International Journal of Public Health and Epidemiology ISSN: 2326-7291 Vol. 4 (1), pp. 110-114, January, 2015. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full length Research paper

Seroprevalence of Zika virus infection specific IgG in Western and North-Western Provinces of Zambia

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Accepted 28 July, 2014

Zika virus infection is an emerging public health problem in Africa and Asia with potential for global spread. This study was conducted to determine the prevalence and correlates for Zika virus infection in Western and North-Western provinces of Zambia. A cross sectional study was conducted in which serum samples were tested for IgG and IgM antibodies against Zika virus. Odds ratio and its 95% confidence interval (CI) were used to determine the magnitude of association. Altogether, 3625 participants were recruited of which 46.7% were male and 9.4% were aged <5 years. The prevalence of Zika infection was 6.1%.Age below 5 years and living in houses that were sprayed with insecticide residual spray were protective factors against the infection (AOR= 64% (AOR=0.36, 95% CI [0.18, 0.72]) and AOR=19% (AOR=0.81, 95% CI [0.66, 0.99], respectively). Meanwhile, visiting Angola and living in houses with roofs made of grass were associated with increased risk of infection (AOR=1.42, 95% CI [1.06, 1.90] and AOR=2.03 (95% CI [1.24, 3.33], respectively). Zika virus infection is prevalent in Western and North-Western Provinces of Zambia and should be curtailed through strengthening of diseases surveillance, laboratory diagnostic capacities and clinical management of cases.

Key Words: Arboviruses, zika virus infection, seroprevalence, correlates, Zambia.

INTRODUCTION

Tropical Africa is the likely site of origin of many of the *Flaviviridae, Togaviridae,* and *Bunyaviridae* arboviruses of modern medical importance and remains one of the most affected regions in the world today (Kuniholm et al., 2006).From the standpoint of evolution, this group of viruses is unique in that it comprises four groups regarding the type of host association: insect viruses that replicate only in insects (mosquitoes), strictly vertebrate viruses without a capacity to replicate in arthropods, tick-borne viruses that replicate in ticks and vertebrates, and mosquito-borne viruses that replicate in mosquitoes and vertebrates (Kuno et al., 2006).The importance of arboviral infections has been illustrated by the dramatically increasing frequency and magnitude of old and newly emerging arboviral disease problems (Kuno et al.,2005).More than 100 arboviruses are known to cause human disease, and are responsible for some of the most explosive epidemics of emerging infectious diseases over the past decade (Dash et al., 2013;Desiree et al.,2011). From 1951 through 1981, serological evidence of human Zika virus infections have been reported from African countries such as Uganda, Tanzania, Egypt, Central African Republic, Sierra-Leone and Gabon (Edward et al.,2009; Whelan and Hall 2008;Tappeet al.,2014;Fayeet al.,2013)and in parts of Asia, such as India, Malaysia, the Philippines, Thailand, Vietnam and Indonesia (Duffy et al.,2009; Grard et al., 2010) with potential for global spread (Faye et al.,2011). In Cameroon, the infection with Zika virus spread to neighbouring Nigeria resulting in an epidemic with symptoms including jaundice (Fokam et al., 2010).

The re-emerging infectious diseases are on the surge because of multiple factors which include environmental

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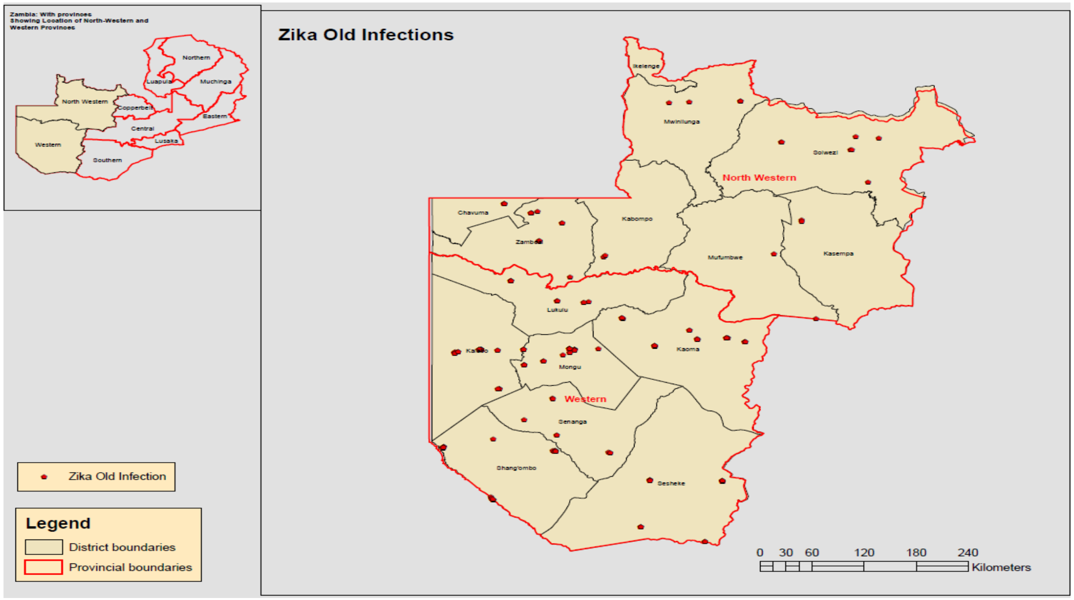
Figure 1. Spatial distribution for old infections for Zika virus in Western and North-Western Provinces.



changes (Duane et al.,2002), transformation of the ecosystems, on-going socio-economic degradation and the deterioration of the public health systems (Gupta et al., 2012;Dikidet al.,2013), societal changes and genetic changes in the pathogen (Duane et al., 1998).Two factors contributing to the global threat from emerging infections stem directly from globalization: the increase in international travel(Morens et al., 2013), tourism, trade(Filder et al., 1996;Preneshniet al., 2011), population growth and environmental degradation (Morens et al., 2008).The presence of causative agent in many territories, along with the alterations in ecological patterns, natural evolution of invertebrate vectors, vertebrate hosts and viruses themselves, combined with rapid movement of people and animals on a global scale constantly generate conditions in which new viral pathogens emerge (Lahariya et al., 2012).

Despite the widespread distribution of Zika virus, there have been very few reported human cases until the Yap outbreak in 2007 (Faye et al., 2014). However, several serological surveys have been carried out in Africa and notable among these is the Portuguese Guinea survey which demonstrated frequent antibodies to group B viruses particularly Zika, among others (Pinto et al., 1967). There is no information on Zika virus infection in Zambia. Hence a study was conducted to determine the prevalence and correlates for Zika virus infection in Western and North-Western provinces of Zambia.

MATERIALS AND METHODS

The study was designed based on Yellow fever information which was the main study factor. Data on Zika virus infection was one of the subsets of this main study.

Study Areas

The survey was conducted in the two provinces of Zambia, namely: Western and North-Western province (Figure 1). North-Western province borders with Angola in the West and Democratic Republic of Congo (DRC) in the North, while Western province borders with Angola to the West. North-Western province covers an area of 125,826 km² and has a population of 695,599, whereas Western province has a total population of 854,890 (CSO, 2011). Peasantry farming (mainly cultivation of maize, cotton and groundnuts) is the major economic activity in North-Western province while fishing and cattle rearing are the main occupation in Western province.

The study area was divided into three main agro ecological zones (Aregheore, 2006) that were classified based mainly on the rainfall patterns. Zone I was characterized by low rainfall, short growing season, high temperatures during the growing season, and a high risk of drought. Zone III was characterized by high rainfall, long growing season, low probability of drought, and cooler temperatures during the growing season. Zone II fell in between Zones I and III for most climatic variables.

Sample Sizes

The sample size calculation was based on the assumption that the Yellow fever sero-prevalence was 7% (Robinson, 1950). After adjusting for 80% response rate, a sample size of 3600 was determined.

Table 1. Simple description for Western and North-Western Provinces for Zika virus infection.

	Total		Male		Female	
Factor	**n**	**%**	**n**	**%**	**n**	**%**
Age (years) (X^2 = 10.41; p = 0.065)						
<5	335	9.4	155	9.3	178	9.4
5-14	853	23.9	424	25.4	429	22.6
15 – 24	738	20.6	344	20.6	392	20.6
25 – 34	593	16.6	245	14.7	348	18.3
35 – 44	460	12.9	214	12.8	245	12.9
45+	596	16.7	286	17.1	310	16.3
Sex						
Male	1669	46.7				
Female	1902	53.3				
Education (X^2 = 37.47; p = 0.001)						
None	758	21.5	312	19.0	444	23.6
Primary	1680	47.6	741	45.1	937	49.8
Secondary or higher	1091	30.9	590	35.9	500	26.6
Occupation (X^2 = 245; p<0.001)						
House wife/husband	307	8.7	18	1.1	289	15.4
Farming	1233	35.1	573	35.1	659	35.1
Other	387	11.0	232	14.2	155	8.3
Student	1590	45.2	811	49.6	775	41.3
Roof type (X^2 = 5.30; p=0.071)						
Grass	2180	61.0	1007	60.3	1171	61.7
Iron sheet	1302	36.4	629	37.7	671	35.3
Asbestos	91	2.5	33	2.0	57	3.0
Zika virus infection (X^2 = 0.01; p = 0.949)						
Yes	217	6.0	100	6.0	116	6.1
No	3408	94.0	1569	94.0	1786	93.9

Sampling

A multi-stage sampling technique was used to select participants for the study in both districts. Firstly, wards were randomly selected from each constituency. In the second stage of sampling, standard enumeration areas (SEAs) proportional to the ward size were systematically sampled. All survey participants aged nine months or older in a selected household were eligible to be enrolled in the study.

Ethical Approval

The study protocol was reviewed and approved by the Tropical Diseases Research Centre Research Ethics Committee, and permission to conduct the study was obtained from the Ministry of Health, Zambia. Informed consent was obtained from survey participants after the interviewer had explained the benefits and risks of participating in the study. Entry forms were viewed only by members of the survey team.

DATA COLLECTION

A detailed semi structured questionnaire was used to collect information. The questionnaire was pre-tested to validate the appropriateness of the questions to capture the required information. During the data collection process, completed questionnaires were checked for inconsistencies and completeness on a daily basis.

Table 2. Factors associated with Zika virus infection in Western and North-Western Provinces in bivariate and multivariate logistic regression analyses.

Factor	OR (95% CI)		AOR (95% CI)	
Age (years)				
<5	0.39	(0.21, 0.74)	0.36	(0.18, 0.72)
5-14	0.74	(0.53, 1.03)	0.76	(0.54, 1.08)
15 - 24	0.86	(0.61, 1.20)	0.91	(0.64, 1.28)
25 - 34	1.18	(0.85, 1.64)	1.20	0.86, 1.68)
35 - 44	1.28	(0.90, 1.81)	1.27	(0.89, 1.82)
45+	1		1	
Sex				
Male	0.99	(0.71, 1.15)	-	
Female	1			
Education				
None	0.91	(0.71, 1.15)	-	
Primary	1.25	(1.04, 1.51)		
Secondary or higher	1			
Use of mosquito nets				
Yes	1.07	(0.93, 1.24)	_	
No	1			
In-door Residual Spraying				
Yes	0.79	(0.65, 0.96)	0.81	(0.66, 0.99)
No	1		1	
Visited Angola				
Yes	1.68	(1.27, 2.23)	1.42	(1.06, 1.90)
No	1		1	
Visited DRC				
Yes	0.40	(0.15, 1.07)	-	
No	1			
Occupation				
House wife/husband	1.14	(0.80, 1.61)	-	
Farming	1.35	(1.09, 1.69)		
Other	1.19	(0.87, 1.63)		
Student	1			
Roof type				
Grass	2.17	(1.33, 3.54)	2.03	(1.24, 3.33)
Iron sheet	0.82	(0.49, 1.37)	0.85	(0.51, 1.43)
Asbestos	1		1	

Laboratory Analysis

Each study participant was assigned a study number and the corresponding blood sample was labeled with the same study number. The study number was linked to the laboratory result and the questionnaire.

Three to 5 millilitres of blood was collected from each participant by venepuncture and collected in an EDTA tube. The samples were transported to a field laboratory on ice, where plasma was separated and finally transported to the University Teaching Hospital Virology Laboratory (UTHVL) where the testing done.

In the process of confirming test results for Yellow fever, specimen were also tested for IgG and IgM antibodies against Zika virus, among other viruses.

Data Management and Analysis

All data were entered in an Epi-Info data entry screen that had consistency and range checks embedded in it. Further editing was conducted by running frequencies during the analysis stage. Epi data files were exported to SPSS for data analysis.

The data collected was summarized to describe the occurrence of Zika virus exposed individuals in absolute numbers and percentage by place of residence, travel, age and sex. Further analysis was conducted to determine independent factors associated with Zika virus infection sero-positivity. Odds ratios and their 95% confidence intervals (CI) were used to estimate the magnitude of associations.

RESULTS

There was a total of 3625 survey participants out of which 3579 were available for analysis on which mandatory variables were complete.The sample comprised1669 males (46.7%) and 1902 females. Male (35.9%) participants attained secondary or higher education level (p=0.001) than females (26.6%). About a third (33.3%) of the participants were aged below 15 years. Only 6.0% of the participants showed evidence of past infection in both provinces. The sample is further described in Table 1.

In multivariate analysis, age, indoor residual spraying (IRS), having travelled to Angola and type of roofing were independently associated with Zika virus infection. Participants aged < 5 years were 64% (AOR=0.36, 95% CI [0.18, 0.72]) less likely to have the infection compared to those aged 45 years or older. Compared to participants whose houses were not sprayed with insecticide residual spray, those who had their houses sprayed were 19% (AOR=0.81, 95% CI [0.66, 0.99]) less likely to have the infection. Participants who visited Angola were 42% (AOR=1.42, 95% CI [1.06, 1.90]) more likely to have the infection compared to those who did not. Compared to participants whose houses were roofed with asbestos, those who had roofs made of grass were 2.03 (95% CI [1.24, 3.33]) times more likely to have the infection (Table 2).

DISCUSSION

Information concerning the distribution of Zika virus in Western and North-Western Provinces of Zambia has not been reported before. Lack of information on the presence or absence of arboviral disease is partly due to limitations on availability of diagnostic methods thereby making it difficult to identify these emerging diseases in the country (Brady et al., 2012). Furthermore, the symptoms of Zika infection apart from being sub-clinical in presentation could be mimicking malaria which has been known to be prevalent.

The current study reports that 6.0% of participants were infected with Zika virus. In Cameroon, the study by Fokam et al., (2010) had similar findings in Fako Division where Zika virus accounted for more than 11% of fevers of unknown origin (Morens et al., 2013). In Oyo State in Nigeria, Fagbami (1979) reported a prevalence of 31% for Zika. Differences in laboratory test may partly explain the differences in the sero-prevalence.

The finding that participants aged less than 5 years were less likely to have Zika virus infection compared to older participants suggest that these individuals may have had maternal protection.

The risk assessment survey revealed that history of travel outside to Angola was significantly associated with acquisition of infection for Zika virus. Stoddard et al.,(2009) using mathematical modules illustrated the importance of human movement in the transmission of pathogens especially for populations most at risk to vector-borne diseases such as Zika virus. Furthermore, mobility and the range of goods transported have increased exponentially in recent times with associated increase in transportation of vectors and pathogens (Reiter, 2008).

Odds for Zika virus infection were significantly higher among respondents living in grass thatched houses than among those living in housed roofed with iron sheets or asbestos. However, a study conducted in Cameroon by Kuniholm et al., (2006) showed that individuals living in grass thatched houses were significantly less likely to be infected with arbo viruses than those living in houses roofed with corrugated tin sheets with unfinished ceilings. The difference observed between this study and that of Kuniholm et al., (2006) may be due to optimal macro-environmental conditions provided by the type of roofing peculiar to the location for the in-door resting mosquitoes.
In conclusion, Zika virus infection is prevalent among the residents of both Western and North-Western Provinces of Zambia. Efficient preventive strategies are necessary to address the emerging challenge of Zika virus infection through strengthening of diseases surveillance, laboratory diagnostic capacities and clinical management of cases.

ACKNOWLEDGEMENTS

We thank our respondents for their cooperation. The research assistants are thanked for their dedication to work. The survey was funded by the Ministry of Health [Zambia] and the World Health Organization.

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