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Socio-demographic determinants of dengue infection during an outbreak in Dar es Salaam City, Tanzania

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Abstract

Background: In recent years, the eastern coast of Africa has witnessed a number of dengue outbreaks. This study was carried out to determine socio-demographic determinants of dengue infection during the 2014 outbreak in Dar es Salaam, Tanzania.

Methods: Unmatched case-control analysis of secondary data from a cross-sectional dengue investigation in three districts of Dar es Salaam in June 2014 was conducted. Febrile patients seeking care at health facilities were recruited. Cases were serologically-confirmed dengue-positive while controls were serologically-confirmed dengue-negative patients. A questionnaire was used to collect sociodemographic information. The association between sociodemographic variables and dengue infection was examined using univariate analysis and multivariate logistic regression analysis.

Results: A total of 81 cases and 281 controls were included in the analysis. Majority of the cases and controls were males (64.2% *versus* 54.1%; P=0.137) and were ≥15 years of age (88.9% *versus* 72.9%; P =0.003). Living in Kinondoni (aOR = 4.28; 95% CI: 1.74 - 10.53); being employed (aOR = 2.06; 95% CI: 1.06-4.04); having piped water at home (aOR = 2.63; 95% CI: 1.40 - 4.95) and a recent visit of health facility (aOR = 1.94; 95% CI: 1.11 - 3.38) were significantly associated with dengue infection.

Conclusions: Dengue infection in Dar es Salaam varied between the three districts and was associated with being employed, having piped water at home and a recent visit to the health facility. These findings provide primary understanding of the influence of socio-demographic factors on dengue and may be used to develop appropriate preventive interventions.

Keywords: Dengue, socio-demographic, determinants, Tanzania

Introduction

Dengue is a mosquito-borne viral infection that poses a threat to public health in more than 100 countries worldwide. Global incidence of dengue has increased in recent years with more than half of the world's population (>3.6 billion people) being at risk, mainly in the urban centres of the tropics and subtropics (Bhatt *et al.*, 2013; Jaenisch *et al.*, 2013). An estimated 96 million clinical dengue with an additional 294 million unapparent infections occur globally (Bhatt *et al*., 2013). In Africa, dengue infections have been reported since the 19th century. Between 1960 and 2010, laboratory confirmed dengue outbreaks were reported in 15 African countries; most of which occurred in Eastern Africa (Were, 2012).

Dengue is becoming a common infection in many geographical areas of Tanzania. A sero-prevalence of anti-Dengue virus (DENV) IgG antibodies of 1.8% in Iringa and 7.7% on Pemba Island in

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2007, and up to 50% in healthy blood donors on Zanzibar Island in 2011 have been reported (Vairo *et al.*, 2012, 2014). In Moshi in northern Tanzania, the incidence of acute dengue infection was reported as 20.9% in 2007/2008 (Hertz *et al.*, 2012), while in Kilosa District in central Tanzania it was 9.5% in 2013 (Chipwaza *et al*., 2014). During the recent dengue outbreak of 2014 that affected mainly the districts of Dar es Salaam City, about 1,500 dengue cases and four deaths were reported (WHO, 2014).

Several factors have been identified to be associated with dengue infections. They include unavailability of piped water supply, increase in international travel and the lack of effective solid waste management (Erlanger *et al*., 2008; Mukhtar *et al.*, 2012; Akter *et al*., 2017). Other factors associated with high risk of dengue include housing types, land use types and household density (Vanwambeke *et al*., 2007; Soghaier *et al.*, 2015; Akter *et al.*, 2017). Previous studies in Tanzania have assessed transmission and clinical characteristics of dengue but none determined socio-demographic determinants of dengue infection (Vairo *et al.*, 2012, 2014; Hertz *et al.*, 2012; Chipwaza *et al.*, 2014; Mboera *et al*., 2016). Studies on dengue risk factors associated with socio-demographic factors have not been conducted in Tanzania. Narrowing down to specific socio-demographic factors that influence dengue transmission could provide evidence to setting up effective intervention programmes and allocate appropriate resources. The objective of this study was determine the socio-demographic determinants of dengue infection in Dar es Salaam, Tanzania during the 2014 epidemic.

Materials and Methods

Study site and design

The survey was carried out in three districts of Dar es Salaam namely, Ilala, Kinondoni and Temeke in Tanzania. Seven health facilities were randomly selected from six wards of the three districts based on the ecological of the geographical location, size of the catchment population and health system strength (e.g. presence of a physician and laboratory). These health facilities were: - Tabata health centre and Mnazi-Mmoja hospital from Ilala; Kibamba dispensary and Sinza hospital from Kinondoni and Temeke hospital, Chamazi dispensary and Kigamboni health centre from Temeke. This study was carried out in May-June 2014 during a dengue outbreak in Dar es Salaam.

Data collection

This was a case-control cross-sectional descriptive study. The survey included febrile patients ≥28 days of age who were seeking medical care at the selected health facilities and had resided in Dar es Salaam for the past three months. Fever was defined as axial body temperature of ≥ 38°C or a history of fever for the past 2-9 days. Patients who were severely ill and could not talk were excluded from the study. A case was defined as a patient ≥28 days of age who presented with fever in any of the selected study sites and tested positive for no-structural protein 1- antigen (NS1- Antigen) or immunoglobulin M (IgM) antibodies for dengue using SD Bioline Dengue Duo rapid test (Standard Diagnostics, Inc., Gyeonggi-do, Korea). A control was defined as a patient ≥28 days of age who presented with fever in any of the selected study sites and tested negative for NS1- Ag or IgM antibodies for dengue. The sample size was estimated using OpenEpi program 3.03 assuming a power of 85%, a case: control ratio of 1:3.5, and an odd ratio of 2.5 for >15 years old study participants. This estimated a total of 81 cases and 281 controls to be involved in the study.

A pre-tested questionnaire was used to collect on socio-demographic information. The variables of interest were geographical location of the house, screening of windows, patient's usages of mosquito repellents and source of water supply. Other information sought were type of employment, visitation of health care facility, recreation places or education centres during the previous one month.

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Data analysis

We used frequencies and proportions to summarize categorical variables and Chi-square test and Fisher's exact test to identify significant differences between patients with and without dengue infection. Multivariable logistic regression was used to determine significant socio- economic risk factors for dengue infection. All variables that had a p-value of ≤ 0.1 in the bivariate analysis were entered into the multivariable logistic regression model fitted using stepwise backward elimination method. Multicollinearity tests were done and only non-collinear variables were included in the multivariate model. Likelihood ratio test was used to determine the best model. A p-value < 0.05 was considered as statistically significant. Data was analysed using Epi Info version 3.5.1.

Ethical considerations

This study received ethical approval from the Medical Research Coordinating Committee of the National Institute for Medical Research (NIMR/HQ/R.8a/Vol. IX/1733) and Muhimbili University of Health and Allied Sciences Review Board. Informed consents were obtained from all study participants.

Results

A total of 483 were enrolled into the cross sectional survey. Of these, 101 (20.9%) were positive for DENV infection, and 9 (1.9%) were positive for past DENV infection. A total of 362 patients were included in the study. Of these, 81 met the case definition and 281 met the control definition (a ratio of 1:3.5). The mean age of the participants was 30±13.9 years. In univariate analysis, there were significantly more respondents aged 15 years and above among cases (88.9%) as compared to controls (72.9%) (p= 0.003). A higher proportion of dengue patients were employed compared to those without dengue (66.7% vs. 45.6%, p = 0.001). A significant larger proportion of cases reported living in Kinondoni compared to controls (54.3% versus 39.5%, p = 0.009). There were no significant differences between cases and controls in in terms of sex, number of household members, use of mosquito repellents, presence of piped water at home, screened windows at home and a previous visit in a health facility, education centres or recreational facilities (Table 1).

Table 1: Socio-economic characteristics of cases and controls in Dar es Salaam, 2014

Variable	Category	Cases n (%) N=81	Control n (%) N=281	P value
Sex	Male	52 (64.2)	152 (54.1)	0.137
	Female	29 (35.8)	129 (45.9)	
Age (years)	<15	9 (11.1)	76 (27.0)	0.003*
	≥ 15	72 (88.9)	205 (73.0)	
	Mean±SD	30±13.9	24±14.8	
Employment	Yes	54 (66.7)	128 (45.6)	
	No	27 (33.3)	153 (54.4)	0.001*
Type of employment	Skilled	33 (61.1)	59 (46.1)	0.066
	Unskilled	21 (38.9)	69 (53.9)	
Residence	Ilala	28 (34.6)	106 (37.7)	0.022*
	Kinondoni	44 (54.3)	111 (39.5)	
	Temeke	9 (11.1)	73 (22.8)	
No. household members	1-2	14 (17.3)	52 (18.5)	0.884
	3-5	40 (49.4)	130 (46.3)	
	≥ 6	27 (33.3)	99 (35.2)	
Use of mosquito repellents	Yes	5 (6.2)	23 (8.2)	0.550
	No	76 (93.8)	258 (91.8)	

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Screened windows	Present	69 (85.2)	216 (76.9)	0.107
	Absent	12 (14.8)	65 (23.1)	
Presence of piped water at home	Yes	33 (40.7)	85 (30.2)	0.076
	No	48 (59.3)	196 (69.8)	
Visit to health facility in previous 1 month	Yes	40 (49.4)	110 (39.1)	0.099
	No	41 (50.6)	171 (60.9)	
Visit recreation facilities	Yes	24(29.6)	79(28.1)	0.790
	No	57(70.4)	202(71.9)	
Visit education centres	Yes	10(12.3)	33(11.7)	0.883
	No	71(87.7)	248(88.3)	

***** *P* value < 0.05

In multivariate analysis respondents who resided in Kinondoni district were four times more likely to have dengue infection (aOR = 4.85; 95% CI: 2.01 – 11.71) than those who resided in Temeke or Ilala districts. Patients who were employed were more than twice likely to be infected with dengue (aOR = 2.11; 95% CI: 1.08 - 4.10) than those who were unemployed. Individuals who visited a health facility in the previous one month were twice as likely to have dengue infection (aOR = 1.89; 95% CI: 1.09 - 3.27) than those who did not make a visit. Respondents with piped water at home were three times more likely to be diagnosed with dengue infection (aOR = 2.80; 95% CI: 1.51 – 5.21) than febrile respondents without piped water (Table 2). All other factors studied were found to have insignificant statistical association with the study outcome.

Table 2: Logistic regression analysis of socio-economic predictors of dengue infection

Variable	Category	Crude OR (95% CI)	Adj. OR (95% CI) §
Sex	Male	1.52 (0.91 - 2.54)	1.16 (0.64 - 2.11)
	Female	1.00	1.00
Age (years)	≥ 15	2.97 (1.41 – 6.22)**	1.91 (0.80 - 4.53)
	< 15	1.00	1.00
Employment	Yes	2.39 (1.42 - 4.01)**	2.11 (1.08 - 4.10)*
	No	1.00	1.00
Residence	Kinondoni	2.82 (1.29 – 6.15)**	4.85 (2.01 - 11.71)**
	Ilala	1.88 (0.83 – 4.23)	1.99 (0.83 - 4.81)
	Temeke	1.00	1.00
Presence of piped water	Yes	1.59 (0.90 - 2.64)	2.80 (1.51 - 5.21)**
	No	1.00	1.00
Visit to health facility	Yes	1.52 (0.92 - 2.49)	1.89 (1.09 - 3.27)*
	No	1.00	1.00

***** *P*< 0.05; ****** *P*< 0.001; §Adjusted for all variables in table

Discussion

The findings of this study provide an understanding of the influence of socio-demographic factors on dengue. In multivariate analysis we found residing in Kinondoni district, being employed, visiting a health facility within the previous month and having piped water at home to be associated with dengue infection in Dar es Salaam. Residents of Kinondoni were more likely to have dengue infection compared to those from the other two districts. This finding may reflect the disparities in access to health systems and services among the three districts. It could also indicate the disproportionate level of awareness and knowledge about dengue hence differences in health seeking behaviour among the residents of the municipalities.

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Those who were employed, and therefore spending most of the day times away from their residences were two times more likely to test positive for dengue infection. Working or going to school has been shown to be associated with dengue infection elsewhere (Braga *et al.*, 2010). The relatively high risk of dengue infection among employees could be attributed to the tendency of employed individuals frequently moving to and from their homes to work hence, increasing their chances of coming into contact with mosquito bites at multiple locations. Further breakdown of employment into skilled and unskilled employment did not yield any more information - probably due to small sample size.

Participants who reported to have visited a health facility in the previous month had a higher likelihood of being diagnosed with dengue infection. We assumed that visiting a health facility in the previous month would represent those who are more likely to have more ill health episodes hence more frequency in health visits. The initial manifestation of dengue of acute febrile illness are similar to other febrile illnesses such as malaria, which is endemic in the area. Most likely people who had visited a health facility in the previous month were at first treated as malaria cases, but later to be diagnosed as dengue cases (Vairo *et al.*, 2016). Clinicians should consider dengue infection among febrile patients especially during an outbreak or potential seasons. This practice may enhance early detection, proper diagnosis and case management, hence, minimizing repeat visits, as these may be associated with more severe outcomes.

Presence of piped water at home was considered as a proxy for higher socio-economic status in this study. In this study, cases reporting having piped water at home were nearly three times more likely to have dengue infection than those without piped water. Similar findings have been observed in Pakistan and Mexico (Mukhtar et al., 2012; Vairo et al., 2016). In the contrary, a study in Vietnam reported that absence of tap water to be strongly associated with dengue incidence (Phuong et al., 2008). It is likely that the higher risk of dengue among those with piped water is associated with household water management, rather than having piped water (Vannavong *et al.*, 2017). Improper water management including water storage, provide the mosquito vector ideal breeding sites. It is important therefore that health messages should be provided to promote proper use and maintenance of household water supply systems.

In a parallel study conducted during this dengue outbreak, *Aedes aegypti* was found to be the only vector of Dengue in Dar es Salaam. Human activities have created an ideal habitat for the *Aedes* mosquito to breed and medium-sized plastic containers and tires were the major breeding sites (Mboera *et al*., 2016). Although piped water was available in some of the study populations' homes, Dar es Salaam has frequent interruptions to its water supply. The intermittent water supply forces people to store water in containers, hence creating unknowingly favourable breeding sites for mosquitoes. However, the relationship between water pipes and dengue is complex and may differ from one locality to another. Houses with pipe water receive frequently visits from those fetching water that lead to spill overs hence wet environment that is conducive for multiplication of mosquito vector compared to houses without piped water. Also, due to availability of plenty of water around houses with pipes, such houses are likely to have gardens and other vegetation that could support mosquito breeding (Colón-González *et al.*, 2013).

The findings of this study have some limitations. The study was a cross-sectional survey carried out at the end of rainy wet season. The socio-determinant associated with dengue infection may vary between seasons. However, the use of a case-control analysis enabled us to investigate causal pathways of multiple risk factors associated with dengue infection. Further modelling with multiple logistic regression allowed for control of potential confounders that might have given alternative explanations of our findings. However, our findings should be interpreted with caution due to possible recall bias by the participants, which may have occurred when remembering some

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socio-demographic factors. This may have led to an underestimation or overestimation of our findings.

In conclusion, dengue infection in Dar es Salaam varied between the three districts and was associated with being employed, having piped water at home and a recent visit to the health facility. These findings provide a primary understanding of the influence of socio-demographic factors on dengue. Prevention and control measures of dengue infection should incorporate interventions that address the socio-demographic factors.

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Conflicts of Interest

The authors declare no conflict of interest.

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