

Immunological And Haematological Responses In Children Who Received Measles Vaccine In Port Harcourt, Rivers State, Nigeria.

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Abstract: Immunological and haematological studies were carried out among children within 10 months to 13 years of age who received measles virus vaccine in Port Harcourt, Rivers State, Nigeria. A total of 172 blood samples were collected and analyzed for anti-measles virus IgM and IgG using commercial ELISA kit [Dia. Pro Diagnostics Bioprobes Srl, Swsto San Giovanni (MI) Italy]. Differential analysis was done on each sample to ascertain the Leucocyte cell counts. The results were interpreted according to the manufacturer's instruction. The data was analyzed using statistical package for social sciences (SPSS) Version 21. Of the total number of 172 samples analyzed for anti-measles virus IgM and IgG antibodies, 12 (6.9 %) and 28 (16.3 %) had detectable IgM and IgG respectively. In relation to the age, for anti-measles virus IgM, age group 4 – 6 years had the highest occurrence of 6 (15.80 %), followed by age group 10-12 years with detectable anti-measles virus IgM of 2 (11.0 %). Age group 1-3 years had the least detectable IgM antibodies of 2(2.3 %). For anti-measles virus IgG, age group <1 year had the highest level of detectable anti-measles virus IgG of 3 (27.0 %), followed by age group 4 – 6 years with the prevalence of 9 (23.7 %)?? while age group 1 – 3 years had the least prevalence of 10(11.2 %). In relation to sex for IgM, female children had a higher detectable anti-measles virus IgM of 8(10.1 %) than male children who had IgM of 4(4.3 %). The opposite was the case for detectable anti-measles virus IgG in relation to sex. Male children had a detectable anti-measles virus IgG of 12(12.9 %) and female children had 16 (20.3 %). There were no significant difference at (p<0.05) between the differential leucocyte cell counts of children who tested positive for measles virus antibodies and those who were negative. The investigation established very low level of IgM and IgG among children who were immunized against measles virus infection. This reason may be that some batches of the vaccine used were not potent or that most of the children who claimed to have been vaccinated were not.

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1. Introduction

Measles disease is an acute illness that is highly contagious with measles virus as its aetiologic agent (Onoja *et al.*, 2013). Measles virus belongs to the paramyxoviridae family and housed in the genus *Morbillivirus*. The feature of measles disease is a prodromal symptom that includes high fever and malaise, coryza, cough, sneeze, and conjunctivitis, followed by a maculopapular rash (Preeta *et al.*, 2013). Measles is known to be one of the main diseases that affect children and pose serious child health issues in Africa, south-east Asia, Latin America, eastern Mediterranean, and Europe (WHO, 2011). Prior to the advent of vaccine in the early 1960s, measles had been a global epidemic affecting over 130 million children every year (Davidkin *et al.*, 2008). The disease was as well known to be leading blindness, deafness, brain damage and death globally among children below five years of age (Isa *et al.*, 2002). With the introduction of effective vaccines, the number global cases of measles

disease have reduced drastically, with a 78% reduction in measles cases between 2000 and 2012 (Pomerai *et al.*, 2012). In spite of successes recorded, there were about 122,000 estimated deaths resulting from measles disease in 2012 alone, with the major part of this mortality recorded from developing countries, primarily Africa and Southeast Asia (Mohammed *et al.*, 2010). In these countries, the disease is one of the principal causes of vaccine-preventable morbidity and mortality among children. There were also about 370,500 estimated deaths attributed to measles in 2011, with about 87% of mortality occurring in African and southeastern regions (Mohammed *et al.*, 2010). There have been several reports in the northern and southern parts of Nigeria on the occurrence and incidence of measles disease, particularly when outbreaks occur. However, there is little or no report on the vaccination status of children infected and the degree of severity of their infection in the nation.

Across the continent of Africa, about thirteen million cases and 650,000 deaths occur yearly, with sub-Saharan Africa at the peak of morbidity and mortality (Muller *et al.*, 1999). Nigeria is the most populated nation in Africa with more than 140 million people (Nigerian Medicines Sans Frontieres (NMSF), 2006). The Health Protection Agency (HPA) in the United Kingdom has revealed that there were about 496 cases of measles confirmed in the laboratory in Wales and England as at the end of May 2011, which is more than the 374 cases confirmed in 2010 (HPA 2011). In France, over 7500 cases were recorded between January and March of 2011. Cases have been reported from 38 countries across the continent, with outbreaks in Macedonia, Spain, Turkey and Serbia, amid others. Over 10,000 cases were recorded from countries in the Economic region of European within the first 4 months of 2011 making measles disease the fifth ranked cause of death among children below five years of age (WHO, 2006).

Notwithstanding the inclusive United Nations International Children Emergency Fund's (UNICEF's) and World Health Organisation's (WHO's) measles-reduction approach, and the joint venture of international organizations aiding measles mortality reduction, some countries still experience recurrent outbreaks of measles (Grais *et al.*, 2007). The required age for the vaccination of infants against measles virus is an important health concern since maternal immunoglobulins may reduce the effect of vaccine antigen before a specific immunity develops. A delay in issuing vaccines on the other hand may increase the possibility of complicated measles disease (Gagneur *et al.*, 2008). In Nigeria, children are vaccinated with monovalent measles vaccine at the age of nine months and this has resulted in a huge reduction in illnesses and death from the measles infection in the country (Aaby *et al.*, 1986). Despite this, Nigeria is still one of the most affected countries with endemic and continuous spread of measles infection every year in Sub-Saharan Africa (WHO, 2015). In 2008, about 9,960 measles cases were recorded in the country, making Nigeria the second highest in the period, while 18,843 cases were reported in 2011 (Pomerai *et al.*, 2012). In spite of the progresses recorded towards eradication of measles disease since the commencement of the Expanded Program on Immunization (EPI) in Nigeria in 1989, some factors have slowed down the actualization of the goals of the program. Among these factors are: the incapability to reach and maintain a very high vaccination coverage in all states in the country, resulting in a pool of vulnerable children, in areas not covered (WHO, 1999; WHO 2004). Other factors are questions on the effectiveness or viability of the vaccine in the field, its capacity to confer lifetime immunity, and the necessity

for a second exposure other than supplemental and catch-up vaccination (Onoja *et al.*, 2013). Apart from political and financial commitments to the eradication of the disease, the possibility of infants becoming exposed before the suggested measles vaccination age of 9 months due to waning maternal immunoglobulins before the age of six months has also been a major challenge. Likewise, the reality that most children who receive measles vaccines still become infected with measles raises an alarm.

In 2005 and 2006, the Federal Government of Nigeria (FGN) through the National Programme on Immunization (NPI) embarked on an integrated catch-up measles campaign in southern and northern Nigeria, respectively and a national follow-up campaign in 2008 (Goitem *et al.*, 2011). This was in partnership with local and state governments. The mortality resulting from measles outbreaks has been either over-blown or under-reported by different media reports. Measles scheduled vaccination has been inadequate in Nigeria and this may account for the recurrent measles outbreaks recorded in different parts of the country. Nonetheless, between 2005 and 2008, there was a nationwide awareness on measles vaccination, which ended up in a mass routine measles immunization program with follow-up vaccinations. The barton fall on researchers to conduct routine epidemiological reviews and give accurate information on the successes of these programs and the severity of measles infection if there is really need to eradicate the disease.

2 Materials and Methods

Braithwaite Memorial Specialist Hospital, and selected Primary Health Care Centres which serves as referral centre for children health in Port Harcourt, Rivers State were the facilities used for sample collection for this study. This study was conducted between November 2017 and March 2018 after ethical approval was obtained from the Rivers State Hospital Management Board.

A total of 172 children between the ages of 9 months and 13 years, from different socio-economic backgrounds, were recruited for this study. Informed parental consent was sought before blood samples were collected. Details of the vaccination history were obtained through questionnaire, and/or from parental recalls.

The working samples (sera) were separated from whole blood by centrifuging at 2000rpm for 10minutes and stored at room temperature ($25 \pm 8^{\circ}\text{C}$) in labeled bottles until it was assayed the same day. The separation was done after leucocyte counts were performed with whole blood samples. Each serum sample was tested for the presence of antibodies to measles virus using DIA. PRO Diagnostic Bioprobes

Srl Via G. Carducci n° 27 20099 Sesto San Giovanni (Milano) – Italy Enzyme Immuno Assay (ELISA) for the qualitative determination of IgM and IgG antibodies to Measles virus in human plasma and sera for the qualitative detection of antibodies to both infections in serum samples. Recommended quality control measures and precautions were adopted in accordance with the test kit manufacturer's instructions; avoidance of repetitive freezing of blood samples were strictly adhered to.

Ethical approval was gotten from the Rivers State Hospitals Management Board before the commencement of sample collection. Data generated

from this study were analyzed statistically with SPSS version 20.0 to test for equality of the means using the independent t-test.

3. Results

The samples analysed were not mutually exclusive and hence a total number of 172(100%) children were recruited as subjects, of which 6.9% (n=12) were positive for measles IgM and 16.3% (n=28) positivity recorded for measles IgG. However, an overall prevalence of 23.2% (n=40) for measles antibodies were recorded of the 172 subjects that made up the study population. See table 1 below:

Table 1. Detectable anti-Measles Virus Antibodies in Vaccinated Children

	Number tested	Number Positive (%)
Measles IgM	172	12(6.9)
Measles IgG	172	28(16.3)
Total	172	40(23.2)

Of the 172 participants recruited in this study, subjects below one year showed a higher positivity of 27.3 % of the anti-Measles Virus IgG as opposed to the 11.2 % prevalence recorded for 1-3 age group.

With respect to gender, males had a prevalence of 12.9 % (n=12) from a total number of 93 subjects tested, whereas female subjects had a higher prevalence of 20.3 % (n=16). Upon previous disease post vaccination, all participants irrespective of gender

showed no positive response. With respect to religion, all respondents were Christians, of which 16.2 % (n=28) tested positive to the anti-measles virus IgG. While ascertaining mothers knowledge of the measles virus, a 15.2 % (n=25) prevalence was observed from mothers with previous knowledge of the disease as opposed to those without prior knowledge of the disease with a prevalence of 42.9 % (n=3). See table 2 below.

Table 2. Detectable anti-Measles IgG in Vaccinated Children Stratified by Demographic Details

Variables	Number. Tested (%)	No. Positive (%)	No. Negative (%)
Age (years)			
< 1	11(6.4)	3(27.3)	8(72.8)
1-3	89(51.7)	10(11.2)	79(88.8)
4-6	38(22.1)	9(23.7)	29(76.3)
7-9	13(7.6)	3(23.1)	10(76.9)
10-13	21(12.2)	3(14.3)	18(85.7)
Sex			
Male	93(54.1)	12(12.9)	81(87.1)
Female	79(45.9)	16(20.3)	63(79.7)
Previous Disease Post Vaccination			
Yes	0(0.0)	0(0.0)	0(0.0)
No	172(100.0)	28(16.2)	144(83.7)
Religion			
Christianity	172(100.0)	28(16.2)	144(83.7)
Islam	0(0.0)	0(0.0)	0(0.0)
Mothers Knowledge of Measles			
Yes	165(95.9)	25(15.2)	140(84.8)
No	7(4.1)	3(42.9)	4(57.1)

Of the 172 participants recruited in this study, subjects between 4-6 years showed a higher positivity of 15.8 % (n=8) of the anti-Measles Virus IgM as opposed to the 2.3 % (n=2) prevalence recorded for 1-

3 age group. With respect to gender, males had 4.3 % (n=4) from a total number of 93 subjects tested, whereas female subjects had a higher rate of 10.1 % (n=8). With respect to religion, all respondents were

Christians, of which 16.2 % (n=28) tested positive to the anti-measles virus IgM. While ascertaining mothers knowledge of the measles virus, a 15.2 % (n=25) prevalence was observed from mothers with previous knowledge of the disease as opposed to those without prior knowledge of the disease with a prevalence of 42.9 % (n=3). See table 3 below:

The result recorded the highest mean±SD of Lymphocyte count of 58.0 ± 19.7 among 7-9 (n=3) of age groups with a mean±SD of anti-MV IgG positive titre of 2.2 ± 0.9 as opposed to 38.7 ± 7.6 recorded among participant of 10years and above having an anti-MV IgG positivity titre of 2.9 ± 0.8. it was also observed that the highest mean±SD of Neutrophil

count was found to be 60.7 ± 8.3 among 10years and above with an anti-MV IgG positivity titre of 2.9 ± 0.8, while the lowest was 40.3 ± 20.6 among 7-9 (n=3) age groups with an anti-MV IgG positivity titre of 2.2 ± 0.9. Also, there was a monocyte count of 2.0 ± 2.4 within 4-6 (n=9) as the highest having an anti-MV IgG positive titre of 1.6 ± 0.6 as opposed to 0.7 ± 1.2 as the lowest mean±SD monocyte count among 10-13 (n=3) age groups with an anti- MV IgG positive titre of 2.9 ± 0.8. The highest and lowest mean±SD of Eosinophil was 2.0 ± 3.5 among <1 (n=3) and 0.1 ± 0.3 among 1-3 (n=10) with 1.2 ± 0.2 and 1.4 ± 0.3 anti-MV IgG positive titre respectively, as in table 4 below:

Table 3. Detectable anti-Measles IgM in Vaccinated Children Stratified by Demographic Details

Variables	No. Tested (%)	No. Positive (%)	No. Negative (%)
Age (years)			
< 1	11(6.4)	1(9.1)	8(90.9)
1-3	89(51.7)	2(2.3)	87(97.7)
4-6	38(22.1)	6(15.8)	32(84.2)
7-9	13(7.6)	1(7.7)	12(92.3)
10-13	21(12.2)	2(9.5)	19(90.5)
Sex			
Male	93(54.1)	4(4.3)	89(95.7)
Female	79(45.9)	8(10.1)	71(89.9)
Previous Disease Post Vaccination			
Yes	0(0.0)	0(0.0)	0(0.0)
No	172(100.0)	28(16.2)	144(83.7)
Religion			
Christianity	172(100.0)	28(16.2)	144(83.7)
Islam	0(0.0)	0(0.0)	0(0.0)
Mothers Knowledge of Measles			
Yes	165(95.9)	25(15.2)	140(84.8)
No	7(4.1)	3(42.9)	4(57.1)

The result recorded the highest mean±SD of Lymphocyte count of 51.0 ± 7.1 among 10-13 (n=2) age groups with a mean±SD of anti-MV IgM positive titre of 1.5 ± 0.4 as opposed to 43.0 ± 0.0 recorded among participant of 7-9 (n=1) having an anti-MV IgM positivity titre of 1.5 ± 0.0. It was also observed that the highest mean ± SD of Neutrophil count was found to be 54.0 ± 0.0 among 7-9 (n=1) with an anti-MV IgM positivity titre of 1.5 ± 0.0, while the lowest was 4049.0 ± 7.1 among 10-13 (n=2) age groups with

an anti-MV IgM positive titre of 1.5 ± 0.4. Also, there was a monocyte count of 3.0 ± 0.0 within 7-9 (n=1) as the highest having an anti-MV IgM positive titre of 1.5 ± 0.0 as opposed to 0.5 ± 0.7 as the lowest mean ± SD monocyte count among 1-3 (n=2) age groups with an anti-MV IgM positive titre of 1.6 ± 0.1. The eosinophil mean ± SD was 0.5 ± 0.7 among 1-3 (n=2) age groups having an anti-MV IgM positive titre value of 1.6 ± 0.1 while other were negligible. See table 5 below:

Table 4: Mean ± SD of Leukocyte Counts of Positive anti-MV IgG Subjects Grouped by Age.

Parameter	<1 (n=3)/N.R	1-3 (n=10)/N.R	4-6 (n=9)/N.R	7-9 (n=3)/N.R	10-13 (n=3)/N.R	f-value	p-value
Positive MV IgG O.D level	1.2 ± 0.2	1.4 ± 0.3	1.6 ± 0.6	2.2 ± 0.9	2.9 ± 0.8		
Lymphocyte count (%)	46.7±4.2/ 45-47	47.6±16.5/ 50-70	39.9± 13.3/ 32-60	58.0±19.7/28-48	38.7±7.6/ 28-48	1.123	0.369
Neutrophil count (%)	50.0 ±.3/ 20-50	51.9 ±14.7/ 35-80	60.3±13.4/ 35-80	40.3±0.6/ 35-80	60.7±8.3/ 35-80	1.481	0.240
Monocyte count (%)	0.0 ± 0.0/ 0.4-2.0	1.1 ± 1.3/ 0.4-2.0	2.0 ± 2.4/ 0.4-2.0	0.0 ± 0.0/ 0.4-2.0	0.7 ± 1.2/ 0.4-2.0	1.325	0.290
Eosinophil count (%)	2.0 ± 3.5/ 0-4	0.1 ± 0.3/ 0-4	± 0.0/ 0-4	0.0± 0.0/ 0-4	± 0.0/ 0-4	2.390	0.080
Basophil count (%)	± 0.0/ 0-1.2	0.0 ± 0.0/ 0-1.2	0.0 ± 0.0/ 0-1.2	0.0 ± 0.0/ 0-1.2	± 0.0/ 0-1.2		

*p< 0.05 (Significant)

Table 5. Mean ± SD of Leukocyte Counts of Positive MV IgM Subjects Grouped by Age Groups

Parameter	<1 (n=3)/N.R	1-3 (n=10)/N.R	4-6 (n=9)/N.R	7-9 (n=3)/N.R	10-13 (n=3)/N.R	f-value	p-value
Poitive MV IgM O.D level	1.6 ± 0.0	1.6 ± 0.1	1.3 ± 0.4	1.5 ± 0.0	1.5 ± 0.4		
Lymphocyte count (%)	48.0 ± 0.0/ 45-47	48.0 ± 36.7/ 50-70	47.3± 12.3/ 32-60	43.0 ± 0.0/ 28-48	51.0 ± 7.1/ 28-48	0.036	0.997
Neutrophil count (%)	52.0 ± 0.0/ 20-50	52.0 ± 36.8/ 35-80	52.7± 12.3/ 35-80	54.0 ± 0.0/ 35-80	49.0 ± 7.1/ 35-80	0.019	0.999
Monocyte count (%)	0.0 ± 0.0/ 0.4-2.0	0.5 ± 0.7/ 0.4-2.0	1.7 ± 2.7/ 0.4-2.0	3.0 ± 0.0/ 0.4-2.0	0.0 ± 0.0/ 0.4-2.0	0.480	0.751
Eosinophil count (%)	± 0.0/ 0-4	0.5 ± 0.7/ 0-4	0.0 ± 0.0/ 0-4	0.0 ± 0.0/ 0-4	0.0 ± 0.0/ 0-4	1.458	0.310
Basophil count (%)	0.0 ± 0.0/ 0-1.2	± 0.0/ 0-1.2	0.0 ± 0.0/ 0-1.2	0.0 ± 0.0/ 0-1.2	0.0 ± 0.0/ 0-1.2		

*p< 0.05 (Significant)

Table 6 shows that of the 172 subjects recruited, four (4) were positive for both IgM and IgG. These four recorded the least mean ± SD of lymphocyte count of 39.5±6.2 when compared to subjects positive for only IgM and IgG with a mean ± SD of

45.18±14.56 and 47.75±14.16. Consequently, the mean ± SD of neutrophils count for IgM/IgG positive subjects were higher 60.5 ± 6.2 compared to 54.10 ± 14.39 and 52.0 ± 14.09 recorded for iGM and IgG positive individuals respectively. See table 6 below.

Table 6. Comparison of the Mean ± SD of Leukocyte Counts of Subjects Positive for both anti-MV IgG and IgM as well as only IgG or IgM.

	Positive IgM (n=12)	Positive IgG (n=28)	Positive IgM/IgG (n=4)
Lymphocytes count	45.18 ± 14.58	47.75 ± 14.16	39.5 ± 6.2
Neutrophils count	54.10 ± 14.39	52.0 ± 14.09	60.5 ± 6.2
Monocyte counts	1.10 ± 1.73	1.17 ± 2.04	1.0 ± 2.0
Eosinophils count	0.25 ± 1.14	0.08 ± 0.29	0.0 ± 0.0
Basophils count	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0

*p< 0.05 (Significant)

N/B: All participants received single dose vaccination at 9months of age and showed no symptom of the disease.

It was observed as shown in table 5 that the Mean ± SD of lymphocyte count in female subject was higher (46.8 ± 16.4) compared to 43.0 ± 12.1 in male subjects, both groups had a positive anti-MV IgG titter of 1.5 ± 0.5 and 1.9 ± 0.9 respectively. The neutrophil counts of 54.9 ± 13.4 and 53.5 ± 15.5, monocyte counts of 0.8 ± 1.3 as well as 1.3 ± 2.0 were recorded for male and female subjects respectively. A Mean ± SD of 0.6 ± 1.7 of eosinophil counts was recorded for male subject only. Also, it was observed in table 6 that

the Mean ± SD of lymphocyte count in female subject was 50.6 ± 13.3 higher compared to 42.0 ± 16.1 in male subjects, both groups had a positive anti-MV IgG titter of 1.3 ± 0.3 and 1.7 ± 0.3 respectively. The neutrophil counts of 58.0 ± 16.1 and 49.0 ± 13.1, then monocyte counts of 0.0 ± 0.0 and 1.8 ± 2.3 were recorded for male and female subjects respectively. A Mean ± SD of 0.1 ± 0.4 eosinophil counts was recorded for male subject only.

Table 7. Comparison of the Mean±SD of Leukocyte Counts of Positive anti-MV IgM and IgG Subjects Stratified by Sex.

	IgM		t- value	p- value	IgG		t-value	p-value
	Male	Female			Male	Female		
MV O.D value	1.7 ± 0.3	1.3 ± 0.3			1.9± 0.9	1.5 ± 0.5		
Lymphocyte Count (%)	42.0 ± 16.1	50.6 ± 13.3	0.927	0.396	43.0± 12.1	46.8± 16.4	0.708	0.484
Neutrophil Count (%)	58.0± 16.1	49.0± 13.1	0.970	0.376	54.9± 13.4	53.5 ± 15.5	0.258	0.797
Monocyte Count (%)	0.0 ± 0.0	1.8 ± 2.3	2.139	0.069	0.8 ± 1.3	1.3 ± 2.0	0.767	0.449
Eoinophil Count (%)	0.1 ± 0.4	0.0 ± 0.0	1.000	0.350	0.6 ± 1.7	0.0 ± 0.0	1.357	0.186
Basophil Count (%)	0.0 ± 0.0	0.0 ± 0.0			0.0 ± 0.0	0.0 ± 0.0		

*p< 0.05 (Significant)

4 Discussion

In this study, detectable anti-measles virus specific IgM and IgG antibodies were accessed in representative samples of vaccinated children population in Port Harcourt, Rivers State, Nigeria using standard ELISA technique. Consequently, it was established that 6.9 % (n=28) of the 172 vaccinated children tested had detectable anti-measles virus IgM

antibodies. However, our findings are in sharp disagreement with the 86% positivity of MV IgM reported by Okonko and Jim George, (2017) in recent studies done at Emohia L.G.A among unvaccinated Children and the 71.1% reported by Chukwu *et al.*, (2009) among children in Kaduna metropolis This could be due to immunological, and haematological factors. However, 6.9% occurrence of detectable anti-

measles virus IgM obtained in this study is closest to finding of 21.1% of IgM among children of age 0 – 9months of age by Olaitan *et al.*, (2015) and the 32% by Chechet *et al.*, (2014) among children between 5-12 years of age in Giwa, Zaria.

The 16.3% MV IgG positivity obtained in our study contradicts that of Rafiei *et al.*, (2013) who reported a 75.8% IgG prevalence among children who received MMR vaccines in Tahrán: and 56.5% prevalence among unvaccinated children in Emohua by Iheanyi and Mercy in 2017. Our findings also deviated from the 89.0 % reported by Plans *et al.*, (2010) among non-vaccinated individuals; the 98.6 % reported by Condorelli *et al.* 1994; the 97.6 % reported by Shilpi *et al.*, 2009 and the 98.5 % reported by Plans *et al.*, 2010. These differences in MV IgG occurrence is suspected to be due to inadequate routine vaccination programmes around Port Harcourt as children only receive measles vaccination at nine (9) months of age after which they are opportuned to have a booster dose only during massive campaigns against measles which is irregular within the study area.

Having recorded the highest IgM prevalence of 15.8% among children age 4-6years and the lowest occurrence of 7.7% among children age 1-3years in our study, our findings agrees with Chechet *et al.*, (2014) who reported a 16.6% occurrence among children within 5-6years and also with their 6.6% among age group 7-8years. However, our study disagrees with the work of Chukwu *at al.* (2009) who reported a higher prevalence of 31.9% between the ages of 5months-2years and the least of 10% among the 6-8years age group. Our findings also had an agreement with the 7% reported by Umeh and Ahaneku (2013) among children below a year old but there was disparity within the 2-4years age group where they reported 64% prevalence as oppose our 15.8%.

In terms of sex related prevalence, our higher MV IgM occurrence of 10.1% among female subjects compared to 4.3% among male subjects agrees with data published by Olaitan *et al.*, 2015 who reported 27.5% detectable anti-measles IgM among female children and 16.3% among male subjects. However, there are clear differences between our findings and the results published by Chechet *et al.*, (2014) who reported 38% in males and 26% in females; Chukwu *et al.*, (2009) reporting 37.4n% in males and 33.7% in females; while Okonko and Jim-George reported 52.7% in male and 47.3% in female. Conversely, our study agrees with the above studies as there was no age related relationship with MV IgM seropositivity at $P < 0.05$.

Among all the 172 children screened for measles virus-specific IgG antibodies, 16.3 % (n=28) had measles virus-specific IgG antibodies (S/Co ratio ≥ 1.0

international standard) while the remaining 83.7 % (n=144) tested negative to measles virus-specific IgG antibodies (S/Co ratio < 1.0 international standard). The 16.3 % seropositivity of measles virus-specific IgG antibodies is lower than and disagree from 75.8 % reported by Rafiei *et al.*, 2013 in Tehran; the 76.0 % reported by Domínguez *et al.*, 2006 and Plans *et al.*, 2010 among individuals aged < 25 years; the 89.0 % reported by Domínguez *et al.*, 2006 and Plans *et al.* 2010 among non-vaccinated individuals; the 98.6 % reported by Condorelli *et al.*, 1994; the 98.3 % reported by Domínguez *et al.* 2006; the 97.6 % reported by Shilpi *et al.*, 2009; the 98.5 % reported by Plans *et al.*, 2010 in related studies. However, the 16.3 % seropositivity of measles virus-specific IgG antibodies reported here is comparable to the 25.0 % seropositivity of measles virus-specific IgG reported among unvaccinated children by Manirakiza *et al.*, 2011. This low seropositivity in measles IgG leaves the children vulnerable to indigenous measles virus transmission should an outbreak arise (Manirakiza *et al.*, 2011). The cause of this low seropositivity is not clear (Manirakiza, *et al.*, 2011) but our study suspects the cause to be inadequate routine vaccination programmes around Port Harcourt as children only receive measles vaccination at nine (9) months of age, after which they are opportuned to have a booster dose only during massive campaigns against measles which is irregular within the study area.

Of the 21 vaccinated children (10 years and above), 14.3 % (n=3) tested positive for measles virus-specific IgG. Higher seropositivity of 23.7 % was observed in vaccinated children (aged 4-6 years) while vaccinated children (aged 1-3 years) had the least seropositivity of 11.2 %.

Despite recording the highest MV IgG prevalence of 27.3% in children below one year, and the least occurrence of 11.2% among the 1-3years age group contrast data published by Manirakiza *et al.*, (2011) that MV IgG prevalence of 57.3% was observed among children below 5years and total absence in children below 8months. The 14.3% occurrence among children between 10-13years of age also contradicts their 45.6% prevalence among children of age 10years and above.

However, Iheanyi and Mercy reported a 19.8% MV IgG occurrence among children of age 6-10 in Emohua, Rivers State. In terms of sex related prevalence, a higher occurrence of 20.3% was detected among female subjects compared to the 12.9% in male. This however disagrees with Iheanyi and mercy who reported a 47.3% and 52.7% prevalence among female and male unvaccinated children respectively.

The seropositivity of measles virus-specific IgG increased with an increase in age, and then decreased in older children. This disagrees with Rafiei *et al.*

2013, who reported that no substantial age association with seropositivity of measles virus-specific IgG antibodies. This corroborates the findings of Shilpi *et al.*, 2009.

Of the 172 subjects recruited, four (4) were positive for both IgM and IgG. These four recorded the least mean \pm SD of lymphocyte count of 39.5 ± 6.2 when compared to subjects positive for only IgM and IgG with a mean \pm SD of 45.18 ± 14.56 and 47.75 ± 14.16 . Consequentially, the mean \pm SD of neutrophils count for IgM/IgG positive subjects were higher 60.5 ± 6.2 compared to 54.10 ± 14.39 and 52.0 ± 14.09 recorded for IgM and IgG positive individuals respectively. There dual positivity to both IgM and IgG could be due to the fact that they were vaccinated of recent and the immune response to the vaccine is still ongoing. However, reduced lymphocyte counts could be attributed to the ongoing cellular response to the vaccine.

The prevalence of measles virus IgG and IgM with respect to sex of the children was observed to be higher in female children with the prevalence of 20.3% (16/79) for measles IgG and 10.1% (8/79) for measles IgM respectively and lowest in male children with the prevalence (12.9%:12/93), (4.3%:4/93). The seroprevalence of measles virus IgG and IgM antibodies in relation to Gender may be attributed to previous vaccination or incomplete course of routine vaccination in both sexes. This result disagrees with previous study in Nigeria (Basse *et al.*, 2010; Aumatel *et al.*, 2013) which reported that measles antibody is marginally higher in male than in their female counterpart. However, this corroborates Okonko and Jim-George who reported no sex ($p > 0.05$) relationship with the seropositivity of anti-MV IgM then Okonko and Mercy 2017 who reported no sex ($p > 0.05$) relationship with the seropositivity of anti-MV IgG.

Seropositivity of anti-MV IgM and IgG was only present among children who were Christian (16.2%) as no Muslim child was among participants. Communities and individuals in the United States decide on not to get vaccinated for various reasons, of which religious motives and idealistic reasons were mainly cited (Wombwell *et al.*, 2015; Okonko and Jim-George, 2017). Religion-based objections most frequently focused on animal-derived gelatins used in production of vaccines and aborted human fetus tissue used in the rubella constituent of the measles, mumps and rubella (MMR) combined vaccine products (Wombwell *et al.*, 2015; Okonko and Jim-George, 2017). These objections amongst religious groups might also not be faith-based, somewhat in some cases were anxieties connected to lack of safety and effectiveness of the vaccination (Wombwell *et al.*, 2015; Okonko and Jim-George, 2017). Ascertaining

mothers' knowledge of the measles virus, this study showed that 15.2 % prevalence of measles was observed in children whose mothers had previous knowledge of the disease as opposed to those without prior knowledge of the disease with a prevalence of 42.9 %.

In all, no Statistical difference was observed in positive subjects haematological parameters (lymphocytes, neutrophils, basophils, eosinophils and monocyte) with ($P < 0.05$) when compared with the negative IgM and IgG subjects. This indicates that measles infection has no effect on the haematological development of children who have received measles vaccines. However, significant differences were noted among the mean titre value of positive and negative immunoglobulin optical density values.

5 Conclusions

In conclusion, the burden of measles in Nigeria remains high despite global efforts targeted at elimination, with infants and the unvaccinated being the most susceptible. The findings in the study suggest the presence of Measles virus in children of all age groups in the Port Harcourt, South-South, Nigeria, with seroprevalence comparable to the rates obtained in other parts of the country. The prevalence of 6.9% was obtained for IgM antibody and 16.3% was obtained for IgG. This is an indication that measles is endemic in the South-South Nigeria and still poses a public health problem, despite the availability of a safe and effective vaccine. The results obtained from this study suggests that the serological method used has a high sensitivity and specificity and are suitable for routine use; therefore ELISA techniques should be employed for routine use due to the high sensitivity and specificity of the techniques.

Complementary seroepidemiological studies to point the changing aspects of measles virus-specific IgG antibodies should be carried out in other areas of Rivers State and Nigeria at large to reduce the chances of susceptible children and improve the immunity profile of older age groups all over the country. Consistent Campaigns of measles vaccination of at least once in each quarter of the year should be carried out in other curtail the drop in titre level of measles antibodies.

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