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Assessing the seroprevalence of Zikavirus antibodies among pregnant women in a health care facility in Lagos southwestern Nigeria

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Abstract

Introduction: Zika virus (ZIKV) is an Aedes mosquito borne or sexually transmitted pathogen resulting in an infection characterized by, fever, rash, conjunctivitis, headaches, muscle and joint pains, which typically start 3-6 days after infection. Currently, the majority of people diagnosed with Zika virus however remain asymptomatic. Zika virus infection in pregnant women results in severe birth defects including microcephaly. The prevalence of the infection among pregnant women in Nigeria is not known. Therefore this study aimed to assess the prevalence of Zika virus antibodies and risk factors implicated with infection among pregnant women accessing care at the Department of Obstetrics and Gynaecology, General Hospital, Lagos Southwest Nigeria.

Methodology: A descriptive cross-sectional study was carried out among 442 consenting pregnant women consecutively enrolled (age ranged 18-48years (SD=-6.1; Mean=30.9) attending Antenatal clinic at General Hospital Badagry from February to March 2018. Blood sample collected from each consenting participant was screened for Zika virus IgG using AudaciaBioScienceZika virus rapid antigen test Kit. Information on Socio-demographic characteristic, reproductive profile and risk factors for contracting zika virus was obtained using questionnaires. Data were analyzed with SPSS at $p< 0.05$ with 95% confidence interval considered significant.

Results: This study found an overall rate of 1.6% for anti-Zika virus among asymptomatic pregnant women in Lagos indicating a passive infection. Highest rate (2.04%) was found among age group 31-35years followed by 1.61% among age group 36-40years. Various risk factors identified included, relatively low Zika virus rates by Reported fever (OR=9.974; 95%CI=-2.29–34.08; p=0.0118), Anaemia (OR=14.34; 95%CI =3.32–50.14; p=0.0018), Skin rash (OR=9.024; 95%CI =-2.154–33.01; p=0.0079), Joint/Muscle pain (OR=5.406; 95%CI=1.31–19.96; p=0.0466), Conjunctivitis (OR=28.06; 95%CI =-5.046–77.52; p=0.0058) and Oedema (OR=4.971; 95%CI=1.216-18.86; p=0.429).. None of the bio-demographic variables as risk factors evaluated significantly influenced Zika virus seroprevalence ($p>0.05$).

Conclusion: This study showed detection of relatively low rate of Zika virus IgG among the participants and further revealed the possibilities of risk factors associated for the spread of the infection in the community.

Keywords: *Zika virus, pregnant women, Risk factors, Congenital, Nigeria*

Résumé

Introduction **:** Le virus Zika (ZIKV) est un agent pathogène transmis par le moustique Aedes ou sexuellement transmissible, entraînant une infection caractérisée par la fièvre, des éruptions cutanées, une conjonctivite, des maux de tête, des douleurs musculaires et articulaires, qui commencent généralement 3 à 6 jours après l'infection. Actuellement, la majorité des personnes diagnostiquées avec le virus Zika restent cependant asymptomatiques. L'infection par le virus Zika chez les femmes enceintes entraîne de graves malformations congénitales, notamment la microcéphalie. La prévalence de l'infection chez les femmes enceintes au Nigeria n'est pas connue. Par conséquent, cette étude visait à évaluer la prévalence des anticorps du virus Zika et des facteurs de risque impliqués dans l'infection chez les femmes enceintes ayant accès aux soins au Département d'obstétrique et de gynécologie de l'Hôpital général de Lagos, au sud-ouest du Nigeria.

Méthodologie : Une étude transversale descriptive a été menée auprès de 442 femmes enceintes consentantes inscrites consécutivement (âge compris entre 18 et 48 ans (écart-type = -6,1 ; moyenne = 30,9) fréquentant la clinique prénatale de l'hôpital

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général de Badagry de février à mars 2018. Échantillon de sang prélevé de chaque participant consentant a été testé pour les IgG du virus Zika à l'aide du kit de test rapide d'antigène du virus AudaciaBioScienceZika. Des informations sur les caractéristiques sociodémographiques, le profil de reproduction et les facteurs de risque de contracter le virus zika ont été obtenues à l'aide de questionnaires. Les données ont été analysées avec SPSS à p<0,05 avec 95 % intervalle de confiance considéré comme significatif.

Résultats: Cette étude a trouvé un taux global de 1,6% pour le virus anti-Zika chez les femmes enceintes asymptomatiques à Lagos indiquant une infection passive. Le taux le plus élevé (2,04 %) a été observé dans le groupe d'âge 31-35 ans, suivi de 1,61 % dans le groupe d'âge 36-40 ans. Divers facteurs de risque identifiés comprenaient des taux de virus Zika relativement faibles par fièvre signalée (OR = 9,974 ; IC à 95 % = -2,29 à 34,08 ; p = 0,0118), anémie (OR = 14,34 ; IC à 95 % = 3,32 à 50,14 ; p = 0,0018), éruption cutanée (OR = 9,024 ; IC à 95 % = -2,154–33,01 ; p = 0,0079), douleurs articulaires/ musculaires (OR = 5,406 ; IC à 95 % = 1,31–19,96 ; p = 0,0466), conjonctivite (OR = 28,06 ; 95 % IC = -5,046–77,52 ; p = 0,0058) et œdème (OR = 4,971 ; 95 % IC = 1,216-18,86 ; p = 0,429).. Aucune des variables biodémographiques en tant que facteurs de risque évalués n'a influencé de manière significative la séroprévalence du virus Zika (p>0,05).

Conclusion: Cette étude a montré la détection d'un taux relativement faible d'IgG du virus Zika parmi les participantes et a en outre révélé les possibilités de facteurs de risque associés à la propagation de l'infection dans la communauté.

Mots-clés : Virus *Zika, femmes enceintes, Facteurs de risque, Congénital, Nigeria*

Introduction

Zika, a flavivirus from the family Flaviviridae[1], has a single stranded RNA [2]. This arthropod-borne virus (arbovirus) [3] is transmitted through the Aedes mosquito species, namely *Ae. africanus*, *Ae. apicoargenteus*, *Ae. luteocephalus*, *Ae. aegypti*, *Ae. vitattus*, and *Ae. furcifer* [4]. Besides vector transmission, the non-vector transmission occurs between the mother and fetus; during transplantation surgeries and hospital stay (nosocomial) [5], and from other substances of human origin (SoHO) [6]. At first the Zika virus (ZIKV) infection did not get much consideration as the mild fever, arthralgia, and rash developed in 20% of the cases; while, 80% of the cases were asymptomatic [7].The virus spreads mostly by the bite of an infected Aedes mosquito or by sexual transmission. In addition, Zika virus can be passed from a pregnant woman to her fetus, which can cause microcephaly and other severe brain defects [8]..

Majority of people diagnosed with Zika Virus remain asymptomatic, whilein symptomatic cases, symptoms (which include, fever, rash, conjunctivitis, headaches and muscle and joint pains), typically start 3-6 days after infection [9,10]. Prevention therefore serves as a protective tool and barrier against the spread of the virus. One measure used to protect persons from Zika virus is enforcing proper vector control strategies like adopting use of appropriate nets and counseling in persons living in at risk locations [1,2]. Zika virus infected an estimated 440000 – 1300000 Brazilians in 2015 and 3 - 4 million Americans in 2016 [10]. About 2.17 billion people are residents of those areas that are favorable for its dispersal [11]. Since 2015, there has been a dramatic spread of ZIKV in 66 countries, even as drastic outbreaks were reported in 44 previously known ZIKV-negative countries [12].

The major threat of today's world is that the fetus of symptomatic ZIKV infected pregnant female can become the victim of this perilous virus. Usually, the chances of microcephaly are only 7 per 10000 live births (13), however, Zika virus increases this estimation up to several folds. Currently, World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), European Centre for Disease Prevention and Control (ECDC), American Society of Reproductive Medicine (ASRM), and the International Planned Parenthood Federation (IPPF) are the leading organizations that deals with the drastic effects of ZIKV on maternofetal health [1].The Nigerian Center of Disease Control (NCDC) has presented a review of current epidemiology for Zika virus and a risk assessment to the public. Interim recommendations for public health response to Zika virus in Nigeria are also being presented [3].

Nevertheless, in order to address this public health crisis, healthcare providers, pediatricians and community medicine workers are required to be well equipped with effective diagnostic tools and educational material to enhance the public dialogue on the transmission, and effective referral systems that will ensure proper monitoring of the virus [14]. Also, healthcare workers need to be at the forefront with necessary prevention resources in order to avoid the spread of this endemic in Nigerian communities [3]. Thus, it is desirable to include Zika virus diagnosis among other tests for antenatal pregnant attendees for early detection of the virus at point of care for appropriate intervention to safeguard the unborn child against malformation. Therefore this study aimed to assess the prevalence of Zika virus antibodies and factors implicated with infection among pregnant

women accessing care at Obstetrics and Gyneacology Department of General Hospital, Lagos, Southwest Nigeria

Methodology

This was a descriptive cross-sectional study involving 442 consenting pregnant women attending Antenatal clinic at the Department of Obstetrics and Gynaecology General Hospital Badagry from February 1st to March 28th 2018. Information on Socio-demographic characteristic, reproductive profile and risk factors for contracting Zika virus was obtained using questionnaires. About 4mls of blood samples was collected into plain bottle to separate the serum and subsequently screened for Zika virus IgG using Zika virus rapid antigen test Kit. The data was analyzed with SPSS, Version 20.0.

The AudaciaBioScienceZika IgM and IgG rapid tests for specific Zika antibody in serum/plasma or whole blood were used for the in vitro diagnostic assay. This was an immunochromatographic assay for fast and easy detection of the Zika virus antibody and testing was carried out following the manufacturer's instructions. Briefly the test cassettes were removed from the test card and laid flat on a clean surface. The test kit and the frozen test sera were kept at room temperature for 20minutes to thaw and thereafter mixed well before running the test. Ten microliter of serum was added to the opened test cassette using a pipette. Following the addition of the sample, three drops of assay buffer were added from the dropper bottle and the results were read within 15-30 minutes. The control line validated the result.

Study design

This was a descriptive cross sectional study

Description of study area

A surveillance study was carried out among pregnant women visiting the Department of Obstetrics and Gynaecology at the General Hospital Badagry, Lagos State Nigeria to assess the burden of Zika virus perceived to be circulating silently in southwest Nigeria using the study area which has large population of pregnant women attending antenatal clinics. The study area is easily accessible in Lagos and presumed to provide relatively cheaper services for the mother to be. However, there is little or no information being provided about the circulation of Zika virus in the study area among the visiting attendees. Badagry is an old ancient area in Lagos with easy accessibility for pregnant women, located at the Badagry local government area under the control of the State Ministry of Health.

Data collection tools and techniques

A structured, semi-validated self-administered application was given to participant after an informed consent had been obtained to gather demographic information and other relevant information. Understanding of the prevalence of Zika virus disease was assessed based on responses to the diagnostic assay and clinical symptoms and patient presentation. There were indications as to which trimester of pregnancy is probable for detecting Zika virus among pregnant women. Future questions will inquire additional knowledge on how the infection in associated trimesters yielded poor foetal outcomes, whether or not transmission occurs in the absence of a vector, whether the response of the National Institutes of Health (NIH) is timely and sufficient, areas of important research to include impact of exposure to environmental factors and the need for further urgent research in Nigeria.

Ethical approval for the study was sought and obtained from the hospital Ethical Board Review Committee (Approval Number: LUTH/HREC/33/267) and respondents' privacy was made possible by not collecting any data that can identify the participants. Informed consent from each participant was indicated by a check-box on the first page.

Statistical analysis

All statistical analyses were performed using SPSS windows version 20. Categorical variables were described using descriptive statistics (frequencies and percentages).Chi-square (x^2) test and Fisher's exact test (at 95% confidence intervals) were used to test for significant association between the prevalence of Zika virus antibodies and baseline characteristics/health-related factors among the study subjects. Associations with independent variables included sex, profession, highest qualification obtained and years of practice were determined using chi-square and significance noted at p=0.05%. In cases of significant association, Binary logistics regression was used to test for the strength of association between variables and the strength of such association was expressed by the Odd ratio (OR) and/or Relative risk (RR). Statistical significance was set at P-value <0.05.

Results

Four hundred and seventy five (475) pregnant women meeting the inclusion criteria were invited to participate in this study, and all of them consented.

Table 1: Clinical and socio-demographic profiles of the study population

Socio-demographic characteristics	Frequency	Percentage (%) frequency
Age group (in years)		
≤25	78	17.6%
26 – 30	137	31.0%
31 – 35	147	33.3%
36 – 40	62	14.03%
≥41	18	4.07%
Level of education		
None	18	4.08%
Primary	26	5.88%
Secondary	212	47.96%
Tertiary	186	42.08%
Reported Fever		
Yes, ≥8ºC at point of enrolment	34	7.69%
No	408	92.31%
Area of Residence		
Urban	359	81.22%
Rural	83	18.78%
Gravidity		
Primigravidae	113	25.57%
Secundigravidae	156	35.29%
Multigravidae	173	39.14%
Parity		
Primiparous	206	46.61%
Multiparous	236	53.39%
Gestational age		
1st trimester (1-14weeks)	142	32.13%
2nd trimester (15-27weeks)	186	42.08%
3rd trimester (≥28weeks)	114	25.79%
Birds around the environment		
Yes	44	9.95%
No	398	90.05%
Body/Skin rash		
Yes	60	13.57%
No	382	86.43%
Joint/Muscle pain		
Yes	56	12.67%
No	386	87.33%
Conjunctivitis		
Yes	8	1.81%
No	434	98.19%
Use of ITNs		
Yes	265	59.95%
No	177	40.05%
Use of mosquito repellants/ insecticide sprays		
Yes	258	58.37%
No	184	41.63%
Edema of extremities		
Yes	96	21.72%
No	346	78.28%
Anaemia (Moderate/mild)		
Yes	41	9.28%
No	401	90.72%

However, thirty three decided to discontinue their participation before collection of blood samples. The results presented were based on data from the four hundred and forty two (442) women whose peripheral blood samples were collected and analysed for Zika virus antibodies. Of the 442 pregnant women examined, seven were positive for Zika virus antibodies with an overall seroprevalence of 1.6% for the study (Table 2).

Socio-demographic profile:

The mean age of the pregnant women was 30.9 years (standard deviation [SD]-6.1; range: 18-48 years) (Table 1). Majority {212 (47.96%)} of the participants had completed secondary education while 186 (42.08%) others had tertiary education. A high proportion 359 (81.22%) of the subjects resided in urban areas of Lagos State while only a few 83 (18.78%) resided in rural areas. At the point of enrolment, 34 (7.96%) of them had fever while 408 (92.31%) were without fever. Over a third (39.14%) of the pregnant women were multigravidae (n=173), 156 (35.29%) were secundigravidae while 113 (25.57%) were primigravidae. As for parity status, 236 (53.39%) of the pregnant women were multiparous while 206 (46.61%) were primiparous. A total of 142 (32.13%) were in first trimester, 186 (42.08%) were in second trimester while 114 (25.79%) were in third trimester. Age group 31-35 recorded highest prevalence (2.04%) of Zika virus antibodies while the lowest rate (1.28%) found among age group d”25 years with no significance difference (P>0.05; X^2 =0.3132) between Zika virus infection and age groups. Highest prevalence (7.69%) of Zika virus antibodies was among pregnant women who had only primary education while those with secondary and tertiary education had prevalences of 1.42% and 0.54% respectively (Figures 1-3). There was a significance difference in the prevalence of Zika virus antibodies in relation to level of education (P<0.05; X^2=9.391).

Clinical profiles:

This indicate that 382 (86.43%) did not show any evidence of body rash, 386 (87.33%) subjects had joint/muscle pain while most of the subjects 434 (98.19%) had no conjunctivitis. Also, 346 (78.28%) them had edema of extremities, 41 (9.28%) had moderate and mild anaemia while 401 (90.72%) were not anaemic (Table 3). Prevalence of Zika virus IgG was significantly higher (8.82%) in pregnant women with reported fever at the point of enrolment when

Table 2: Prevalence of Zika virus antibodies in relation to demographic variables

Variables	Number tested	Number positive (%)	Number negative (%)	X^2	p-value
Age group (yrs)				0.3132	0.9575
≤25	78	1 (1.28)	77 (98.72)		
26 – 30	137	2 (1.46)	135 (98.54)		
31 – 35	147	3 (2.04)	144 (97.96)		
36 – 40	62	1 (1.61)	61 (98.39)		
≥41	18	0 (0)	18 (100)		
Level of education				9.391	0.0245
None	18	1 (5.56)	17 (94.44)		
Primary	26	2 (7.69)	24 (92.31)		
Secondary	212	3 (1.42)	209 (98.58)		
Tertiary	186	1 (0.54)	185 (99.46)		
Area of Residence					0.1261
Urban	359	4 (1.11)	355 (98.89)		
Rural	83	3 (3.61)	80 (96.39)		
Birds around the environment				0.1474	
Yes	44	2 (4.55)	42 (95.45)		
No	398	5 (1.26)	393 (98.74)		
Gravidity				0.1413	0.9318
Primigravidae	113	2 (1.77)	111 (98.23)		
Secundigravidae	156	2 (1.28)	154 (98.72)		
Multigravidae	173	3 (1.73)	170 (98.27)		
Parity					0.4570
Primiparous	206	2 (0.97)	204 (99.03)		
Multiparous	236	5 (2.12)	231 (97.88)		
Gestational age				0.7765	0.6782
1st trimester (1-14weeks)	142	2 (1.41)	140 (98.59)		
2nd trimester (15-27weeks)	186	4 (2.15)	182 (97.85)		
3rd trimester (e”28weeks)	114	1 (0.88)	113 (99.12)		

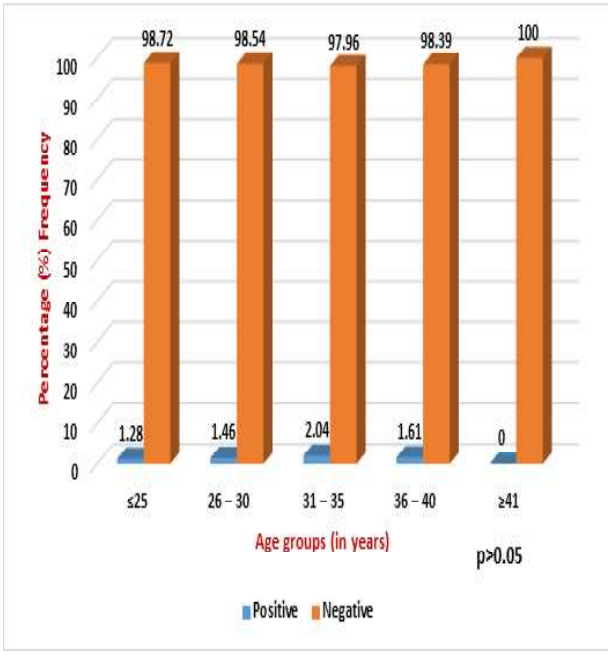

Fig. 1: Prevalence of Zika virus antibodies in relation to age

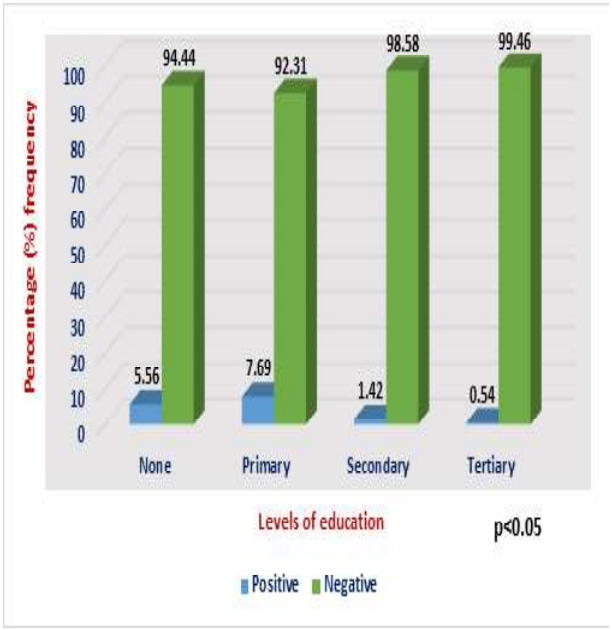

Fig. 2: Prevalence of Zika virus antibodies in relation to levels of education

Table 3: Prevalence of Zika virus antibodies in relation to Clinical signs and other health related factors

Variables	Number tested	Number positive (%)	Number negative (%)	X^2	p-value
Reported Fever					0.0118
Yes, ≥38ºC at point of enrolment	34	3 (8.82)	31 (91.18)		
No	408	4 (0.98)	404 (99.02)		
Anaemia					0.0018
Yes	41	4 (9.76%)	37 (90.24%)		
No	401	3 (0.75%)	398 (99.25%)		
Body/Skin rash					0.0079
Yes	60	4 (6.67)	56 (93.33)		
No	382	3 (0.79)	379 (99.21)		
Joint/Muscle pain					0.0466
Yes	56	3 (5.36)	53 (94.64)		
No	386	4 (1.04)	382 (98.96)		
Conjunctivitis					0.0058
Yes	8	2 (25)	6 (75)		
No	434	5 (1.15)	429 (98.85)		
Use of ITNs					0.0182
Yes	265	1 (0.38)	264 (99.62)		
No	177	6 (3.39)	171 (96.61)		
Use of mosquito repellants/ insecticide sprays					
Yes	258	2 (0.78)	256 (99.22)		0.1334
No	184	5 (2.72)	179 (97.28)		
Edema of extremities					0.0429
Yes	96	4 (4.17)	92 (95.83)		
No	346	3 (0.87)	343 (99.13)		

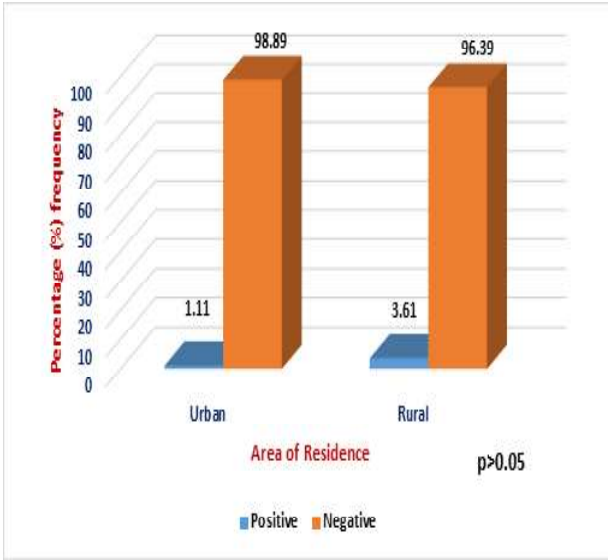

Fig. 3: Prevalence of Zika virus antibodies in relation to area of residence

compared with women without fever (P<0.05). Similarly, pregnant women with anaemia had significantly higher prevalence of Zika virus antibodies (9.76%) when compared with women without anaemia (p<0.05). In relation to body/skin rash, the prevalence of Zika virus antibodies was significantly

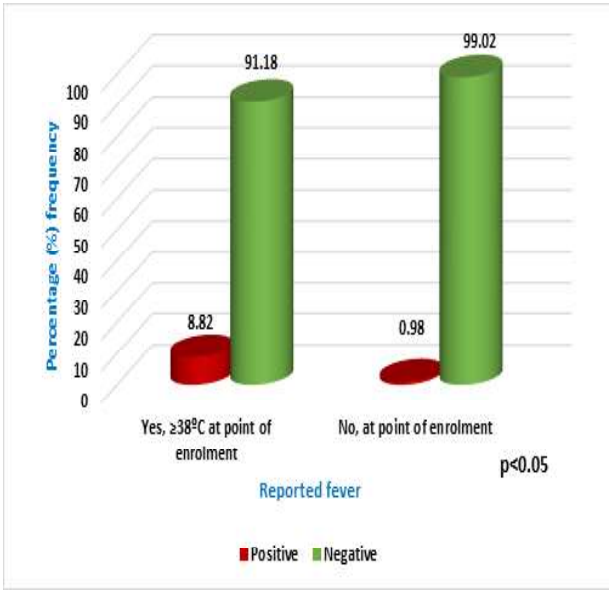

Fig. 4: Prevalence of Zika virus antibodies in relation to reported fever

Fig. 5: Prevalence of Zika virus antibodies in relation to body/ skin rash

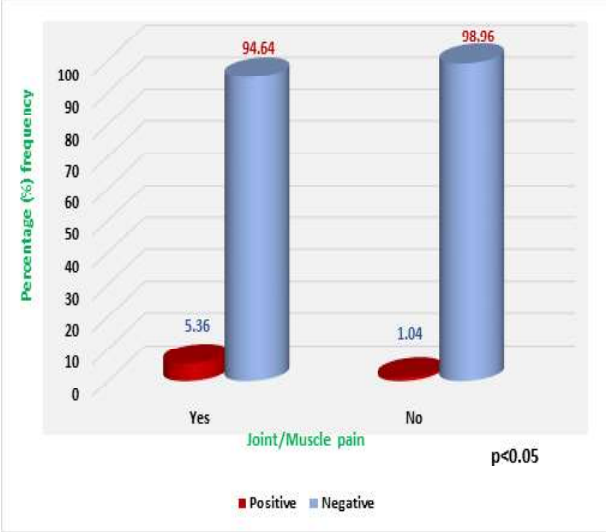

Fig. 6: Prevalence of Zika virus antibodies in relation to Joint/ Muscle pain

higher among pregnant women with reported cases of skin/body rash when compared with pregnant women without body rash ($p<0.05$). Pregnant women with body/skin rash recorded a prevalence of 6.67% for Zika virus antibodies while those without body rash recorded a prevalence of 0.79%. Prevalence of Zika virus antibodies was significantly associated with conjunctivitis ($p<0.05$). The prevalence of Zika virus antibodies was significantly higher among pregnant with conjunctivitis when compared with those without conjunctivitis ($p<0.05$). Pregnant women with joint/muscle pain recorded a prevalence of 5.36% for zika virus antibodies while those without joint/muscle had a prevalence of 1.04% (Figures 4-5). Pregnant women using ITNs had a reduced prevalence of 0.38% for Zika virus antibodies while those who were not using ITNs had a higher prevalence rate of 3.39% for zika virus antibodies but no statistical association ($p>0.05$). Pregnant women with edema of lower extremities had significantly higher prevalence (4.17%) of zika virus antibodies when compared to women without edema of lower extremities ($p<0.05$) (Table 3).

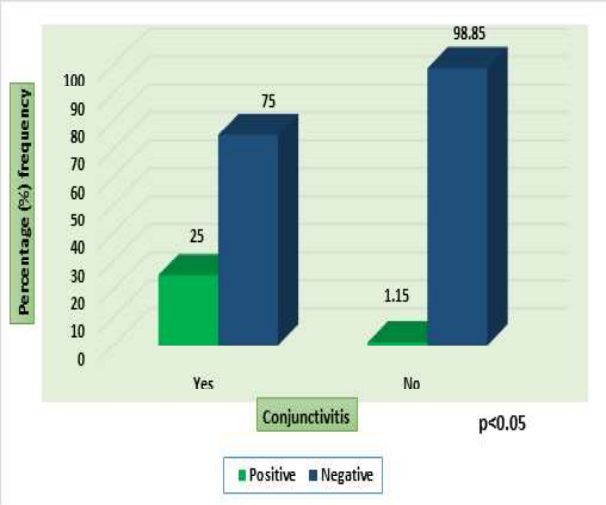

Fig.7: Prevalence of Zika virus antibodies in relation to conjunctivitis

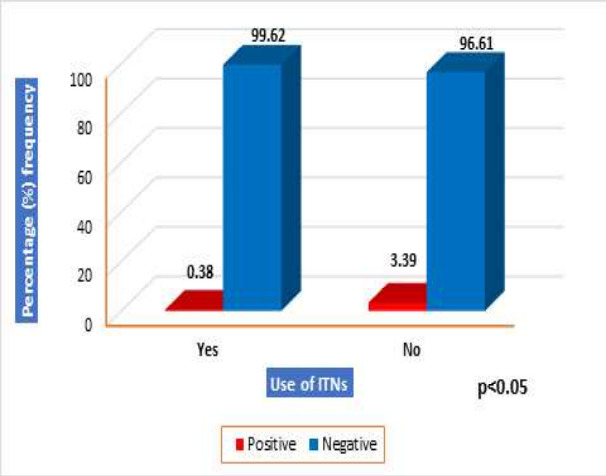

Fig.8: Prevalence of Zika virus antibodies in relation to the use of ITNs

Binary logistic regression analysis

This indicates that fever, anaemia, body/skin rash, joint/muscle pain, conjunctivitis, use of ITNs and edema of lower extremities were significantly associated with the prevalence of zika virus antibodies. Pregnant women with fever had increased

odds of zika virus infection by 9.8 times than women without fever. Also, the odds of having Zika virus infection increased by 14.34 times higher among pregnant women with anaemia than in others with no anaemia. Pregnant women with body/skin rash were associated with increased odds of having zika virus infection by 9.02 times than those without body rash. The odds of having zika virus infection increased 5.4 times among pregnant women who reported joint/ muscle pain compared to women without joint/muscle pain (Fig. 6-8). Pregnant women with conjunctivitis are more likely to have zika virus infection with an increased odd of almost 29 times more than pregnant women without conjunctivitis. The use of insecticide treated nets (ITNs) was significantly associated with the prevalence of Zika virus antibodies. Pregnant women who constantly slept under ITNs were 0.11 times less likely to have Zika virus infection with a reduced odds ratio of 0.108 compared to women who did not use ITNs. There was also a significant association between edema of lower extremities and Zika virus infection. Pregnant women with edema of lower extremities are almost 5 times more probably going to have Zika virus infection than those without edema of lower extremities (Table 4**)**.

Discussion

The results from the study indicate exposure levels to Zika virus which suggest the possible circulation of the virus among febrile and asymptomatic patients accessing care at antenatal clinics in Lagos Nigeria with an overall sero-prevalence of 1.6%. The available information from the results generated in this study again indicates noticeable levels of susceptibility to Zika virus infections among the participants. This could mean many infected pregnant women are at risk of giving birth to babies with defects. Congenital Zika virus syndrome may include microcephaly, ventriculomegaly, intracranial calcifications, extra-axial fluid, decreased brain parenchymal volume, lissencephaly, cerebellar hypoplasia, delayed myelination and hypoplasia of the corpus callosum [15-17]. Furthermore, newborns of infected mothers can develop cardiac anomalies with septum defects [18,19], seizures due to the underlying brain malformations, neuromotor abnormalities such as spasticity and feeding difficulties [20,21], ocular abnormalities [22] and can be born small for the gestational age [23]. Hence the need to investigate the circulation of Zika virus in expectant mothers with ultimate goal to prevent birth defects will be interesting for further studies in Nigeria.

The overall sero-prevalence of Zika virus antibodies of 1.6% found in this study was consistent

Table 4: Binary Logistics Regression of health related factors associated with the prevalence of Zika virus antibodies

Variables	OR	RR	95% C.I	p-value
Reported Fever	9.774			0.0118
Yes, ≥38ºC at point of enrolment		9.0	2.29 - 34.08	
No		0.1111	0.02934 - 0.4367	
Anaemia	14.34			0.0018
Yes		13.04	3.32 - 50.14	
No		0.07668	0.01994 - 0.3012	
Body/Skin rash	9.024	8.489	2.154 - 33.01	0.0079
Yes		0.1178	0.0303 - 0.4643	
No				
Joint/Muscle pain	5.406			0.0466
Yes		5.17	1.31 - 19.96	
No		0.1934	0.05009 - 0.7635	
Conjunctivitis	28.6			
Yes		21.7	5.046 - 77.52	0.0058
No		0.04608	0.0129 - 0.1982	
Use of ITNs	0.108			0.0182
Yes		0.1113	0.01768 - 0.6966	
No		8.983	1.436 - 56.55	
Edema of extremities	4.971			0.0429
Yes		4.806	1.216 - 18.86	
No		0.2081	0.05303 - 0.8221	

with study findings from other African countries which falls within the rates ranging from 0.1% in Gabon and Senegal and as high as 38% in Cameroon [24]. These differences could be due to inconsistency in the study participants' inclusion criteria or diagnostic test used. Zika virus infection was estimated to affect females and males in a ratio of 2:1 which correlate well with several studies [14,25]. Considering the findings of Mattew *et al* [25] with that obtained of this study, there may be gender-related differences in Zika virus infection incidence, which might be due to exposure differences [26]. Nevertheless, our study was only carried out among female participants without any comparison with their male counterparts. Activeness of females during the early hours of the day exposes greater proportion of females to Zika virus-carrying *Aedes* spp. of mosquitoes either at work or while travelling to and from work especially among pregnant women with higher risk of exposure [8]. This may also be attributed to possible differences in who sought medical care following symptomatic Zika virus infection.

Relatively high prevalence of IgG of 2.04% found in age group 31–35 compared to **e"**41 years and above support data from earlier studies by Mattew *et al* [25].and Kumar *et al* [27]. Possible explanation to this observation could be the activeness of age group 31–35 during the early hours of the day which exposes them to the bites of Zika virus-carrying *Aedes* spp. of mosquitoes more frequently than older age bracket with no reported infection rate. This could also suggest female adults manifest with disease less, as they become immune to Zika virus. The proportions of the IgG antibody titers recorded in age group 35–40 and **e"**41 years may suggest that, Zika virus infection is not endemic in Lagos Nigeria, rather the virus had been introduced to a non-exposed population as endemicity is attained when the adult infection decreases and only the new entrants into the population are more affected [8,27].

One of the target populations for the public health strategies are pregnant women because of the associated complications that Zika virus infection could have on them and their newborns [28]. Our findings show a prevalence of 1.6% (n=432) of Zika virus infection among the asymptomatic pregnant women population of Badagry in Lagos, southwest Nigeria which is higher than the 0.1% confirmed cases of Zika virus in asymptomatic women found in Gabon and Senegal but much lower than 20.6% in Ghana while a higher rate of 38% was reported in Cameroon, a neighboring country to Nigeria [14,29]. This supports the evidence of global occurrence of Zika viral infection which suggests that in Africa the circulation of the virus which causes asymptomatic infection in 80% of cases, could be undetected and/or overlooked [24]. The mentioned findings may indicate that there is an underestimation of Zika virus infection that could be explained by the lack of sensitive and specific molecular diagnostic methods in isolated localities. Furthermore, the prevalence in this study highlights the importance of epidemiological surveillance of Zika virus infection in pregnant women that live in newly Zika virus endemic regions. These findings cannot be extrapolated to the Zika virus infection rates among pregnant women in other endemic regions of the world because of the lack of similar molecular diagnostic studies in other sub-Saharan localities [14].

Suggested clinical features of Zika virus infection ranged from joint/muscle pain seen in 5.36% (95%CI=1.31–19.96; p=0.0466) to conjunctivitis (25%) OR=28.06; 95%CI =5.046–77.52; p=0.0058) in Lagos ante-natal clinic among those with such symptoms and this could be due to several reasons. A major possibility is that differences in definitions of symptoms and criteria for Zika virus infection (including the diagnostic test used) could have led to differences in prevalence estimates when compared with Zika endemic regions of the world in which the participants presented with clearly defined symptoms corresponding to higher rates of infection [8,30,31]. This possibility is supported by the lower prevalence of asymptomatic Zika virus infection in pregnant women with confirmed passive infection than in those with possible recent infection of 42% against 63% in a previous study in the United States [32]. Furthermore, in this study, commonly reported symptoms of Zika virus infection documented were fever, muscle pain, joint pain and conjunctivitis. This suggests symptomatic infection among the pregnant women thus confirming the possibility of presumptive diagnosis. In a previous study in the US, prevalence rates of Zika virus infection using presumptive diagnosis was 63% compared with a prevalence of 42% using molecular diagnosis. Patients presenting with clinical features of joint/muscle pain and conjunctivitis could therefore be further evaluated for Zika virus infection using laboratory diagnostic measures. This will therefore reveal the true picture of the state of Zika virus infection rather than presumptive diagnosis based only on clinical symptoms.

Conclusion

The disease caused by Zika virus could be a major public health issue in Nigeria especially in Lagos due to asymptomatic nature in isolated localities such as Badagry as revealed by the results of this study. This

study reports the first detection of Zika infection in the region of Badagry in Lagos Nigeria among asymptomatic pregnant women and describes a low rate of Zika infection in comparison to other hot spot zones of the world such as Brazil and the US. The low rate of Zika infection among the asymptomatic pregnant women accessing care at the ante-natal clinics using rapid diagnostic kit could have been higher if more sophisticated diagnostic kits such as ELISA and molecular techniques were available. Therefore, it is advocated that molecular diagnosis of Zika virus infection be included in pregnancy screening programs. This may help to reduce the burden of fetal anomalies associated with the asymptomatic cases.

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