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Knowledge and actions for the control of the vector *Aedes aegypti* in a municipality in the Legal Amazon

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ABSTRACT

Infections caused by arboviruses that have mostly impacted the Brazilian morbidity and mortality are caused by the same vector, *Aedes aegypti.* Preventive actions related to the vector are the most effective strategies in the prevention and control of these diseases. This study aimed to associate the knowledge on the vector that transmits dengue, Zika and chikungunya with the sociodemographic and behavioral preventive practices towards *Aedes aegypti* in the municipality of Tangara da Serra, Mato Grosso State, in the Brazilian Legal Amazon. A probabilistic urban population sampling was obtained by clusters: census sectors and households. The sample size calculation considered 10% of loss and a 1.5 design effect. This is a cross-sectional research carried out through a household survey in February and March 2018. There were 583 participants. The study variables were knowledge on the vector, sociodemographic characteristics and preventive practices related to the vector. The statistical analysis was based on a bivariate analysis and Poisson multiple regressions. Inadequate or insufficient knowledge on the vector *Aedes aegypti* remained associated with education in the categories illiterate (p<0.001) and 8 years of study or less (p<0.001), in addition to not adopting practices of capping and cleaning the water tank (p=0.002) and not using insecticides at home (p=0.007). It is concluded that there is a need for health communication actions that consider characteristics the population, especially the level of education and previous knowledge on the vector, allowing a dialogical approach and enabling the community participation in preventive practices and control of the vector *Aedes aegypti*.

KEYWORDS: *Aedes aegypti*. Dengue fever. Zika virus. Chikungunya virus. Health Knowledge, Attitudes, Practice.

INTRODUCTION

The epidemics caused by arbovirus infections are a concern in public health, not only in Brazil, where DENV, CHIKV and ZIKV viruses have a large circulation, but also in the Americas and in the world, due to their capacity of dissemination, adaptation and universal susceptibility, besides their ability to cause severe cases and complications that can be neurological, articular and hemorrhagic[1]. According to the Brazilian Epidemiological Bulletin, until the Epidemiological Week 50 of 2020, 979,764 probable cases of dengue were reported in Brazil, and the Midwest region presented with the highest incidence of 1,200 cases/100,000 inhabitants. In the same period 80,914 probable cases of chikungunya were reported in the country, and in relation to Zika, until the Epidemiological Week 49 of 2020, 7,119 probable cases were reported[2].

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Aedes (*Stegomyia*) *aegypti* and *Aedes* (*Stegomyia*) *albopictus* have a wide geographic distribution and are vectors of viruses that cause diseases such as dengue, Zika, chikungunya and yellow fever[3], despite the similarities between them, climate conditions, domiciliation, dispersion, feeding and reproduction are differences that determine the dynamics of transmission[4]. Brazilian studies show levels of infestation of *Aedes albopictus* much lower than those found for *Aedes aegypti*[3,5]. These factors define *Aedes aegypti* as the main species responsible for the transmission of these infections in Brazil. Disorderly growth of cities, absence of adequate basic sanitation conditions, and large variations in weather patterns are factors that favor the proliferation of *Aedes aegypti* in all regions of Brazil[6]. In Mato Grosso State, distribution and abundance of vector populations are influenced by the environmental complexity and the geographic confluence of Pantanal, Cerrado and Amazon biomes[7].

Preventive measures for vector control are carried out according to the guidelines of the National Dengue Control Program (NCPD) launched in 2002 by the Brazilian Ministry of Health[8], and several technologies have been developed as complementary strategies in an attempt to reduce mosquito infestation and the incidence of arbovirus infections, such as innovations in biological and genetic modification of mosquito vectors and replacement of interventions to promote resistance to viral infections, targeting different *Aedes aegypti* stages[9]. Among these strategies are information campaigns and health education activities, whose content have focused on the similarity between the symptoms of dengue, Zika and chikungunya, and the fight against *Aedes aegypti*[10], often leading to the understanding that preventing the disease means adopting behaviors to avoid contact with the mosquito[11]. However, a fragmentation of actions has been perceived with an emphasis on seasonal periods, requiring a reflection on the implementation of permanent educational actions that would permeate integral strategies, appropriate to the social realities and that could foster a collective construction of popular knowledge.

For the planning and implementation of health communication strategies that have the potential to contribute to the construction of popular knowledge, support preventive behaviors and community participation, it is essential to know how people think and act in relation to the control of the vector that transmits arbovirus infections[12]. Thus, this study aimed to associate the knowledge on the vector that transmits dengue, Zika and chikungunya with the sociodemographic and preventive behavioral characteristics related to *Aedes aegypti* in the municipality of Tangara da Serra, Mato Grosso State, in the Brazilian Legal Amazon.

MATERIALS AND METHODS

This is a cross-sectional study performed through a household survey, conducted in the period of February and March 2018, in the urban region of the municipality of Tangara da Serra, located in Mato Grosso State, in the Legal Amazon.

The municipality of Tangara da Serra has a territorial area[13] of 11,636,976 km^2, is located in the Southwest region of Mato Grosso State, about 250 km from Cuiaba, the State capital. The estimated population for 2018 was 101,764 inhabitants. Among the total population of Tangara da Serra, 91% resides in the urban area, representing 25,581 of permanent private households[14]. The climate of the region is tropical humid and megathermal (Aw), acording the classification proposed by Koppen, and characterized by rains in summer, drought in winter and high temperatures[15].

A probabilistic sampling was investigated, comprising the urban population by conglomerates, in two stages: primary sampling units, 34 census sectors, defined by the Brazilian Institute of Economics and Statistics (IBGE) for the 2010 Demographic Census, and secondary units composed of 660 households, proportionally drawn according to the size of each sector (Figure 1). The sample size calculation considered the adopted standard error adopted of 0.025 for a sample of 400 individuals, adding to this number 10% of losses and 1.5 of design effect. Then, one resident per household, aged 18 years or older was invited to participate in the study, and the interview was carried out after the signature of the Informed Consent Term. For closed households, three visits were made at different times, on different days before replacing them by another home, which was done by drawing lots. Thus, from the total of 660 individuals randomly chosen, 583 constituted the final sample of this study due to losses caused by rejection and absence.

Data collection was composed of the application of a questionnaire with the following sections: 1) sociodemographic characteristics; 2) knowledge on the vector that transmits dengue, Zika, and chikungunya; 3) information on water supply; and 4) preventive practices for the control of arbovirus infections. These data were double entered into the EpiInfo version 7.2.2.6 database (Centers for Disease Control and Prevention, Atlanta, GA, USA).

Studies on knowledge use different ways to assign value to variables. In this study, knowledge on the vector was considered as adequate or inadequate/ insufficient, according to the guidelines established by the Brazilian Ministry of Health (MS), according to three criteria:

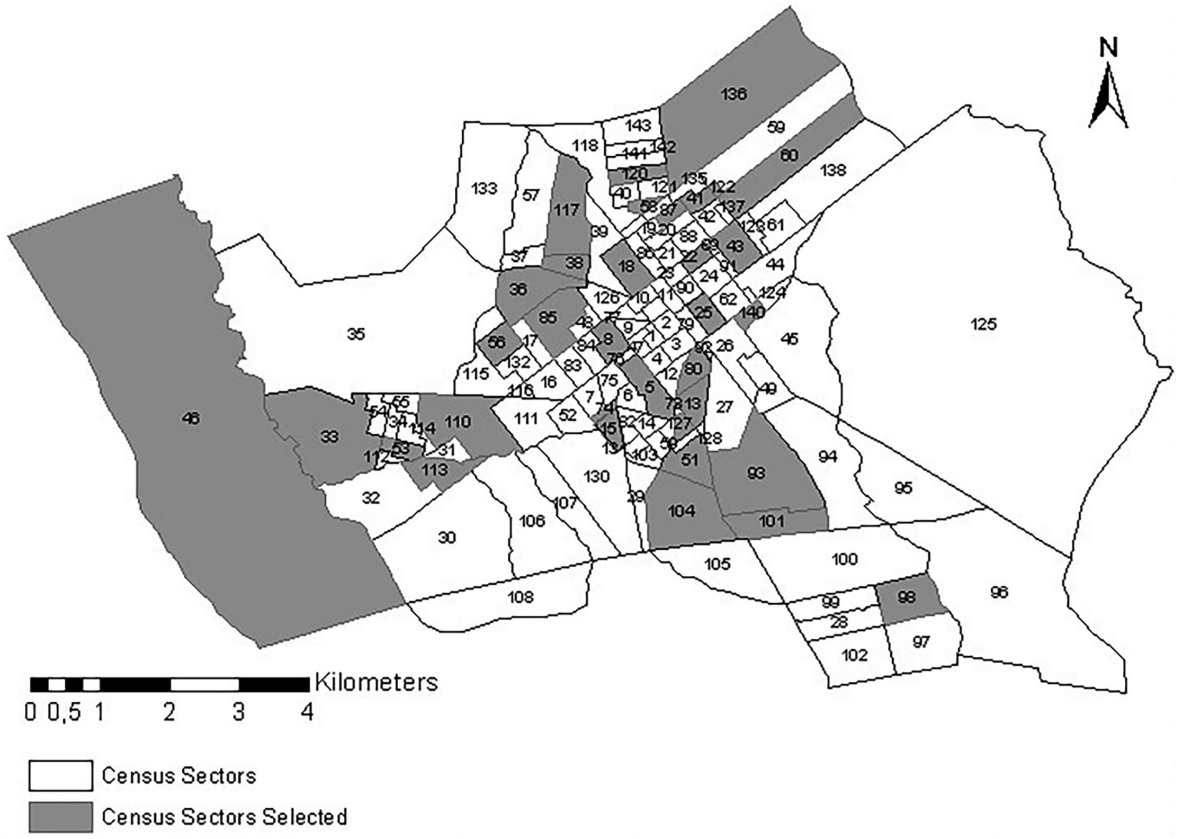

Figure 1 - Map of census sectors and selected census sectors in the municipality of Tangara da Serra, Mato Grosso State, 2018.

reproduction (asked if they had ever seen a mosquito larva); morphology (asked if they had ever seen the specific mosquito, the transmitter), habits (times when *Aedes aegypti* mosquitoes usually feed and usually bite). Knowledge was considered adequate when there were 2 or 3 affirmative and/or correct answers about these criteria. The dependent variable was the knowledge on the vector *Aedes aegypti* (inadequate/insufficient and adequate knowledge on the vector). The independent variables were: gender (male, female), age group (18-39, 40-59 and ≥ 60 years), education (illiterate, ≤ 8 years of study, > 8 years of study), auto-declared skin color (non-white, white), if the voluntary lives with a spouse/partner (yes, no), availability of water through the general municipality network (not applicable, alternate days, daily), water storage in a water tank (yes, no), water used for drinking (untreated at home, treated at home, industrialized). Regarding the variables related to preventive practices, they were categorized as yes or no.

For data analysis, the SPSS software (Statistical Package for the Social Sciences, version 20.0, SPSS Inc., Chicago, IL, USA) was used. Bivariate and multiple analyses were performed. In the bivariate analysis, the crude prevalence ratios ($_{c}$PR) with their respective 95% confidence intervals (95%CI) were estimated, and the independent variables that kept a p value lower than 20% ($p<0.20$) were selected for the multiple analysis, adjusted by the Poisson multiple regression model with robust variance, considering a significance level of 5% ($p<0.05$) for variables that remained associated with knowledge on the vector *Aedes aegypti*.

This study was approved by the Research Ethics Committee of Porto Alegre Clinical Hospital, Federal University of Rio Grande do Sul, Rio Grande do Sul State, Brazil, under the process Nº 2.068.222.

RESULTS

From the total of 583 participants, 68.1% were female, and 46.3% were between 18 and 39 years old; regarding the level of education, 58.5% had more than eight years of schooling, the non-white skin color was self-declared by 65.2% of the individuals and 61.9% lived with a spouse or partner. Regarding information on water supply, 87% reported daily availability of water from the general municipality network, 95% had the habit of storing water in water tanks, and 41.7% used drinking water treated at home (Table 1).

Knowledge on the vector that transmits dengue, Zika and chikungunya was considered adequate for 52.7% of participants. The association between inadequate or insufficient knowledge and sociodemographic

Table 1 - Sociodemographic characteristics of the study population, Tangara da Serra, Mato Grosso State, 2018.

Characteristics	n	(%)
Gender		
Female	397	(68.1)
Male	186	(31.9)
Age group		
≥ 60	116	(19.9)
40 to 59	197	(33.8)
18 to 39	270	(46.3)
Education (in years)		
Illiterate	26	(4.5)
≤ 8	216	(37.0)
> 8	341	(58.5)
Self-declared skin color		
Non white	380	(65.2)
White	203	(34.8)
Lives with a partner		
No	222	(38.1)
Yes	361	(61.9)
Availability of water by mains		
Not applicable	49	(8.4)
Every other day	27	(4.6)
Daily	507	(87.0)
Stores water - water tank		
No	29	(5.0)
Yes	554	(95.0)
Water to drink		
No home treatment	213	(36.5)
Treated at home	243	(41.7)
Industrialized	127	(21.8)

n = sample size per variable.

characteristics were found in the age group greater than or equal to 60 years old (p=0.017), among illiterate individuals (p=0.002) and among those with 8 years or less of study (p<0.001). As for water supply, inadequate or insufficient knowledge was associated with storing water in a water tank (p=0.044) and using untreated drinking water at home (p=0.023), while adequate knowledge on the vector was associated with receiving mains water every other day (p=0.002) (Table 2).

Regarding preventive practices, inadequate or insufficient knowledge on the vector was associated with the lack of coverage or cleaning of water reservoirs (p=0.001) and not using insecticides at home (p<0.001) (Table 3).

After the Poisson model analysis with robust variance, inadequate or insufficient knowledge on the vector that transmits dengue, Zika, and chikungunya remained associated with education in the illiterate (p<0.001) and 8 years or less of study (p<0.001) categories, in addition to not performing the capping and cleaning of the water tank (p=0.002) and not using insecticides at home (p=0.007), while adequate knowledge on the vector remained associated with receiving water from the general network supply every other day (p=0.017) (Table 4). The other variables lost significance after the statistical modeling.

DISCUSSION

Regarding the reproduction, morphology and habits of the vector that transmits dengue, Zika and chikungunya, a little more than half of the studied population had sufficient knowledge, an inferior result in comparison with those described in a Mexican study, in which knowledge on the breeding sites of mosquitoes was described by 95.5% of participants[16]. In a survey of an urban community in Northeastern Brazil, participants reported knowing that not all types of mosquitoes transmit infections[11], a fact evidenced in this survey, as people from Mato Grosso identified the larva and the transmitting mosquito in some occasions, differentiating it from other types of mosquitoes. Besides the identification of the vector, 21% of the individuals gave an adequate response according to the Ministry of Health, that is, they informed that the blood repast of the vector occurs in the morning and early evening, similar to the study in El Salvador, in which 40.9% of respondents provided adequate information[16], whereas in another survey, in Northeastern Brazil, 71% reported knowing the diurnal habits of the mosquito[11].

Knowledge on the vector can be established through the meaning and relevance of information individuals have access to[17], and in this sense, the understanding of the vector found in this study may be related to the actions of the endemic disease control agents (ECA) and community health agents (CHA), as well as the campaigns to disseminate information in the media, which have as their main theme, the characteristics and morphology of the vector, the presence of larvae in containers with standing water and diurnal habits of the mosquito, showing appropriation of the contents disseminated[11,16]. To face endemic diseases in Brazil, one of the strategies is the integration of ECAs actions, with the activities of CHAs in the Family Health Strategy teams (FHS), and among these actions, orientation to residents on possible breeding sites of the vector and signs and symptoms of arboviruses[18], plays a strategic role in the prevention and control of these diseases[19].

An association was found between inadequate or insufficient knowledge on the vector of these arbovirus

Table 2 - Prevalence, crude prevalence ratio and 95% confidence interval of inadequate/insufficient and adequate knowledge on the vector, according to sociodemographic characteristics and water supply in the municipality of Tangara da Serra, Mato Grosso State, 2018.

Variables	Inadequate/ Insufficient n (%)	Adequate n (%)	$_{c}$PR	95% CI	p-value
Gender					
Female	179 (45.1)	218 (54.9)	0.87	(0.73-1.03)	0.111
Male	97 (52.2)	89 (47.8)	1.00	-	-
Age group					
≥ 60	66 (56.9)	50 (43.1)	1.30	(1.06- 1.60)	0.017
40 to 59	92 (46.7)	105 (53.3)	1.07	(0.87-1.31)	0.520
18 to 39	118 (43.7)	152 (56.3)	1.00	-	-
Education (in years)					
Illiterate	18 (69.2)	8 (30.8)	1.80	(1.35-2.41)	0.002
≤ 8	127 (58.8)	89 (41.2)	1.53	(1.29-1.82)	<0.001
> 8	131 (38.4)	210 (61.6)	1.00	-	-
Self-declared skin color					
Non white	191 (50.3)	189 (49.7)	1.20	(0.99-1.45)	0.053
White	8 5(41.9)	118 (58.1)	1.00	-	-
Lives with a partner					
No	102 (45.9)	120 (54.1)	0.95	(0.80-1.14)	0.597
Yes	174 (48.2)	187 (51.8)	1.00	-	-
Availability of water by mains					
Not applicable	25 (51.0)	24 (49.0)	1.05	(0.79-1.40)	0.738
Every other day	5 (18.5)	22 (81.5)	0.38	(0.17-0.85)	0.002
Daily	246 (48.5)	261 (51.5)	1.00	-	-
Stores water - water tank					
No	19 (65.5)	10 (34.5)	1.41	(1.07-1.87)	0.044
Yes	257 (46.4)	297 (53.6)	1.00	-	-
Water to drink					
No home treatment	121 (56.8)	92 (43.2)	1.29	(1.03-1.62)	0.023
Treated at home	99 (40.7)	144 (59.3)	0.92	(0.72-1.18)	0.535
Industrialized	56 (44.1)	7 1(55.9)	1.00	-	-

$_{c}$Pr = crude prevalence ratio; 95% CI = 95% confidence interval; N = sample size per variable.

infections and the educational level of the interviewees, suggesting that individuals with lower educational levels have less information on the vector. A study with health professionals and the general population found that the length of studies may have positively influenced a higher level of knowledge[20] and in Nepal, an association was found between the educational level of the participants and better prevention attitudes towards dengue[21]. Therefore, the level of education can be considered a determining factor of knowledge, as well as of attitudes and preventive practices, especially when it comes to actions with participation of the community for the vector control, suggesting that a higher level of education is related to the empowerment of the population in these activities[22]. In view of these results, it is necessary to consider that, for health educational activities, people with fewer years of education may need a different approach, supplying their information needs, so that prevention actions can occur.

In this survey carried out in Mato Grosso State, an association was found between having adequate knowledge on the vector and the availability of the municipality general network supply in the household every other day. Some studies such as one from the Northeastern Brazil, suggested that the availability of water is a determinant

Table 3 - Prevalence, crude prevalence ratio and 95% confidence interval of inadequate/insufficient and adequate knowledge on the vector, according to preventive practices in the municipality of Tangara da Serra, Mato Grosso State, 2018.

Variables	Inadequate/ Insufficient	Adequate	$_{c}$PR	95% CI	p-value
	n (%)	n (%)			
Cleaning of areas and plant pots					
No	30 (56.6)	23 (43.4)	1.22	(0.95-1.57)	0.157
Yes	246 (46.4)	284 (53.6)	1.00	-	-
Covering and cleaning of water reservoir					
No	96 (58.2)	69 (41.8)	1.35	(1.14-1.60)	0.001
Yes	180 (43.1)	238 (56.9)	1.00	-	-
Use of insectices at home					
No	154 (55.8)	122 (44.2)	1.40	(1.18-1.67)	<0.001
Yes	122 (39.7)	185 (60.3)	1.00	-	-

$_{c}$Pr = crude prevalence ratio; 95% CI = 95% confidence interval; N = sample size per variable.

Table 4 - Prevalence ratio and 95% confidence interval of knowledge about the vector, adjusted by the multiple Poisson model with robust variance, according to demographic variables, water supply and prevention practices in the municipality of Tangara da Serra, Mato Grosso State, 2018.

Variable	$_{a}$PR	95% CI	p-value
Education (in years)			
Illiterate	1.77	(1.31 ; 2.39)	<0.001
≤ 8	1.53	(1.29 ; 1.82)	<0.001
> 8	1.00	-	-
Availability of water by mains			
Did not apply	0.86	(0.64 ; 1.15)	0.306
Every other day	0.39	(0.18 ; 0.84)	0.017
Daily	1.00	-	-
Covering and cleaning of water reservoir			
No	1.30	(1.10 ; 1.54)	0.002
Yes	1.00	-	-
Use of insecticides at home			
No	1.27	(1.07 ; 1.52)	0.007
Yes	1.00	-	-

$_{a}$PR = Adjusted prevalence ratio; 95% CI = 95% confidence interval; N = sample size per variable; model p value p<0.001.

for the maintenance of the mosquito life cycle[23], showing a correlation between dengue cases and water /sewage treatment rates[24]. Therefore, water supply/ sewage treatment is an important indicator in the control of *Aedes aegypti*. The water supply is a factor that influences the ecology of the vector, and has been identified as a key factor in the transmission of arbovirus infections, because in places in which the water supply is irregular, with lack or intermittence of water supply, storage through the use of inadequate reservoirs is frequent, creating an ideal environmental condition for the increment of breeding sites, favoring reproduction and survival of the vector[25].

The residents of the municipality of Tangara da Serra experienced a water crisis in the year 2016, prior to the collection period of this study, having been decreed a situation of emergency caused by drought, resulting in irregular and insufficient distribution of rainfall[26,27], an important factor that may have influenced the responses to the need for rationing and care of water reservoirs, highlighting the need of considering the community characteristics and previous knowledge when planning educational activities for disease prevention. Still on the availability of water, the study suggests that the government should ensure substantial investments in measures such as

environmental sanitation and environmental and health education on a continuous basis, which can contribute for the elimination of breeding sites, larvae and mosquitoes, as well as the selection of socio-environmental indicators can assist in the analysis of the Building Infestation Index, acting as a subsidy in the implementation of public policies for prevention and control of *Aedes aegypti*[28].

Not performing the capping and cleaning of water tanks was associated with inadequate or insufficient knowledge on the vector, which may suggest that not knowing how the mosquito reproduction takes place is related to the lack of preventive actions, especially in households that need to store water for consumption in temporary reservoirs due to intermittent supply. Similar results were found in a study conducted in the Northeast region of Brazil, in which water care practices were associated with knowledge on dengue, suggesting that it is possible that having sufficient knowledge may influence the preventive practices such as cleaning and sealing water reservoirs[11].

Inadequate knowledge on the vector was also statistically associated with the non-use of insecticides or spatial repellents at home. The application of these insecticides is efficient in containing the adult form of the mosquito, and is a practice used and seen by many individuals as the solution to the problem of arbovirus infections, but this belief has led to the misuse of products and environmental contamination[25]. In addition to the resistance of *Aedes aegypti* to conventional insecticides that has already been observed in Brazilian studies[29,30], space repellents have the function of avoiding human contact with the vector, are of low molecular weight and produce a mosquito-free area, protecting people from bites, but are not yet fully recognized as an effective component of vector control strategies, but may be an option to be considered in situations of high infestation[31]. Furthermore, control measures based on the identification and elimination of breeding sites of vectors in the larval stage are the most efficient, making the research and development of less polluting or less toxic alternatives urgent[32], resulting in their dissemination and access to the population.

To improve the knowledge on the vector that transmits dengue, Zika and chikungunya, and the preventive practices against the mosquito, it is believed that communication and health education interventions are necessary, aiming to produce sense in the population on the guidelines proposed by the government and the scientific community, focusing on innovative and important information for the effective participation of the community in the control of mosquito infestation and to promote and reinforce the importance of domestic preventive, simpler and more effective, as much as less harmful practices, such as the rational use of repellents and insecticides[16], emphasizing to the population in a clear and accessible way, and in adequate language, how these actions, if properly conducted, can bring benefits to their quality of life[33].

Knowledge is one of the factors influencing the performance of preventive practices for arboviruses[34], and a dialogic approach of educational strategies is necessary, despite efforts to control the *Aedes aegypti* vector, if dengue outbreaks and the emergence of other arboviruses, such as chikungunya and Zika occur. In addition, to face problems related to the proliferation of *Aedes aegypti*, it is essential to improve water supply services, sewage systems and housing conditions[35].

Among the limitations of this study is the fact has a cross-sectional design, and the answers on knowledge and practices were self-reported. Selection bias may also have occurred, as only individuals who were present in the household at the time of the interview were invited to participate in the survey. Another limitation for this type of study is related to the subjectivity of knowledge, recognizing the importance of knowledge that communities have, however, considering for the purpose of analysis, knowledge as the information to which the population had access to, coming from mass communication campaigns and/or health education actions.

CONCLUSION

The positive association with inadequate or insufficient knowledge on the vector that transmits dengue, Zika and chikungunya found in this study suggests that individuals with lower levels of education have less knowledge, confirming the need for improved communication and health educational actions that would meet the demands of each population, considering an accessible language and prior knowledge.

Adequate knowledge on the vector was associated with intermittent water supply for consumption, leading to the need of water storage in reservoirs; thus, this finding is relevant. Furthermore, regarding the water reservoirs, the inadequate or insufficient knowledge was associated with the lack of cleaning and sealing of storage reservoirs, showing the need for more information on the vector, its characteristics of reproduction, and the proper care towards water reservoirs.

Similar studies, which analyze the relationship between knowledge and preventive practices adopted by a population, are important for planning of public policies as well as efficient communication actions conducted according to the community characteristics, providing a dialogical approach that would encourage the participation

of all citizens. Based on the results found here, a future study is suggested to verify the association between the knowledge and preventive practices on arbovirus infections and the occurrence of these diseases.

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AUTHORS' CONTRIBUTIONS

JPN participated in the study design, data collection, analysis, interpretation, and writing of the manuscript. LS participated in the study design. MA participated in the study design and correction of the manuscript. MME participated in the statistical analysis. ACPT and JHS participated in data collection and correction of the manuscript. All authors read and approved the final version of the manuscript.

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