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ORIGINAL ARTICLE

Facility-Based Cross-Sectional Survey on Aedes-Borne Diseases and Associated Symptoms among Febrile Patients During the 2019 Dengue Outbreak in Moshi Rural District, Tanzania

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ABSTRACT

Background: Diseases caused by Aedes-borne viruses, such as; dengue, chikungunya, and Zika are emerging and re-emerging in different parts of the world. Tanzania has experienced several dengue outbreaks since 2010. The present study aims to determine the seroprevalence and associated symptoms of dengue and chikungunya fever in the Moshi rural district during the 2019 dengue outbreak.

Methodology: A facility-based cross-sectional survey was conducted in 15 health facilities in the Moshi Rural district. A total of 397 participants with malaria-like symptoms were enrolled. Participants were screened for seropositivity towards dengue and chikungunya Immunoglobulin G and M (IgG and IgM) using ELISA-based kits.

Results: Out of 397 participants, 28 (7.1 %) and 8 (2.0%) were dengue IgM and IgG positive respectively. Chikungunya IgM positives were 34 (8.6%). The most commonly reported symptoms were; headache 189 (27.7%), joint pains 132 (19.4%) and muscle pain 106 (15.5%). Factors such as being a farmer and history of travelling to outside regions was associated with dengue IgM seropositivity ($p<.05$).

Conclusion: Aedes-borne illnesses appear to be endemic in the area, with IgG antibodies against the Chikungunya virus being more prevalent among study participants. These results provide an understanding of arboviral diseases as well as provide an early warning signal on the risk of transmission in north Tanzania. The results inform the allocation of local and national public health intervention to prevent future outbreaks.

BACKGROUND

Arboviruses are a group of viruses that are transmitted to humans mainly through bites of infected arthropods such as; mosquitoes, ticks, sand flies, or midges.[1] Diseases caused by Arboviruses include; dengue, chikungunya, zika, yellow fever, and rift-valley fever to mention a few.

These viruses cause diseases ranging from asymptomatic to life-threatening conditions such as haemorrhagic fever as well as neurological disease.[2,3] Most individuals infected with arbovirus experience mild or no symptoms at all. Typical symptoms of most arboviral diseases include; high fever, flu-like illness, headache, joint pain, muscle pain, skin rash, backache, fatal hemorrhagic complications, myalgia, and nausea.[2,4] For long, arboviral diseases have not been considered to be among the major contributors to global mortality and disability.[5] As a result of increased urbanisation, globalisation, and international travel, arboviral diseases are expanding their geographical range and affecting global public health. International travel accelerates the introduction of arbovirus into new areas.[5,6] Dengue and other arboviral diseases are endemic in many African countries, however, the extent of arboviral infections is unknown because arboviral are not considered a priority in many African countries' ministry of Health.[7,8] In a systematic review and meta-analysis study, the prevalence of dengue in Africa is reported to be 24.8% (13.8–37.8), 10.8% (3.8–20.6), and 8.4% (3.7–14.4) for Immunoglobulin G (IgG), immunoglobulin M (IgM), and for acute dengue respectively.[9] However, the burden of dengue remains largely unknown in Africa.

In Tanzania mainland and Zanzibar, there are several reports of the prevalence of arboviral diseases.[10–13] Dengue has been reported to be 9.9% (PCR) in Morogoro[14], 43.5% in Dar es Salaam (IgG)[15], 3.7% to 9.0% (IgM) in Lower Moshi[16], and 37.8% in Zanzibar (IgG)[15], while chikungunya has been reported to be 21.2% in Dar es Salaam (IgG)[15], 11.4% in Hai Kilimanjaro (IgM)[16], 23.1% (PCR) in Lower Moshi[17] and 12.2% in Zanzibar (IgG).[15] Similarly, the *Aedes aegypti* mosquito has been implicated to transmit dengue and chikungunya in Tanzania.[16,18,19] *Aedes aegypti* mosquitoes are the main vectors for Dengue

and Chikungunya virus transmissions in Kilimanjaro.[16,18] In recent years, there has been an unprecedented emergence of epidemic arboviral diseases (such as dengue) in Tanzania. The first epidemic was reported in Dar es Salaam in 2010, among travellers returning to Europe and Japan.[20] The second outbreak was recorded in 2013 involving 20 febrile patients.[21] A third outbreak occurred in 2014, with 1000 confirmed cases.[22,23] A large-scale outbreak was reported in 2019, with a total of 6,859 dengue confirmed cases.[24] Most reported cases were from regions along the coast of the Indian Ocean, Tanzania. Besides, these arboviruses are underestimated in Tanzania due to limited health care resources that do not extend to confirming the actual pathogen causing fever in patients presenting with malaria-like symptoms.

Since the outbreak began in Dar es Salaam, other regions were not subject to the same public health measures, and as a result, dengue continued to cause severe morbidity in other regions within Tanzania. Since dengue or chikungunya may increase the risk of outbreaks, it is crucial to closely monitor the prevalence or incidence of arboviruses throughout Tanzania and use this information to support public health action. This study aimed at determining the prevalence of dengue and chikungunya in Moshi rural district during the 2019 dengue outbreak. Identification of arboviral infections in the area is essential for thorough management of cases and planning for further control.

METHODS

Study Settings

The study was conducted in Moshi's rural area which includes the proposed urban extension area. The following dispensaries were included in the study; Himo, Uoni Mission, Alep Health, Chekereni, Kyomu, Uchira, Mrawi, Mabogini, Mtakuja, Mikocheni, Kahe, Kilema Pofo, Makaa Pomuwani, as well as two hospitals TPC and Upendo. The area is characterised by dense forests, savannah type of vegetation, and irrigation schemes. Altitudes range from 700 to 950 metres above sea level. The area experiences a bimodal form of rainfall with long rains occurring from March to June and short rains occurring between October and November. The area was selected based on available evidence of dengue (3.6%) and chikungunya infection (10.1%) as well as high diagnosis of malaria cases.[10]

Study Design, Sampling, and Recruitment

This was a facility-based cross-sectional study conducted in selected dispensaries. The study utilised a purposive sampling technique to get the 397 participants. The study included participants who visited a health facility for care and treatment during the 2019 dengue outbreak. The study included all patients irrespective of their age who experienced febrile illness during the data collection period (June to July 2019).

Data Collection

Community members and heads of facilities were involved before recruiting study participants. Study staff explained the purpose of the study and answered any questions in an open forum. The forum was conducted in a local language and participants were allowed to ask questions. Participants' consent to take part in the study was sought. The questionnaires were completed by the study staff who were trained in data collection. A structured Swahili questionnaire was used to collect information from the study participants. Information collected included; socio-demographic characteristics such as; age, sex, marital status, education level, occupation, housing characteristics, preventive measures, travel history, and history of fever or illness in the past 24 hours prior to questioning time.

Validity of the Questionnaire

To maximise validity, the questionnaire was pre-tested on 5 respondents before distribution as a pilot study. The aim was to examine how the participants understood and responded to the questions. After the pre-test, adjustments in phrasings were made to make the questionnaire simple to understand.

Blood Sample Collection and Serology Test

About 1 to 5 millilitre (ml) of whole blood sample was collected from suspected patients, and transported to Kilimanjaro Christian Medical University College laboratory in an ice box maintained at 2 to 8°C temperature within 24 hours. The blood samples were tested for both dengue and chikungunya antibodies using Dengue IgG/IgM Combo Rapid Test and Chikungunya IgM Combo Rapid (CTK Biotech, Inc. USA). The tests were carried out following the manufacturer's recommendations.

Statistical Analyses

Data was analysed using Statistical Package for Social Sciences 20.0 software (SPSS Inc., Chicago, USA). Descriptive statistics was summarised using frequencies and percentages for categorical variables while means and standard deviations for continuous variables, particularly respondents' age in years. The chi-square test or Fischer exact test was used to test the association between categorical variables. A *p-value* of less than 5% was considered statistically significant.

Ethical Approval

The study was approved by the Kilimanjaro Christian Medical University College Research and Ethics Review Committee (CRERC) with certificate number 2492. Written informed consent was obtained from all participants. In the case of children under 18 years of age, a parent or legal representative provided consent on behalf of the participant. Permission to conduct this study was sought from the District Medical Officers and the heads of each health facility. Confidentiality and restricted access to collected data were adhered to throughout the study.

RESULTS

Characteristics of the Studied Population

A total of 397 participants were included in the analysis. The mean age of the population was 33.4 ± 20.1 years (range 1–80 years) and 261 (65.7%) were female. Adults aged above 15 years were more represented as compared to other age groups, 313 (78.8%). Ninety-eight participants had a history of travel within the past 2 weeks to various regions of Tanzania. Most participants had travelled to epidemic regions such as; Dar es Salaam 30 (30.6%), Tanga 17 (17.3%), Arusha 15 (15.3%), Dodoma 8 (8.2%) and Zanzibar 6 (6.1%). (Table 1)

TABLE 2: Prevalence of Dengue and Chikungunya

	Variables	n (%)
Fever	Yes	171 (43.1)
	No	226 (56.9)
Chikungunya IgM	Positive	34 (8.6)
	Negative	363 (91.4)
Dengue IgM	Positive	28 (7.1)
	Negative	369 (92.9)
Dengue IgG	Positive	8 (2.0)
	Negative	389 (98.0)

Prevalence of Dengue and Chikungunya among Patients and Common Reported Symptoms

Twenty-eight (7.1%) and 8(2.0%) participants were laboratory confirmed to be dengue IgM and IgG positive respectively. A total of 34 (8.6%) participants were confirmed to be chikungunya IgM-positive. One hundred and seventy-one (43.1%) participants had fever. (Table 2) The most commonly reported symptoms were; headache 189 (27.7%), joint pains 132 (19.4%), Muscle pain 106 (15.5%), eye pain 58 (8.5%), skin rash 52 (7.6%), cough 32 (4.7%), back pain 23 (3.4%), chest pain 16 (2.3%), dizziness, cold, nausea/vomit (both) 9 (1.3%). (Figure 1).

Factors Associated with Dengue and Chikungunya IgM

Fever was associated with chikungunya seropositivity as compared to those without fever, 25 (73.5%) $p<.01$. Headache was associated with chikungunya seropositivity as compared to those without headache 23 (67.7%), $p=.01$. Other factors such as; age, sex, occupation, travel history, joint pain, and muscle pain were not associated with chikungunya seropositivity. (Table 3) Being a farmer was associated with dengue IgM seropositivity as compared to other occupations 13(46.4%), $p=.02$. Travel history was associated with dengue IgM seropositivity, 23(82.1%), $p=.003$. (Table 3)

FIGURE 1: Commonly Reported Clinical symptoms

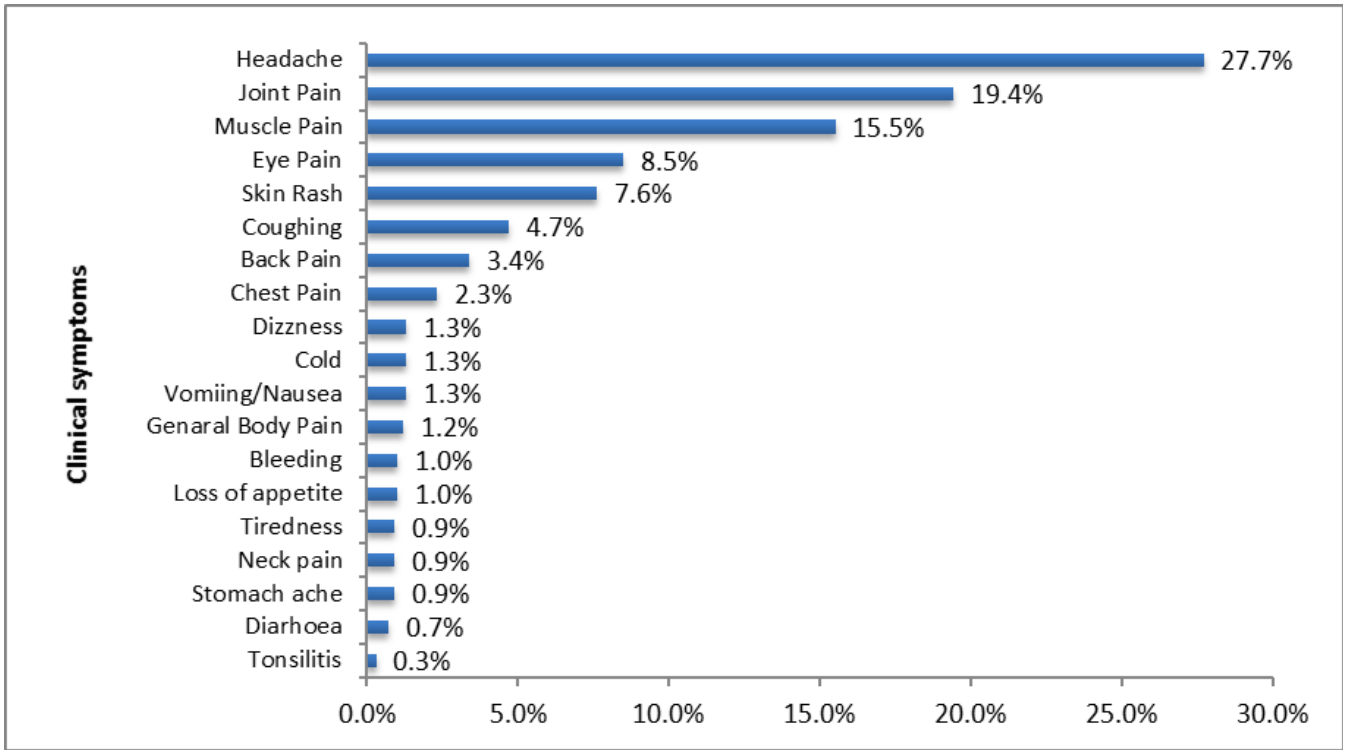

TABLE 3: Symptoms and other factors associated with Dengue IgM and Chikungunya IgM Seropositivity

Variable	Chikungunya IgM n(%) Positive	Negative	P-value	Dengue IgM n(%) Positive	Negative	P value
Age category						
≤5 Years	2 (5.9)	48 (13.2)	0.5	2 (7.1)	48 (13.0)	0.6
6 to 15 Years	4 (11.8)	45 (12.4)		3 (10.7)	46 (12.5)	
>15 Years	28 (82.4)	270 (74.4)		23 (82.1)	275 (74.5)	
Sex						
Female	26 (76.5)	235 (64.7)	0.1	20 (71.4)	241 (65.3)	0.5
Male	8 (23.5)	128 (35.3)		8 (28.6)	128 (34.7)	
Occupation						
Student/Child	5 (14.7)	85 (23.4)	0.5	5 (17.9)	85 (23.0)	0.02*
Farmer	14 (41.2)	108 (29.8)		13 (46.4)	115 (31.2)	
Employed	11 (32.4)	117 (32.2)		3 (10.7)	119 (32.2)	
Self-Employed	4 (11.8)	53 (14.6)		7 (25.0)	50 (13.6)	
Travel History						
Yes	14 (41.2)	162 (44.6)	0.6	23 (82.1)	198 (53.7)	0.003
No	20 (58.8)	201 (55.4)		5 (17.9)	171 (46.3)	
Fever						
Yes	25 (73.5)	153 (42.1)	<0.01	16 (57.1)	162 (43.9)	0.1
No	9 (26.5)	210 (57.9)		12 (42.9)	207 (56.1)	
Headache						
Yes	23 (67.7)	169 (46.6)	0.01	12 (42.9)	180 (48.8)	0.5
No	11 (32.4)	194 (53.4)		16 (57.1)	189 (51.6)	
Joint Pain						
Yes	12 (35.3)	120 (33.1)	0.7	9 (32.1)	123 (33.3)	0.5
No	22 (64.7)	243 (66.9)		19 (67.9)	246 (66.8)	
Muscle pain						
Yes	7 (20.6)	263 (72.5)	0.3	6 (21.4)	101 (27.4)	0.4
No	27 (79.4)	100 (27.5)		22 (78.6)	268 (72.6)	

*Fisher exact Test
Farmers both agriculturalist and livestock keepers

TABLE 1: Characteristics of the Studied Population (N=397)

Variables	Value n (%)
Age categories	
≤5 Years	50 (12.6)
6 to 15 Years	34 (8.6)
>15 Years	313 (78.8)
Mean age ± standard deviation 33.4 ± 20.1 years (range 1–80 years)	
Sex	
Female	261 (65.7)
Male	136 (34.3)
Occupation	
Students/Child	90 (22.7)
Farmer	122 (30.7)
Employed	128 (32.2)
Self-Employed	57 (14.4)

Continue

TABLE 1: Continued

Variables	Value n (%)
Travel History (n=98)	
Dar	30 (30.6)
Tanga	17 (17.3)
Arusha	15 (15.3)
Dodoma	8 (8.2)
Tabora	3 (3.1)
Zanzibar	6 (6.1)
Mwanza	4 (4.1)
Mbeya	2 (2.0)
Manyara	2 (2.0)
Nairobi	4 (4.1)
Pwani	3 (3.1)
Singida	4 (4.1)

DISCUSSION

The outbreak of dengue recorded in Tanzania demonstrate a potent epidemiological threat. The outbreak measures provide opportunity for combating similar vector-borne viral diseases such as; chikungunya, zika and West Nile fever since they are all transmitted by the same *Aedes aegypti* vector. This study determined the prevalence and associated symptoms of dengue and chikungunya fever during the 2019 dengue outbreak in Moshi Rural District, Tanzania. The prevalence of chikungunya IgM was 8.6%.This is relatively low when compared to results of a previous study conducted in the same area which reported a prevalence of 10.1%.[10] Despite this study having been conducted during the dengue outbreak period, findings indicate that chikungunya was also circulating during this period. The study reports the prevalence of dengue IgM to be 7.1%. This is higher than results of a previous study conducted in similar settings which reported prevalence of dengue to 3.6% among 138 febrile patients.[10] Both studies focused on health facilities located in rural areas. This implies that there is continued transmission of dengue in such area spread by mosquitoes infected with the dengue virus. Moreover, it is reported that dengue viral infections may be more prevalent than reported data suggests, and that the *Aedes aegypti* mosquito vectors appear to be increasing in different geographical settings.[25]

This study reports that the most common symptoms were; headache 27.7%, joint pains 19.4%, Muscle pain 15.5%, eye pain 8.5% and skin rash 7.6%. These commonly reported symptoms concur with results of a study that was conducted in Mexico and Cuba which reported fever, joint pain, myalgia, and skin rash as the most common symptoms among patients with arboviral infection.[26,27] Strategies to successfully control and eliminate dengue and chikungunya depend on early and accurate diagnosis. It has been reported that symptoms of these infections overlap[28], and therefore, jeopardise the clinical decision if a clinical diagnosis is done. To achieve better diagnosis, health facilities need to be equipped with tools that can rapidly and effectively detect pathogens in a patient sample. In areas like Tanzania, where dengue, chikungunya, and other pathogens like malaria are endemic, there is a need for a multiplexing assay that can detect both dengue and malaria and hence be able to differentiate dengue, chikungunya or malaria from other febrile illness.[29]

In this study, it was observed that farmers were more likely to be dengue IgG seropositive as compared to other occupation. This is due to the fact that farmers are more exposed to mosquito bites since farming is generally an out-door activity. Likewise, since Aedes mosquitoes bite animals as an alternative host, being close to animals also increase the risk of mosquito bite. This has also been reported in studies conducted in other settings that livestock keeping can influence higher number of mosquito vectors close to humans as the keeping of livestock is associated with the presence of larval habitats.[30,31] A study in Vietnam reported similar results that farmers have up to almost eight times more risk of dengue virus infection.[32]

The reported serology results (IgM and IgG) indicate endemicity of both diseases. Future studies should conduct more sensitive tests such as molecular tests that will be able to detect active circulation of the virus. Effective management and control of dengue and chikungunya must include surveillance of other diseases such as malaria and bacteria that mislead clinical diagnosis. Vector control is the cornerstone for vector-borne diseases and should be escalated in rural areas in the fight against arboviruses.[33,34]

CONCLUSION

Aedes-borne illnesses such as Chikungunya appear to be endemic in the area, with IgG antibodies against Chikungunya virus being more prevalent among study participants. These results provide an understanding of arboviral diseases as well as provide an early warning signal on the risk of transmission in north Tanzania. The results inform the allocation of local and national public health intervention to prevent future outbreaks.

Study Limitations

The study reports the prevalence of dengue during the outbreak period, however, the reported signs and symptoms may be overlapping with other febrile illness such as malaria. Future studies should consider excluding all cases positive for other pathogens causing fever or febrile illness. This study didn't report entomological and molecular data. Future studies should incorporate such data so as to clearly explain transmission patterns.

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