in the domains of family planning and population studies and are now widely used to study public health (Launiala, 2009). KAP studies are widely regarded as easily conductible, measurable, and interpretable (Raina, 2013). Within the context of VBD research, KAP approaches are used to shed light on at-risk communities' understanding and behaviors related to the vector, the pathogen, prevention and treatment strategies (Potter et al., 2016; Udayanga et al., 2018). Social, cultural, political, and economic factors affect human behavior, which in turn can influence the transmission, emergence, and distribution of VBDs (Heintze et al., 2007). The results of KAP studies can be used to improve vector control and management strategies by understanding how human knowledge, behavior, and decisions may influence VBD risk (Alobuia et al., 2015).

Several studies have utilized KAP-type surveys to examine DENF, CHIK, and Zika (Fritzell et al. 2016, 2018; Higuera-Mendieta et al., 2016; Wong et al. 2016, 2017; Corrin et al., 2017; Diaz-Quijano et al., 2018; Samuel et al., 2018; Udayanga et al., 2018). Fritzell et al. (2016) found that French Guiana residents had less understanding of CHIK than DENF, while education and living in single family homes were positively associated with more knowledge of CHIK. Wong et al. (2017) compared perceptions of DENF and Zika in Malaysia, suggesting that respondents believed DENF was more severe than Zika, while personally knowing someone who died from DENF was associated with higher perceived severity of Zika. Corrin et al. (2017) provided a systematic review of KAP studies that examined CHIK; finding that KAP of CHIK among the public and health professionals varied across populations. Furthermore, they found that although knowledge of CHIK is higher in affected areas, a large proportion of the population does not well understand the risks posed by the disease to protect themselves and their communities.

While KAP has been utilized in Asia and Central and South America, it is not well understood how KAP results vary among DENF, CHIK, and Zika; and between different neighborhoods within a municipality. Understanding KAP variation among concurrent VBDs, especially the differences between endemic and novel diseases can improve targeted interventions, education programs and health policy. Colombia is a prime candidate for understanding KAP variation due to the presence of three VBDs transmitted by *Ae. aegypti* and *Ae. albopictus*: dengue (endemic), chikungunya (novel), and Zika (novel). Whiteman et al. (2018) highlight the importance of understanding community perceptions of co-circulating VBDs caused by the same vector (DENF, CHIK, and Zika). They found that low income, low education, and elderly residents should be prioritized when improving education and vector surveillance programs, while participants had better knowledge of DENF than CHIK and Zika. However, Whiteman et al. (2018) did not sample residents from middle socioeconomic status (SES) neighborhoods; their sample only included residents from four neighborhoods, which may not encompass KAP variation across an entire administrative area (e.g. Panama City). Furthermore, KAP results may not be necessarily generalizable to other regions due to sociocultural, socioeconomic, and institutional factors.

The purpose of this study is to utilize community surveys to identify the role of neighborhood and individual level factors on knowledge, attitudes, and preventative practices regarding three co-circulating VBDs in Cali, Colombia. We support the notion that perceptions and behavior are spatially heterogeneous across space, but could be spatially homogenous within certain boundaries. There is an inherent nexus between health and place (Rudisill et al., 2012; Flamand et al., 2017), therefore, it is critical to capture the community-place-based determinants of VBD risk. The findings of this study provide critical insights about the effectiveness of public health campaigns, areas of improvement regarding intervention strategies, and where to enhance educational programs. We administered KAP surveys to residents in a variety of healthcare centers, universities, and door-to-door in certain neighborhoods during the month of June of 2019.

Among the expected results was that participants would be more familiar with DENF (endemic) than CHIK or Zika (novel/emerging) due to the area under study being endemic. We also expected that participants living in low socioeconomic status neighborhoods would have less knowledge of the three VBDs, participate in less preventative measures, and would be less worried about becoming infected, especially for CHIK and Zika. Furthermore, we also aimed to examine how accessibility to healthcare resources might influence KAP, and we expected that those with poorer accessibility will have less knowledge and participate in less preventative measures. We use a generalized linear modeling approach to identify significant predictors of resident and community KAP of DENF, CHIK, and Zika in Cali. This work is also part of a long-term and ongoing body of research that seeks to improve VBD surveillance in Cali in collaboration with public health officials, the communities, and universities (Hagenlocher et al., 2013; Eastin et al., 2014; Delmelle et al. 2014, 2016; Hohl et al., 2016; Krystosik et al., 2017, 2018; Desjardins et al., 2018).

The remainder of the paper is structured as follows: section 2 describes the study area, sampling design of the KAP survey approach and the methods for analyzing the surveys; section 3 provides descriptive and inferential statistical results; section 4 constitutes a discussion based on key findings; and section 5 provides concluding remarks.

2. Study area & methods

2.1. Study area

The city of Cali is the second-largest city in Colombia and third most populous with an estimated 2019 population of 2.7 million. Cali is very densely populated with an estimated 4900 people per square kilometer. The city is comprised of 340 neighborhoods (Spanish: barrios), which are classified by socioeconomic stratum (see Fig. 1). The stratum classifications are a combination of social class (e.g. income levels) and housing infrastructure and characteristics. The majority of the low strata neighborhoods are in the east, southwest, and western "handle" of Cali; the majority of middle strata neighborhoods are scattered central and western regions; and the high strata neighborhoods are found in the south, and along the west and northern regions. In general, the middle strata neighborhoods typically separate the high from the low, and there are also instances of low strata being adjacent to high strata. According to 2010 estimates, approximately 1.1 million people lived in low strata neighborhoods (1–2); 800,000 in middle (3–4); and 160,000 in high (5–6).

In Colombia, DENF is endemic with increasingly frequent epidemic outbreaks every 2–3 years. The biggest national outbreak in the last 11 years occurred in 2010, cases increased from 9745 in 1992 to 151,774 in 2010 (Castrillón et al., 2015). In January 2019, the Secretary of Health of Valle del Cauca Department where the city of Cali is located

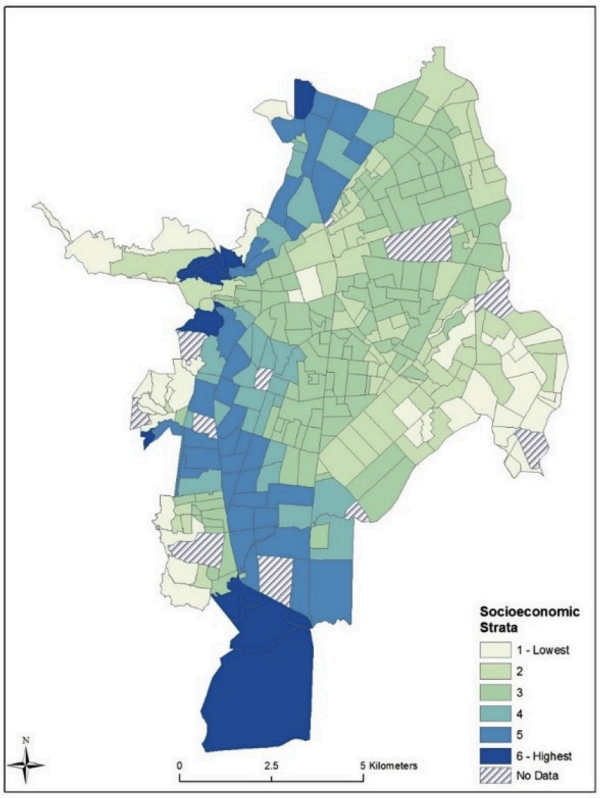

Fig. 1. Socioeconomic stratification for neighborhoods in Cali, Colombia (2010)

(Departments are similar to U.S. states) announced a yellow alert to the probable increase in cases of VBDs throughout the year. Different efforts in community prevention strategies and education managed to control the alert and allowed this region to avoid an epidemic. Still, by September 2019, a total of 2495 cases of DENF, 6 of severe dengue and one death were reported after a 4-year period without dengue-related deaths (Valle del Cauca, 2019). On the other hand, CHIK was first reported in 2014 causing a national epidemic with 106,592 cases (INS, 2014), and since then a total of 488,996 cases has been notified to SIVIGILA (Sistema Nacional de Vigilancia en Salud Pública - National Public Health Surveillance System). In 2015, the highest proportion of cases and national incidence was reported, with 1359 cases per 100,000 inhabitants (INS, 2019). On October 2015, the first cluster of confirmed Zika cases was identified; there were a total of 106,659 reported cases from the start of the outbreak to the final week of 2016 (INS, 2017). During the two following years, the number of cases has decreased significantly, but still persist with the higher proportion in regions such as Valle del Cauca, Putumayo and Santander (INS, 2019).

2.2. Sampling design

Surveys were administered at three different locations: health care centers, universities, and door-to-door to maximize sample size and ensure we captured a wide variation of residents. The healthcare centers targeted are located in each neighborhood strata group (low, medium, high). Out of the 494 healthcare facilities in Cali, we randomly selected 37 that treated DENF, CHIK, and Zika; then contacted the directors of each healthcare institution to request permission to administer our surveys. Five healthcare centers granted permission to survey in their waiting rooms: Clínica Amiga Comfandi, Dime, Comfandi Morichal, Hospitalito Infantil Niño Dios and Comfandi Tequendama, which are found in all three strata groups (see Fig. 2B). Surveys were also conducted at Universidad Icesi and Universidad Libre. Even though the universities are located in the same area of the city, the student population comes from all over town as well as neighboring cities, helping introduce variation in the sample. The last method used to collect surveys was door-to-door. Neighborhoods were selected, as in the case of the universities to add SES variability. Informed verbal consent was obtained from each participant before the survey was administered by a trained researcher. The survey and research protocols were approved by the University of North Carolina at Charlotte's IRB board (UNC-Charlotte Case No. 18–0399); and additional approvals were issued by ethical boards from each university and healthcare center in Cali, Colombia that took part in the survey process. The full survey (both English and Spanish versions) can be found in the supplemental materials. The surveys were filled out by hand by participants in the approved locations.

2.3. Survey instrument

The questionnaire took approximately 15 min to complete and is comprised of six sections: (1) sociodemographic information, (2) general questions, (3) knowledge, (4) attitudes, (5) practices 1, and (6) practices 2. Section 1 collected numerous sociodemographic information, including the participant's address that can be linked with a neighborhood and strata shown in Fig. 1. Section 2 contained questions about previous diagnoses and familiarity with the three VBDs; additionally, we asked respondents about their accessibility to healthcare services. Section 3 was organized around 12 multiple choice and fill-in questions about a participant's knowledge of the VBDs. Section 4 contained twelve statements and utilizes a Likert scale to capture a participant's fear of contracting a disease, prevention responsibility (government or individual), belief of fumigation effectiveness and necessity to seek treatment if infected with a VBD. Section 5 contained five statements and questions regarding the potential risk that sexual intercourse may have on disease transmission, motivation to learn about preventative techniques, and how often fumigation efforts are carried out on their residence and their neighborhood. Finally, section 6 asked participants: "how often do you practice the following measures to prevent mosquitoes in your home/neighborhood?" Nine preventative measures were listed, and a Likert scale was provided to capture the frequency of participation.

2.4. Data coding

Survey answers were coded and entered in a secure database. The address and neighborhood of their home were used for geocoding purposes that allowed us to link their residence to a neighborhood stratum and recoded it accordingly. Answers to non-Likert scale questions were recoded to a specific number (e.g. 1 if a participant ever had DENF, 2 if they had DENF and CHIK or Zika, etc.). Correct answers for the knowledge section were assigned a value of '1' if a participant answered yes to the following: each disease is transmitted by mosquitoes; Zika can be transmitted via sexual contact; there are currently no vaccines available for the three VBDs; a baby is at risk of birth defects if a pregnant woman is infected with each disease; female *Aedes* bite in the morning and afternoon; and people are at a higher risk of contracting the three VBDs during the cities wet seasons (given the tropical location of Colombia, there are no seasons. Climate is based on altitudinal zonation with Cali having 2 wet and 2 dry periods during a year). A value from 0 to 9 was entered depending on how many information sources were checked by participants, which was completed for each disease. For section 4 (attitudes), the responses were coded from 1 to 6 (on a scale from: not sure to completely agree). For section 5 (practices 1), a value of '1' was entered for "yes" responses and '0' otherwise. The frequency of spraying was entered from '0' (never/don't know) to '5' (daily). For section 6 (practices 2), the frequency of individuals participating in mosquito prevention measures were assessed using a range from '0' (never) to '5' (daily).

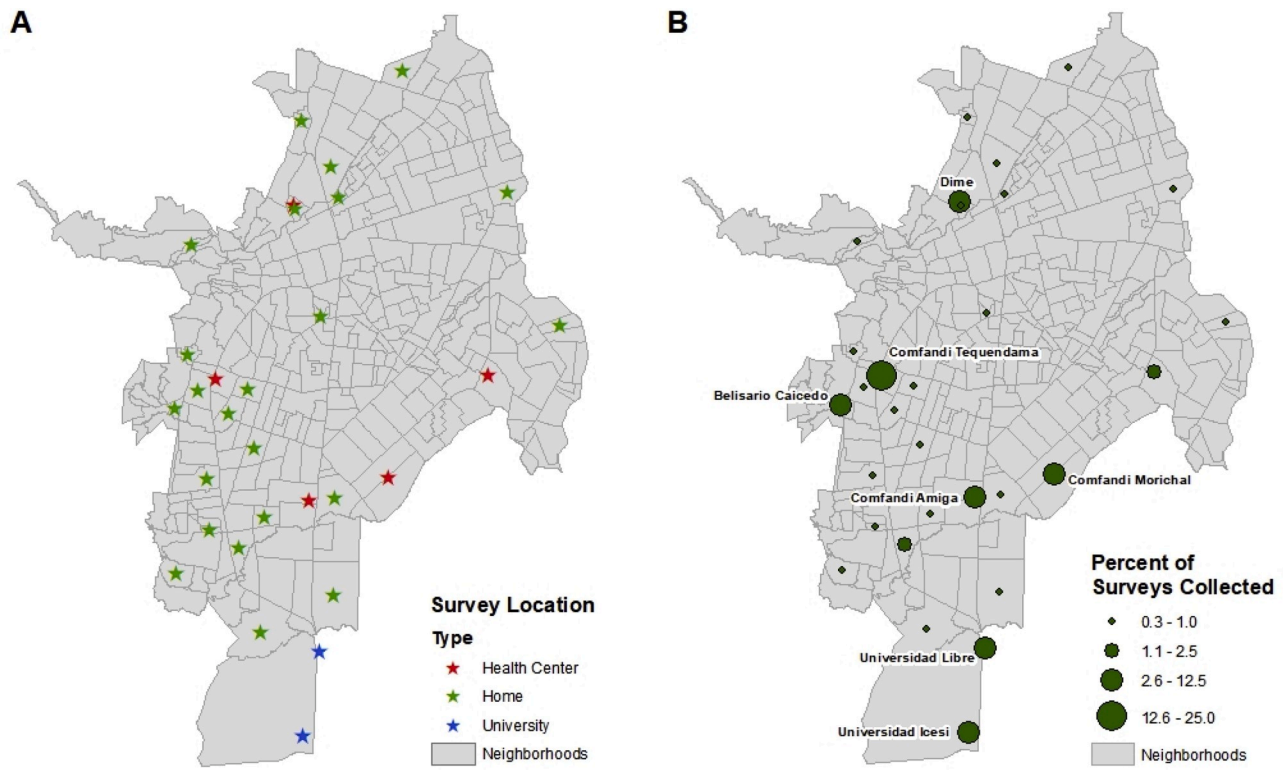

Fig. 2. Location of surveys – homes indicate centroid of neighborhood where survey was collected (A); and percent of surveys collected from each location (B).

2.5. Data analysis

Generalized linear models (GLM) were utilized to examine the effects between KAP scores and socioeconomic, sociodemographic, and accessibility variables. Three separate GLMs were used for knowledge, attitudes and practices, respectively (each acting as the dependent variable). Total scores for knowledge, attitude, and practice were determined by adding the responses for each section (maximum value of 57, 60 and 60, respectively). The independent variables came from section 1 of the survey (sociodemographic information), and the accessibility variables also serve as potential predictors in the GLMs. Variable inflation factor (VIF) tests were conducted to assess potential collinearity. Chi-square (X^2) tests were employed to compare the independent variables between the three socioeconomic strata groups and to test for significant differences regarding the answers to individual questions. Data analysis was conducted in R.

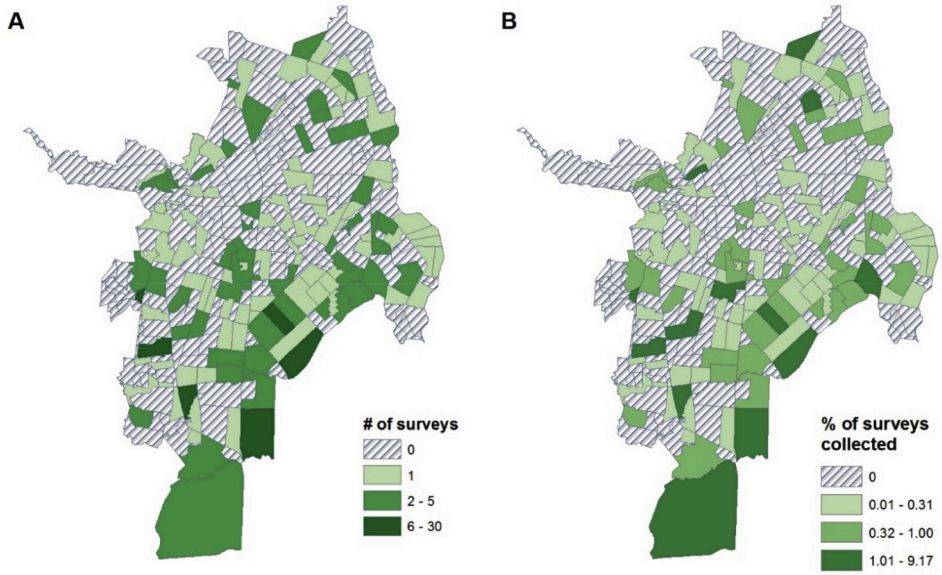

Fig. 3. KAP participants' place of residence per neighborhood – 21 participants live outside of Cali's boundary, but live in Valle del Cauca. Total number of surveys per neighborhood in (A); and percent of surveys collected per neighborhood in (B).

3. Results

3.1. Sociodemographic information

A total of 327 surveys were collected during the one-month fieldwork window from homes in various neighborhoods across Cali, Universidad Icesi, Universidad Libre and from five healthcare centers. Fig. 2 shows the locations where the surveys were conducted. Fig. 3 shows the place of residence for the survey participants.

Table 1 provides the socioeconomic and demographic characteristics of the 327 participants in our study, with 96 (29.4%) surveys collected in low strata neighborhoods, 159 (48.6%) in middle strata, and 72 (22%) in high strata. Chi-squared tests were conducted to compare the sociodemographic attributes between the low, middle, and high strata neighborhoods, suggesting significant differences between the 3 strata groups for 6 out the 9 sociodemographic attributes. There was no significant variation in gender, educational attainment, and income. However, we identified significant variation in the age groups of respondents ($p < 0.05$); occupation status ($p < 0.05$); civil status ($p < 0.05$); children in the household with a higher proportion of children in middle and low strata ($p < 0.05$); household size ($p < 0.05$); and race with a higher proportion of Afro-Colombians and Mestizos in low strata neighborhoods ($p < 0.05$).

3.2. General questions

The majority of participants reported never contracting DENF, CHIK, or Zika (Fig. 4). For those who reported contracting DENF and Zika, the highest proportion of individuals lived in middle strata neighborhoods. For those who had CHIK or more than one of the VBDs, the highest number of cases were in low strata neighborhoods, followed by middle and high. In general, the participants were more familiar with DENF, followed by CHIK and Zika.

Fig. 5 compares the participants' approximate travel time to a healthcare facility. We find that participants from low and middle strata were more likely to travel 60 min or more ($p < 0.05$). Furthermore, participants who lived in a high strata neighborhood reported generally less travel times to access healthcare. Other questions about access to care revealed that 21.4% of participants reported discontinuing medical treatment because of excessive commuting times, and those from high strata neighborhoods ranked their overall access to care better than those from middle and low areas ($p < 0.05$).

Table 1
Socioeconomic and demographic characteristics of the KAP participants.

Variable	N	%	Variable	n	%
Strata		**Occupational Status**			
Low	96	29.4	Full-time	120	36.7
Middle	159	48.6	Part-time	20	6.1
High	72	22	Independent	66	20.2
Age			Unemployed	12	3.7
18–35	143	43.7	Student	36	11
36–55	108	33	Pension	30	9.2
56–70	60	18.3	Housewife	43	13.1
70+	15	4.6	**Children in Household**		
Marital Status		Yes	163	49.8	
Single	126	38.5	No	163	49.8
Married	89	27.2	**Household Size**		
Free Union	81	24.8	1	16	4.9
Separated/ Divorced	19	5.8	2	72	22
Widow	18	3	3–4	152	46.5
Other	1	0.3	5–6	68	20.8
Education Level		>6	19	5.8	
Primary	25	7.6	**Race**		
Secondary	109	33.3	White	115	35.2
Undergraduate	73	22.3	Mestizo	158	48.3
Postgraduate	46	14	Afro-Colombian	42	12.9
Technical	73	22.3	Indigenous	6	1.8
	Other	3	0.9		
	Mixed-Race	2	0.6		

3.3. Knowledge

Approximately 76% of participants correctly stated how DENF is transmitted, while 58% and 46% were correct for CHIK and Zika, respectively. Figs. 6 and 7 summarize the types of sources where participants learned about the three VBDs. In general, television, radio, and doctors are most common sources of information of VBDs in Cali. Also, participants reported that newspaper contained more information about CHIK and Zika than DENF. Interestingly, low strata neighborhoods reported slightly more sources of information about DENF and CHIK than middle strata neighborhoods (chi-squared $p < 0.05$). However, we expected this finding due to these low-strata neighborhoods manifesting higher risk and more cases of VBDs (Hagenlocher et al., 2013; Delmelle et al. 2014, 2016). Therefore, targeted interventions and educational material are distributed more frequently in those locations than middle and high strata neighborhoods of Cali (based on conversations with public health officials in Cali during the fieldwork period).

Approximately 57% reported the correct answer that Zika can be transmitted sexually, and one-third of the participants believed that each VBD can be prevented with a vaccine. Around two-thirds correctly answered that a child is at risk for birth defects if a pregnant mother is infected with Zika, and 65% and 43.7% incorrectly answered (no) for DENF and CHIK, respectively. In general, two-thirds of the participants knew the correct times of day when they are at the highest risk of being bit by *Aedes*; however, the responses varied by disease, suggesting that many individuals are not aware that *Aedes* can transmit all three VBDs. Furthermore, 50% of participants think DENF is becoming more severe in Cali, and 43% think similarly of CHIK and Zika. Finally, around two-thirds of participants knew that seasonality will impact DENF and CHIK transmission risk, and only 50% guessed correctly for Zika.

Overall, the results suggest that participants have the greatest knowledge of DENF, followed by CHIK and Zika, and particularly so for residents in high strata neighborhoods. Average knowledge scores increased with socioeconomic status, except in the case of CHIK (Fig. 8).

Table 2 shows the results of the GLM using total knowledge score as the dependent variable. The total knowledge scores were significantly related to strata, sex, civil status, race, and occupation. Compared to high strata neighborhoods, low and middle strata neighborhoods had significantly less knowledge of DENF, CHIK, and Zika. Notably, males had significantly less knowledge than females. Married individuals had significantly more knowledge, while separated/divorced individuals had significantly less knowledge. Compared to Afro-Colombians, Whites and Mestizos had significantly more knowledge. Finally, individuals working full-time had significantly more knowledge of the three VBDs.

3.4. Attitudes

In general, participants seemed to think that DENF is more severe than CHIK and Zika, but the median scores suggested that they thought there was an equal risk of infection for all three VBDs. Interestingly, participants believed that they are generally more responsible to prevent VBDs than the government; and the vast majority of participants think fumigation efforts are effective. The results also indicated a consensus of seeking immediate medical treatment if infected with DENF, CHIK, or Zika. When comparing the attitude scores by neighborhood strata, there are no significant differences (see Fig. 9).

Table 3 shows the results of the GLM using total attitude score as the dependent variable. The total attitude scores were significantly related

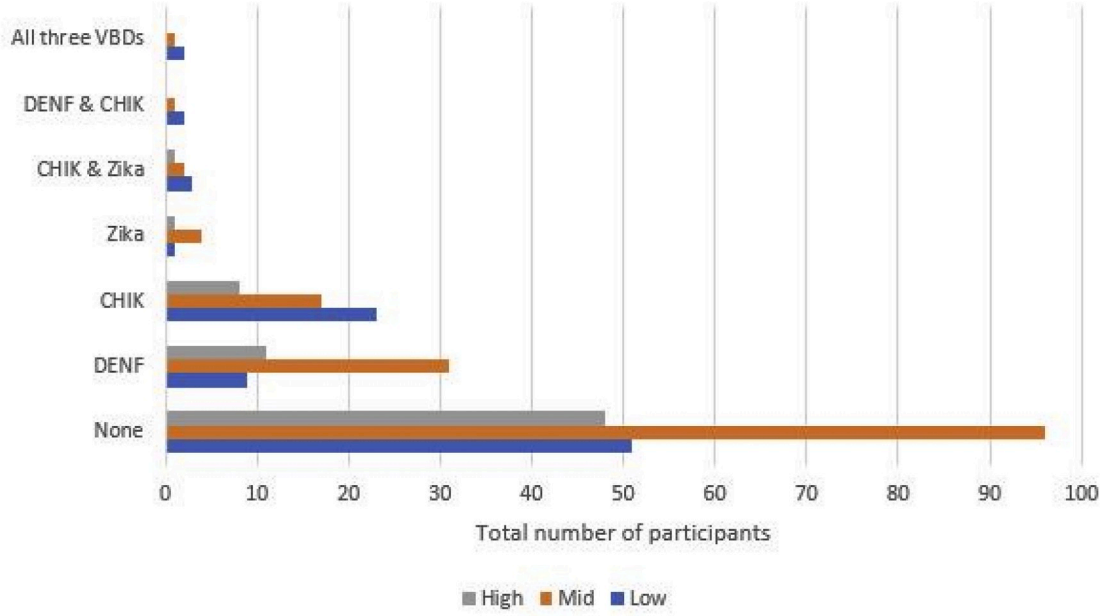

Fig. 4. Number of participants who reported having one or more of the three VBDs.

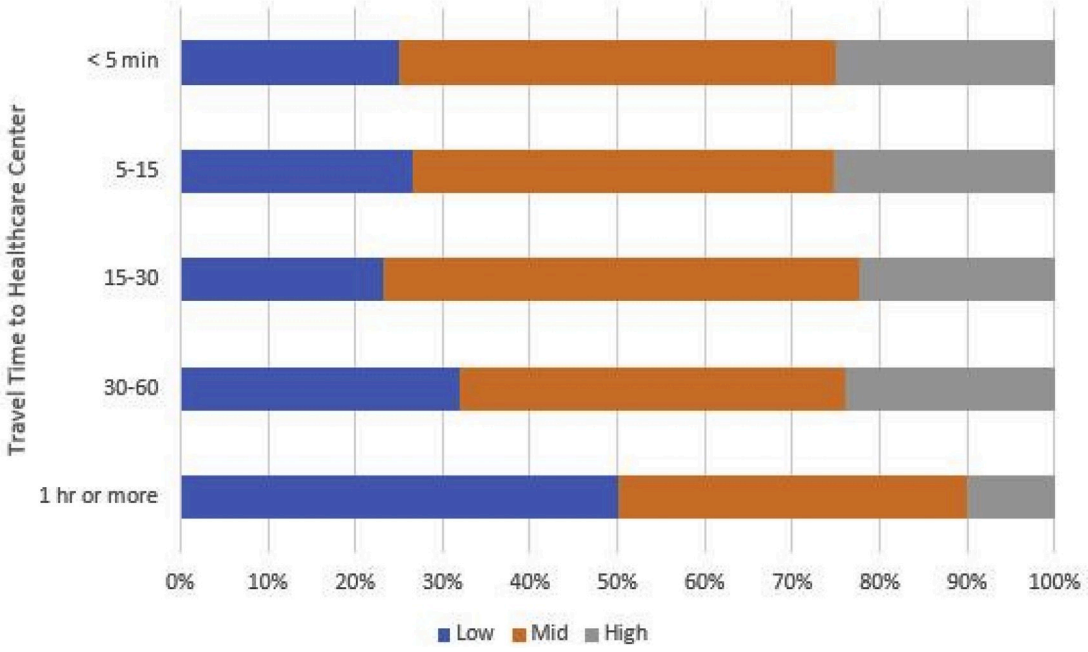

Fig. 5. KAP participants' approximate time to a healthcare center.

to education, race, occupation, and previous infection of one or more of the VBDs. Compared to individuals with a postgraduate education, individuals with a secondary education had a significantly lower attitude score. Compared to Afro-Colombians, Whites and Mestizos had a significantly higher attitude score, while Mixed-Race individuals had a significantly lower attitude score. Compared to students, individuals who worked full-time, part-time, independently, collected pension, housewives, and those who were unemployed all had a significantly higher attitude score. Finally, individuals who were previously infected with one or more of the three VBDs were significantly more likely to report higher attitude scores.

3.5. Practices

Approximately 63% answered that they strive to learn about DENF, 56.9% for CHIK, and 51% for Zika. Two-thirds of participants were worried about mosquitoes in their neighborhood. Only 16% of participants stated that they contacted public health authorities if they identified mosquitos or larvae in their home or neighborhood. Almost half stated that they do not know when their residence or neighborhood was last sprayed or reported only annual fumigation. The vast majority of our sample reported never wearing effective clothing to prevent bites; the majority also reported changing water in containers, checking the containers for larvae, and removing materials that can accumulate water on a weekly basis. In general, the participants do not take part in

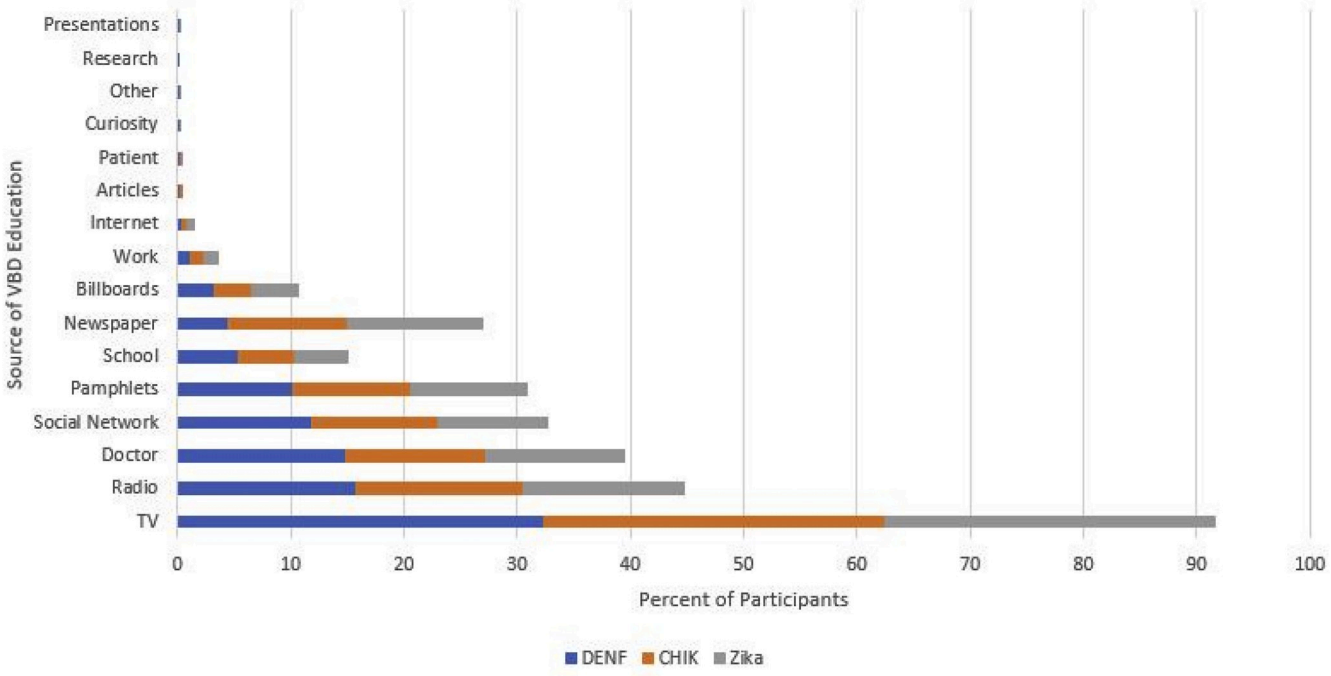

Fig. 6. Educational sources of VBDs reported by KAP participants.

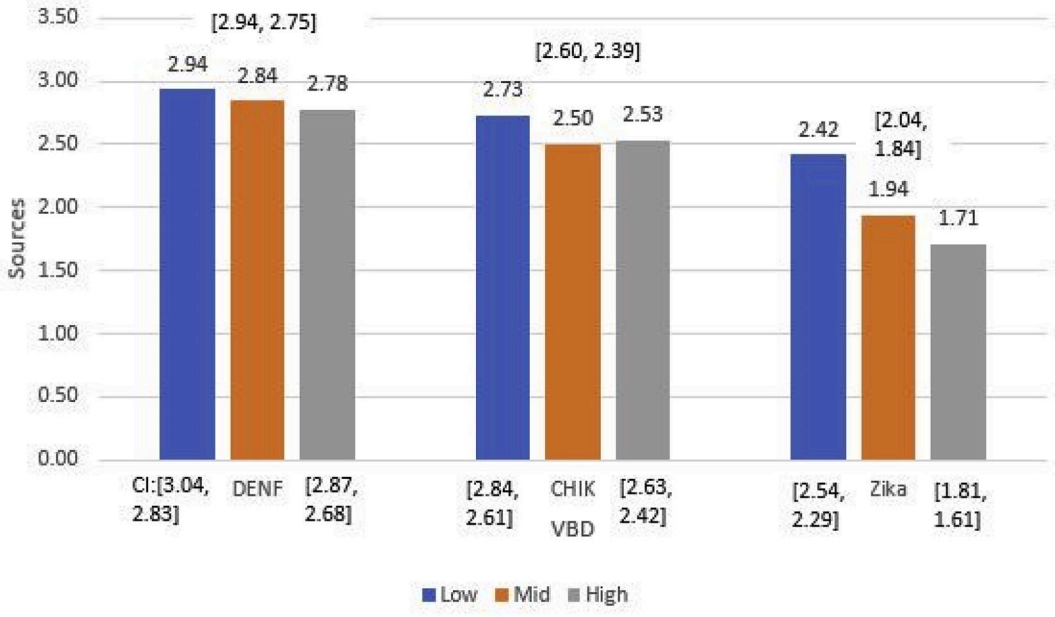

Fig. 7. Average educational sources per neighborhood strata regarding DENF, CHIK, and Zika.

community cleanup activities.

Table 4 shows the results of the GLM using total practice score as the dependent variable. The total practice scores were significantly related to previous infection of one or more of the VBDs, familiarity with one or more VBDs, access rating to healthcare, travel time to a healthcare facility and refusing healthcare because of the cost. Interestingly, no demographic or socioeconomic variables had a significant relationship with total practice score. Individuals who were previously infected with or were familiar with one or more of the three VBDs were significantly more likely to participate in more preventative measures against DENF, CHIK, or Zika. Next, the positive relationship between practices and access rating suggests that individuals are significantly more likely to participate in preventative measures as their access to healthcare increases. Furthermore, compared to individuals who travel an hour or more to a healthcare facility, individuals who travel 5–15 min were significantly less likely to participate in preventative measures, while individuals who travel less than 5 min were significantly more likely to participate in preventative measures.

4. Discussion

This study is the first of its kind to assess and compare KAP across low, middle, and high strata neighborhoods across an entire city that is at risk for DENF, CHIK, and Zika, simultaneously. Although the

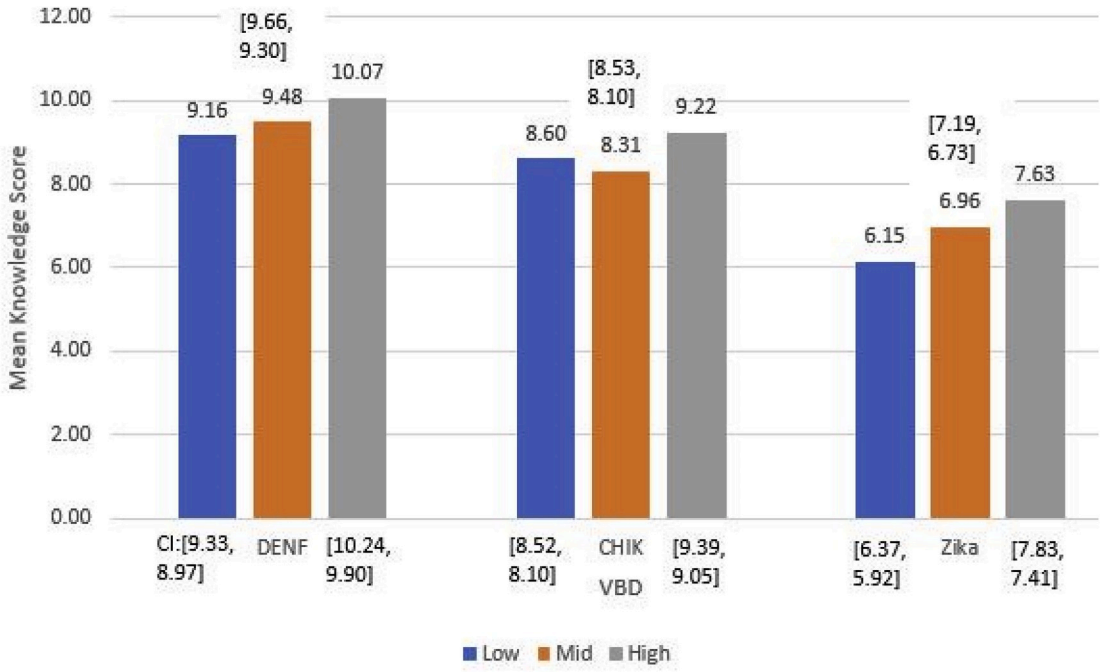

Fig. 8. Average knowledge scores by strata and disease.

Table 2
Modeling results of Knowledge - significant predictor variables.

Variable	Coefficient	*p*	Compare
Intercept	3.225	0.000	NA
Low Estrata	-0.089	0.005	High Estrata
Middle Estrata	-0.067	0.017	High Estrata
Males	-0.064	0.006	Females
Married	0.105	0.000	Free Union
Separated/Divorced	-0.158	0.003	Free Union
White	0.125	0.000	Afro-Colombians
Mestizo	0.135	0.000	Afro-Colombians
Work Full-Time	0.082	0.035	Student

usefulness of studies that evaluate KAP of populations at risk of diverse diseases has been previously recognized, these studies are essential to understand individual's prevention practices in order to assess the impact of various education strategies and design, develop and implement community tailored programs (Hernández-Escolar et al., 2014). Our findings suggest that knowledge of DENF, CHIK, and Zika in Cali, Colombia is related to community characteristics (e.g. strata), while attitudes and practices are more related to the individual level (Higuera-Mendieta et al., 2016). Individuals knew more about DENF, followed by CHIK; likely due to the latter two diseases first appearing between 2013 and 2014, while DENF has been endemic since the 1970s. This is common throughout the world where DENF has been endemic for decades, followed in recent years by novel outbreaks of CHIK and Zika (e.g. Wong et al., 2016; Wong et al., 2017).

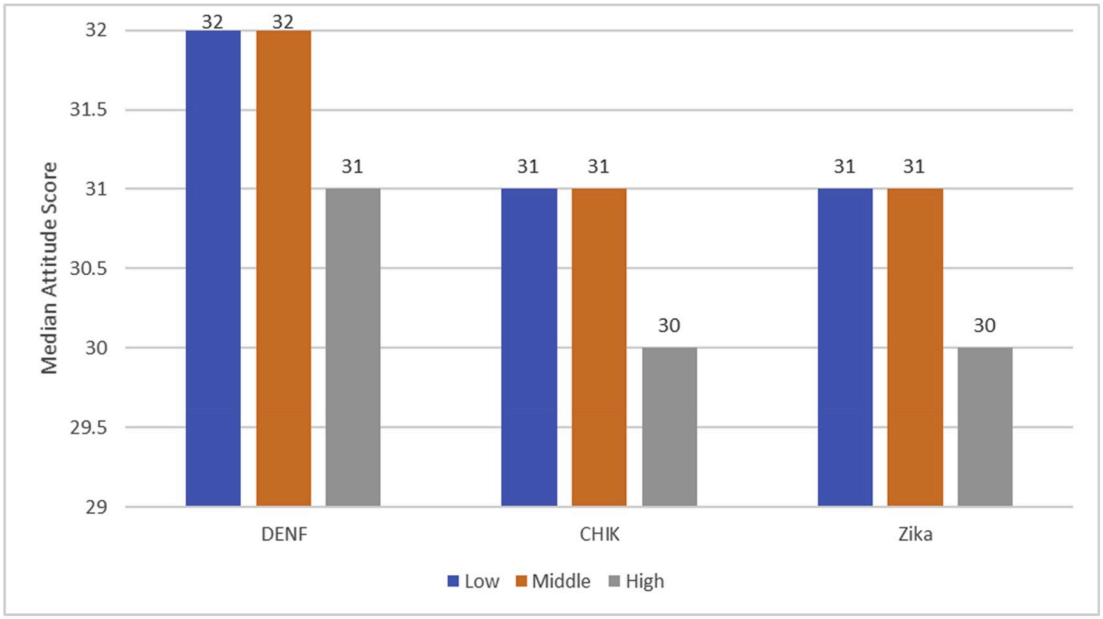

Fig. 9. Median attitude scores by strata and disease.

Table 3
Modeling results of Attitudes - significant predictor variables.

Variable	Coefficient	*p*	Compare
Intercept	3.991	0.000	NA
Secondary Educ	-0.075	0.001	Postgraduate
White	0.057	0.017	Afro-Colombian
Mestizo	0.063	0.006	Afro-Colombian
Mixed-Race	-0.221	0.038	Afro-Colombian
Work Full-time	0.077	0.003	Student
Housewife	0.11	0.000	Student
Independent Work	0.065	0.023	Student
Work Part-Time	0.087	0.016	Student
Pension	0.086	0.009	Student
Unemployed	0.11	0.012	Student
Had 1 or more VBDs	0.028	0.006	NA

Table 4
Modeling results of Practices - significant predictor variables.

Variable	Coefficient	*p*	Compare
Intercept	3.504	0.000	NA
Had 1 or more VBDs	0.052	0.000	NA
Familiar with 1 or more VBDs	0.027	0.002	NA
Rating Access to Healthcare	0.017	0.047	NA
Travel 5–15 min to Healthcare	-0.069	0.039	1 h +
Travel <5 min to Healthcare	0.295	0.000	1 h +
Refused Healthcare because of Cost	-0.042	0.026	NA

As we expected, knowledge scores were higher in high strata neighborhoods, then middle, followed by low. Knowledge gaps are clear barriers for the population to get empowered with the corresponding prevention plans. This issue could be approached with the proper use of media and the dissemination of diverse campaigns, detailing the origin of these diseases, the factors that perpetuate them, their transmission, necessary treatment and prevention methods. This way, each citizen acquires responsibility for their environment, the periodic inspection of the potential reservoirs and their respective elimination. As Hernández-Escolar et al. (2014) mentioned, empowerment is a key condition for the community to face complex public health problems. Even though, the constant role of public health expert authorities is essential to guarantee the transformation of good knowledge into better practices (Sarmiento-Senior et al., 2019).

In general, attitude scores were similar when comparing each neighborhood strata, but varied by numerous sociodemographic characteristics (Whiteman et al., 2018; Fritzell et al., 2018) and previous infection with one or more of the VBDs (see Table 3). The community is the one that exerts control over the vector and its proliferation, therefore, the greatest importance lies in the attitudes of individuals and their awareness of the problem which will ultimately create the foundation for behaviors turned into habits over time. It is necessary to raise awareness in communities (Diaz-Quijano et al., 2018), so attention focuses on vector control through fumigation and use of repellent, but also on prevention and targeted actions in the eradication of the disease (Castañeda-Porras et al., 2017). Despite TV, radio, and doctors as the predominant source of information about the risks of the three VBDs in this study, there is a degree of ineffectiveness and educational campaigns need to be improved. The involvement of local stakeholders such as community leaders and teachers, from the initial stages of education and promulgation of campaigns, could improve the acceptance and adaptation of the strategies to the specific conditions of each neighborhood. Furthermore, assessing the specific problems faced by each area of the municipality and having information on risk conducts related to vector breeding allows the design of local communication strategies that would consider concrete proposals for behavioral changes (Castro et al., 2008).

Access to health and previous infection with the disease significantly improved an individual's willingness to take preventative measures against DENF, CHIK, and Zika. Timely diagnosis of a disease is critical to morbidity and mortality and can help mitigate current and future outbreaks (Casas et al., 2017). We encourage more KAP-related studies to incorporate healthcare access and utilization questions. Furthermore, doctors were the third main source of knowledge, which highlights that routine access to medical care is a major component to reduce VBDs.

Our study corroborates the results found by Whiteman et al. (2018); we found that there were a low number of participants who closed their windows throughout the day. Since *Aedes* is known to seek shelter inside during the hottest temperatures of mid-day (Dzul-Manzanilla et al., 2017), vector-control efforts should address the issues of utilization of window screens. Public health officials may need to communicate with property owners to install structures (i.e. screens) to reduce mosquito presence inside residences.

While many studies typically compare high and low-income neighborhoods or locations, we have found evidence that middle-income neighborhoods may lack resources due to a variety of reasons. Our findings and other similar KAP studies suggest that high strata individuals are typically more educated and have access to more healthcare resources (Fritzell et al. 2016, 2018), while the low strata individuals in Cali live in neighborhoods that are frequently targeted by public health campaigns and mosquito eradication programs. Therefore, individuals living in middle strata neighborhoods in Cali may face public health disparities regarding targeted interventions both before, during, and after outbreaks of DENF, CHIK, and Zika.

It is also worth noting that this study occurred in the summer of 2019, while major outbreaks of CHIK and Zika occurred between 2014 and 2016 (Krystosik et al., 2017; Desjardins et al., 2018). It is therefore surprising that the findings of the KAP survey suggest that CHIK and Zika are still relatively misunderstood and awareness did not match the levels of DENF in Cali. Since CHIK and Zika are transmitted by the same vector, it is critical to improve the community's understanding regarding CHIK and Zika. In practice, if an individual is participating in preventative measures against DENF, they are also protecting themselves against CHIK and Zika. However, CHIK and Zika can also be spread vertically, and safe-sex education campaigns should be improved to combat the congenital complications (especially microcephaly resulting from vertical transmission of Zika).

Our findings also suggest that proximity to high-risk areas of DENF, CHIK, and Zika do not necessarily influence knowledge, attitudes, and preventative practices (Flamand et al., 2017). Therefore, spatial proximity to disease outbreaks will not change the knowledge, attitudes, and behaviors of individuals and communities at risk of transmission. As shown in previous papers (e.g. Delmelle et al., 2016; Krystosik et al., 2017), low strata neighborhoods in Cali are the highest risk areas of DENF, CHIK, and Zika. As such, we strongly suggest that KAP studies be implemented in VBD surveillance, coupled with typical spatial analysis, statistics, and modeling. After the first KAP study is completed for a baseline, follow-up studies can determine if surveillance and educational programs are improving overall KAP and mitigating the spatial and space-time clustering of VBDs.

Despite the strengths of this paper, we acknowledge that there are several limitations which can serve as avenues for future research. First, the results may be slightly biased towards middle strata participants due to the higher proportion of surveys collected from that group. Second, as with any survey, recall bias may have affected the accuracy of the individual responses. Third, follow-up studies with the highest risk neighborhoods can determine the best approaches for improving KAP. Finally, our results may not be generalizable to other at-risk populations of DENF, CHIK, and Zika outside of Cali; but should inspire other communities to assess their understanding and preventative practices regarding infectious disease. Despite these limitations, we are confident that the statistical significance of the results improves our understanding of KAP disparities between low, middle, and high strata neighborhoods.

5. Conclusion

We encourage public health officials and community leaders to examine the efficacy of their educational campaigns, while enforcing preventative measures against the *Aedes* mosquito before an epidemic may occur to minimize future cases. We also suggest that educational and targeted intervention campaigns could be improved by allocating resources to community leaders, considering that certain populations have a distrust in government. These community leaders can disseminate educational materials to at-risk neighborhoods, which may increase awareness and willingness to practice VBD preventative measures. VBD prevention should also be proactive instead of reactive, that is public health officials should not wait until an epidemic begins to intervene; rather funding and stakeholders should be utilized year-round to raise awareness and understanding about the diseases that are constantly prevalent in certain communities.

This study also provides evidence that public health programs may be lacking in middle income areas, due to targeted interventions focusing on the lowest and "highest risk" neighborhoods. It is also clear that more resources need to be devoted to improving the understanding of CHIK and Zika. Therefore, educational material (e.g. TV, radio, and social media – see Giustini et al., 2018) should discuss the risks and complications of DENF, CHIK, and Zika since there are all transmitted by the same vector and require the same climatic and environmental conditions for successful infection. We also found that living within a high-risk neighborhood or closer proximity to outbreaks of VBDs does not necessarily translate into more knowledge and preventative measures, corroborating with Flamand et al., (2017). Overall, more fine-level studies that evaluate community and individual KAP are necessary to improve public awareness of VBD transmission.

Funding

This research was supported by a 2019 American Association of Geographers (AAG) Dissertation Research Grant; and a 2019 UNC-Charlotte Graduate School Summer Fellowship.

Acknowledgements

The authors would like to acknowledge several people that helped make this study possible: Drs. Alejandro Varela and Angelica Lopez of DIME Clínica Neuro-Cardiovascular; the students of Universidad Libre for participating in a pilot study; Jaydiber Garcia Vaca for her help with the door-to-door surveys; Robinson Pacheco of Universidad Libre for his help organizing the collaboration between UNC-Charlotte, Universidad Libre, and Universidad Icesi; and all of the participants who volunteered their time to fill out the surveys. We would also like to thank the editor and anonymous reviewer for their constructive feedback that helped improve the quality of this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2020.102339.

References

Alobuia, W.M., Missikpode, C., Aung, M., Jolly, P.E., 2015. Knowledge, attitude, and practices regarding vector-borne diseases in Western Jamaica. Ann. Global Health 81 (5), 654–663.

Araujo, A.Q., Silva, M.T.T., Araujo, A.P., 2016. Zika virus-associated neurological disorders: a review. Brain 139 (8), 2122–2130.

Calle-Giraldo, J.P., Rojas, C.A., Hurtado, I.C., Barco, C., Libreros, D., Sánchez, P.J., et al., 2019. Outcomes of Congenital Zika Virus Infection During an Outbreak in Valle del Cauca, Colombia. Pediatr. Infect. Dis. J. 38 (7), 735–740.

Calvet, G.A., Santos, F.B.D., Sequeira, P.C., 2016. Zika virus infection: epidemiology, clinical manifestations and diagnosis. Curr. Opin. Infect. Dis. 29 (5), 459–466.

Casas, I., Delmelle, E., Delmelle, E.C., 2017. Potential versus revealed access to care during a dengue fever outbreak. J. Transp. Health 4, 18–29.

Castañeda-Porras, O., Segura, O., Garón-Lara, E.C., Manosalva-Sánchez, C., 2017. Conocimientos, actitudes y prácticas frente al control del vector Aedes aegypti, Villanueva Casanare, Colombia, 2016. Rev. Méd. Risaralda 23 (1), 14–22.

Castrillón, J.C., Castaño, J.C., Urcuqui, S., 2015. Dengue en Colombia: diez años de evolución. Rev. Chil. infectol. 32 (2), 142–149.

Castro, M., Pérez, D., Pérez, K., Polo, V., López, M., Sánchez, L., 2008. Contextualización de una estrategia comunitaria integrada para la prevención del dengue. Rev. Cubana Med. Trop. 60 (1).

Chouin-Carneiro, T., et al., 2016. Differential susceptibilities of Aedes aegypti and Aedes albopictus from the Americas to Zika virus. PLoS Neglected Trop. Dis. 10 (3), e0004543.

Corrin, T., Waddell, L., Greig, J., Young, I., Hierlihy, C., Mascarenhas, M., 2017. Risk perceptions, attitudes, and knowledge of chikungunya among the public and health professionals: a systematic review. Trop. Med. Health 45 (1), 21.

Delmelle, E., Dony, C., Casas, I., Jia, M., Tang, W., 2014. Visualizing the impact of space-time uncertainties on dengue fever patterns. Int. J. Geogr. Inf. Sci. 28 (5), 1107–1127.

Delmelle, E., Hagenlocher, M., Kienberger, S., Casas, I., 2016. A spatial model of socioeconomic and environmental determinants of dengue fever in Cali, Colombia. Acta Trop. 164, 169–176.

Desjardins, M.R., Whiteman, A., Casas, I., Delmelle, E., 2018. Space-time clusters and co-occurrence of chikungunya and dengue fever in Colombia from 2015 to 2016. Acta Trop. 185, 77–85.

Diaz-Quijano, F.A., Martínez-Vega, R.A., Rodriguez-Morales, A.J., Rojas-Calero, R.A., Luna-González, M.L., Díaz-Quijano, R.G., 2018. Association between the level of education and knowledge, attitudes and practices regarding dengue in the Caribbean region of Colombia. BMC Publ. Health 18 (1), 143.

Duffy, M.R., Chen, T.H., Hancock, W.T., Powers, A.M., Kool, J.L., Lanciotti, R.S., et al., 2009. Zika virus outbreak on yap island, Federated States OF Micronesia. N. Engl. J. Med. 360 (24), 2536–2543.

Dzul-Manzanilla, F., Ibarra-López, J., Bibiano Marín, W., Martini-Jaimes, A., Leyva, J.T., Correa-Morales, F., et al., 2017. Indoor resting behavior of Aedes aegypti (Diptera: Culicidae) in acapulco, Mexico. J. Med. Entomol. 54 (2), 501–504.

Eastin, M.D., Delmelle, E.M., Casas, I., Wexler, J., Self, C., 2014. Intra-and interseasonal autoregressive prediction of dengue outbreaks using local weather and regional climate for a tropical environment in Colombia. Am. J. Trop. Med. Hyg. 91 (3), 598–610.

Flamand, C., Fritzell, C., Obale, P., Quenel, P., Raude, J., 2017. The role of risk proximity in the beliefs and behaviors related to mosquito-borne diseases: the case of chikungunya in French Guiana. Am. J. Trop. Med. Hyg. 97 (2), 344–355.

Fritzell, C., Raude, J., Adde, A., Dusfour, I., Quenel, P., Flamand, C., 2016. Knowledge, attitude and practices of vector-borne disease prevention during the emergence of a new arbovirus: implications for the control of chikungunya virus in French Guiana. PLoS Neglected Trop. Dis. 10 (11).

Fritzell, C., Raude, J., Kazanji, M., Flamand, C., 2018. Emerging trends of Zika apprehension in an epidemic setting. PLoS Neglected Trop. Dis. 12 (1), e0006167.

Giustini, D., Ali, S.M., Fraser, M., Boulos, M.N.K., 2018. Effective uses of social media in public health and medicine: a systematic review of systematic reviews. Online J. Publ. Health Informat. 10 (2).

Gubler, D.J., Clark, G.G., 1994. Community-based integrated control of Aedes aegypti: a brief overview of current programs. Am. J. Trop. Med. Hyg. 50 (6_Suppl. l), 50–60.

Guilland, A., 2016. Zika Virus Is a Global Public Health Emergency. declares WHO, p. i657.

Hagenlocher, M., Delmelle, E., Casas, I., Kienberger, S., 2013. Assessing socioeconomic vulnerability to dengue fever in Cali, Colombia: statistical vs expert-based modeling. Int. J. Health Geogr. 12 (1), 36.

Harrington, L.C., Edman, J.D., Scott, T.W., 2001. Why do female Aedes aegypti (Diptera: Culicidae) feed preferentially and frequently on human blood? J. Med. Entomol. 38 (3), 411–422.

Healy, K., Hamilton, G., Crepeau, T., Healy, S., Unlu, I., Farajollahi, A., Fonseca, D.M., 2014. Integrating the public in mosquito management: active education by community peers can lead to significant reduction in peridomestic container mosquito habitats. PloS One 9 (9), e108504.

Heintze, C., Garrido, M.V., Kroeger, A., 2007. What do community-based dengue control programmes achieve? A systematic review of published evaluations. Trans. R. Soc. Trop. Med. Hyg. 101 (4), 317–325.

Hernández-Escolar, J., Consuegra-Mayor, C., Herazo-Beltrán, Y., 2014. Conocimientos, actitudes y prácticas sobre Dengue en un barrio de la ciudad de Cartagena de Indias. *Rev. Salud Pública.* Volumen 16 (Número 2), 281–292, 2014. Electronic ISSN 2539-3596. Printed ISSN 0124-0064.

Higuera-Mendieta, D.R., Cortés-Corrales, S., Quintero, J., Gonzalez-Uribe, C., 2016. KAP surveys and dengue control in Colombia: disentangling the effect of sociodemographic factors using multiple correspondence analysis. PLoS Neglected Trop. Dis. 10 (9).

Hoarau, J.J., Bandjee, M.C.J., Trotot, P.K., Das, T., Li-Pat-Yuen, G., Dassa, B., et al., 2010. Persistent chronic inflammation and infection by Chikungunya arthritogenic alphavirus in spite of a robust host immune response. J. Immunol., ji_0900255

Hohl, A., Delmelle, E., Tang, W., Casas, I., 2016. Accelerating the discovery of space-time patterns of infectious diseases using parallel computing. Spatial Spatio Temporal Epidemiol. 19, 10–20.

INS, 2014. Informe Quincenal Epidemiológico Nacional (IQEN). Instituto Nacional de Salud y Ministerio de Salud y Protección Social, Colombia. https://www.ins.gov.co/buscador-eventos/IQEN/IQEN%20vol%2020%202015%20num%205.pdf.

INS, 2017. *Protocolo de Vigilancia en Salud Pública – Enfermedad por Virus Zika.* Colombia. Instituto Nacional de Salud y Ministerio de Salud y Protección Social. https://www.ins.gov.co/buscador-eventos/Lineamientos/PRO%20Zika.pdf.

INS, 2019. *Boletín Epidemiológico Semanal (BES) Chikungunya.* Colombia. Instituto Nacional de Salud y Ministerio de Salud y Protección Social. https://www.ins.gov.co/buscador-eventos/BoletinEpidemiologico/2019%20Bolet%C3%ADn%20epidemiol%C3%B3gico%20semana%2018.pdf.

Krystosik, A.R., Curtis, A., Buritica, P., Ajayakumar, J., Squires, R., Davalos, D., et al., 2017. Community context and sub-neighborhood scale detail to explain dengue, chikungunya and Zika patterns in Cali, Colombia. PloS One 12 (8), e0181208.

Krystosik, A., Curtis, A., LaBeaud, A., Dávalos, D., Pacheco, R., Buritica, P., et al., 2018. Neighborhood violence impacts disease control and surveillance: case study of Cali, Colombia from 2014 to 2016. Int. J. Environ. Res. Publ. Health 15 (10), 2144.

Launiala, A., 2009. How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi. Anthropol. Matters 11 (1).

Mustafa, M.S., Rasotgi, V., Jain, S., Gupta, V., 2015. Discovery of fifth serotype of dengue virus (DENV-5): a new public health dilemma in dengue control. Med. J. Armed Forces India 71 (1), 67–70.

Nakkhara, P., Chongsuvivatwong, V., Thammapalo, S., 2013. Risk factors for symptomatic and asymptomatic chikungunya infection. Trans. R. Soc. Trop. Med. Hyg. 107 (12), 789–796.

Potter, A., Jardine, A., Neville, P.J., 2016. A survey of knowledge, attitudes, and practices in relation to Mosquitoes and Mosquito-Borne disease in Western Australia. Front. Publ. Health 4, 32.

Raina, S., 2013. Assessment of knowledge, attitude, and practice in health care delivery. N. Am. J. Med. Sci. 5 (3), 249.

Rudisill, C., Costa-Font, J., Mossialos, E., 2012. Behavioral adjustment to avian flu in Europe during spring 2006: the roles of knowledge and proximity to risk. Soc. Sci. Med. 75 (8), 1362–1371.

Samuel, G., DiBartolo-Cordovano, R., Taj, I., Merriam, A., Lopez, J.M., Torres, C., et al., 2018. A survey of the knowledge, attitudes and practices on Zika virus in New York City. BMC Publ. Health 18 (1), 98.

Sarmiento-Senior, D., Matiz, M.I., Jaramillo-Gómez, J.F., Olano, V.A., Vargas, S.L., Alexander, N., Lenhart, A., Stenström, T.H., Overgaard, H.J., 2019. Knowledge, attitudes, and practices about dengue among pupils from rural schools in an endemic area in Colombia. Biomedica 39, 478–490.

Shepard, D.S., Undurraga, E.A., Halasa, Y.A., Stanaway, J.D., 2016. The global economic burden of dengue: a systematic analysis. Lancet Infect. Dis. 16 (8), 935–941.

Simon, F., Javelle, E., Oliver, M., Leparc-Goffart, I., Marimoutou, C., 2011. Chikungunya virus infection. Curr. Infect. Dis. Rep. 13 (3), 218.

Sissoko, D., Malvy, D., Ezzedine, K., Renault, P., Moscetti, F., Ledrans, M., Pierre, V., 2009. Post-epidemic Chikungunya disease on Reunion Island: course of rheumatic manifestations and associated factors over a 15-month period. PLoS Neglected Trop. Dis. 3 (3), e389.

Toan, N.T., Rossi, S., Prisco, G., Nante, N., Viviani, S., 2015. Dengue epidemiology in selected endemic countries: factors influencing expansion factors as estimates of underreporting. Trop. Med. Int. Health 20 (7), 840–863.

Udayanga, L., Gunathilaka, N., Iqbal, M.C.M., Pahalagedara, K., Amarasinghe, U.S., Abeyewickreme, W., 2018. Socio-economic, Knowledge Attitude Practices (KAP), household related and demographic based appearance of non-dengue infected individuals in high dengue risk areas of Kandy District, Sri Lanka. BMC Infect. Dis. 18 (1), 88.

Valle del Cauca, S.D.d.S., 2019. Autoridades de salud estudian probable caso de dengue grave, tras fallecimiento de niña de 5 años. Secretaria Departamental de Salud, Valle del Cauca.

Wang, H., et al., 2016. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the global burden of disease study 2015. Lancet 388 (10053), 1459–1544.

Whiteman, A., Mejia, A., Hernandez, I., Loaiza, J.R., 2018. Socioeconomic and demographic predictors of resident knowledge, attitude, and practice regarding arthropod-borne viruses in Panama. BMC Publ. Health 18 (1), 1261.

Wong, L.P., Alias, H., Aghamohammadi, N., Sam, I.C., AbuBakar, S., 2017. Differences in perceived severity of Zika virus infection and dengue fever and its influence on mosquito control practices in Malaysia. J. Community Health 42 (5), 854–864.

Wong, L.P., Alias, H., Aghamohammadi, N., Sam, I., AbuBakar, S., 2016. The self-regulation model of illness: comparison between Zika and dengue and its application to predict mosquito prevention behaviours in Malaysia, a dengue-endemic country. Int. J. Environ. Res. Publ. Health 13 (12), 1210.

World Health Organization, 2014. WHO factsheet vector-borne diseases. Factsheet Number 387 (March: 10). http://www.who.int/kobe_centre/mediacentre/vbdfactsheet.pdf.