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## Seroprevalence of Paediatric Malaria Infections in Two Hospitals in Kano State, Nigeria.

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### Abstract

A study of Seroprevalence of malaria infections in Wudil and Gaya General Hospitals, Kano State, Nigeria was conducted between April and July 2013. Blood smears were obtained from 229 children (102 from Wudil General Hospital and 127 from Gaya General Hospital) who comprised of 62 males and 40 females; and 79 males and 48 females from Wudil and Gaya General Hospitals respectively. These were screened for the presence of malaria parasites using thick and thin Giemsa stained blood films method as well as test kits procedure specific for *P. falciparum*. Results obtained showed that children aged 1-3 years had the highest (85.4% and 46.6%) prevalence of malaria infections than other age groups at both hospitals respectively). The difference in prevalence of malaria infections with regards to age groups was not statistically significant ( $P>0.05$ ). Males seem to be mostly infected (85.5% and 33.9%) with plasmodium parasite than their female counterpart (60.0% and 20.8%) at both hospitals respectively; and these were found to be statistically significant ( $P<0.05$ ).

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Wudil General Hospital, Kano had the highest (75.5%) prevalence rate of paediatric malaria than Gaya General Hospital, Kano (41.7%). *P. falciparum* was found to be significantly predominant among the species recorded ( $P < 0.05$ ). The study revealed that malaria is a major public health problem among the children aged 1-10 years in both villages. Hence, complete mobilization and health education in order to reduce man-vector contact as well as reduce frequent self medication and prophylaxis is advocated among others in the study areas.

**Keywords:** Gaya; Malaria infections; Paediatric; *Plasmodium falciparum*; Prevalence; Wudil

## 1. Introduction

Malaria is one of the most devastating diseases in the World, being endemic in more than one hundred countries. It is the second most frequently observed disease in under-developed countries. World Health Organization estimated that 216 million clinical malarial cases occur worldwide, with 0.655 million deaths mostly among African children [1]. Malaria is therefore a major cause of infant mortality and is the only insect borne parasitic disease comparable in impact to the world's major killer disease like diarrhoea, acute respiratory infections, tuberculosis and AIDS [2]. Its common symptoms include headache, weakness, fever, arches and pains, high body temperature (chills and rigors) and bitterness of mouth and loss of appetite. In children, additional symptoms include more than normal sleeping, nausea and vomiting.

Four species of malaria parasites can affect humans under natural conduction: *Plasmodium falciparum*, *P. vivax*, *P. ovale* and *P. malariae*. The first two species cause the most infections worldwide. *Plasmodium falciparum* is the agent of severe, potentially fatal malaria, causing an estimated 700,000-2.7 million deaths annually, most of them in young children in Africa [3]. *Plasmodium vivax* and *P. ovale* have dormant liver state parasites ("hypnozoites"), which can reactivate ("relapse") and cause malaria several months or years after the infecting mosquito bite [3]. *Plasmodium malariae* produced long-lasting infections and if left untreated can persist asymptotically in the human host for years, even a life time [3].

Malaria is endemic throughout Nigeria. The Sahel regions and the high mountain area of the plateau states experience slightly lower rates of transmission malaria parasites. Malaria currently accounts for nearly 110 million clinically diagnosed cases per year, 60 percent of outpatient visits, and 30 percent hospitalizations. An estimated 300,000 children die of malaria each year. It is also believed to contribute up to 11 percent maternal mortality, 25 percent infant mortality, and 30 percent under-five mortality. It is estimated that 132 billion Naira lost to malaria annually in the form of treatment costs, prevention and loss of work time in Nigeria [4]. In Nigeria, malaria is the most common cause of outpatient to hospitals and it consistently rank among the three most important cause of death among children [5]. The prevalence in African children is much higher as 81.9 % children were affected in Nigeria [6].

The sub-Saharan African region has the greatest number of people exposed to malaria transmission and the highest malaria morbidity and mortality rates in the world [7]. Malaria is known to have a negative impact on performance

and learning in children [8]. It also aggravates anaemia and malnutrition in children and pregnant women [9]. Malaria usually presents with fever which may explain the frequent use of paracetamol and antimalarials for febrile children. These medicines are frequently adulterated in Nigeria, thus losing their efficacy. In addition, they may become substandard as a result of chemical instability from inappropriate importation and storage conditions or due to poor quality control during their manufacture [10]. Counterfeiting therefore has contributed to resistance of Chloroquine and Sulphadoxine-pyrimethamine to malaria parasites [11]. Quinine or artemisinin derivatives have been recommended by the WHO for severe malaria treatment [12]. According to the World Health Organization (WHO), the number of annual malaria cases worldwide is actually decreasing, yet the impact of the disease burden remains an enormous challenge, for sheer numbers and threat to human life [13].

Nigeria is one of Africa's hardest-hit, accounting for between 30 and 40 percent of malaria deaths on the continent [13]. This magnitude of occurrence in this part of the world correlates with poverty, ignorance and social deprivations in the community [13]. On the possible eradication of malaria, [14] opined that prevention is better than cure, advising that people should learn to maintain personal and environmental hygiene.

In view of the negative socio-economic and health impacts as well as the dearth of information of malaria on children at local level, this study attempts to examine the prevalence of paediatric malaria in Wudil and Gaya General Hospitals, Kano State, Nigeria.

## **1.2. Materials and methods**

### **1.2.1. The Study Area**

The areas of the study are Wudil General Hospital and Gaya General Hospital in Wudil and Gaya Local Government Areas. The two Local Government Areas are located 43Km and 53Km respectively, South-East from the state capital. Wudil town is one of the important commercial towns in Kano State. It covers an area extending between latitude 11°37'N and latitude 11°56'N as well as between longitude 8°45'E and 8°57'E and has a population of 105,106 [15]. The rainy season lasts from mid-April to mid-September while the dry season begin from mid-September to mid-April [16].

The inhabitants of both areas are diverse in occupation ranging from the elite to traders and artisans with majority of its populace using farming as a source of income. Major crop produce are corn, rice, sugar cane, groundnut, vegetables and with some few people engaged in fishing activities, cattle rearing, pottery and traditional hand weaving [16].

### **1.2.2. Study Population and Sample Size**

This study was conducted on paediatric outpatients aged 1-10 years attending Wudil and Gaya General Hospitals, Kano State. Two hundred and twenty nine (229) children were screened within four months i.e. April, May, June

and July, 2013 for the presence of malaria parasites. 102 children were screened in Wudil General Hospital whereas 127 children in Gaya General Hospital, Kano State, Nigeria.

### **1.2.3. Sample Collection**

Venous blood samples were collected using a tubing tourniquet tied to the upper arm of each of the children with care and adequate safety precautions to ensure test result are reliable, contamination of the samples was avoided and infection from blood transmissible pathogens was also prevented. Protective gloves were worn when collecting and handling blood samples. The blood samples were collected into EDTA bottle/container which was labelled with information such as name of the child, sex and age; and mixed gently. This anticoagulant (EDTA) is commonly used for haematological test. The chemicals therein, prevent blood from clotting by removing calcium [17].

### **1.2.4. Thin/Thick Blood Film preparation and parasitological examination**

The laboratory method employed for staining and identification of malaria parasites in collected blood samples was as described by [17]. Both thick and thin films were prepared.

A small drop of blood was placed on a clean microscopic slide near the end of a slide, a spreader was used to smear a blood steadily across the slide in a steady even movement at an angle of 45°, and the slide was allowed to dry and labelled appropriately.

One (1) volume of Giemsa stain was flooded on the slide for few minutes, two (2) volumes of buffered distil water of PH 6.8 was added and left for further 10 minutes, the slide was washed thoroughly under tap water to differentiate (the colour should be salmon pink), the slide was left to dry and back of the slide was clean with cotton wool soaked in alcohol.

A drop of oil immersion was placed on a stained slide to cover about 10mm in diameter in the areas of the film and viewed with the (X100) objective of compound microscope in order to identify the plasmodium parasites [17]. Positive or negative results were recorded accordingly.

### **1.2.4. Test Kits Procedure**

The test kits method was also used in all the samples as fast diagnostic method for *Plasmodium falciparum*. The sealed pouch was opened by tearing along the notch, test strip from the pouch was removed, 5µl sample was added on the absorbant area of test strip and the diluents for three drops was added, the result was read at 10 minutes in a result area.

### **1.2.5. Statistical Analysis**

The data collected were subjected to statistical analysis using paired t-test in SPSS 16 windows. The result was considered significant at  $p < 0.05$  level.

## 2. Results

Table 1 shows the distribution of malaria infections in relation to age at Wudil General Hospital, Kano. The result indicated that out of 102 children that were examined, malaria infection was at its peak (85.4%) within the age group of 1-3 years, whereas the age group of 7-9 had the least (62.5%) prevalence rate of malaria infections. There was no significant difference in the prevalence of malaria infections between the age groups ( $P > 0.05$ ).

The age related distribution of malaria infections at Gaya General Hospital, Kano State showed that out of 127 children that were examined, the age group within 1-3 years had the highest prevalence (46.6%) of malaria infections and the least (36.7%) was within the 7-10 age group (Table 2). The difference in prevalence of malaria infections with regards to age groups was not statistically significant ( $P > 0.05$ ).

Figure 1 depicts the distribution of 102 children of different age groups examined for malaria infections at Wudil General Hospital, Kano State, in which 62 were males and 40 were females. The males had higher (85.5%) prevalence of infections than their female counterparts (60.0%). Males had higher preponderance of malaria infections in all the age groups (88.9%, 87.5% and 78.9%, respectively) than the female category from the same age groups (78.3%, 61.5% and 38.5%), respectively. There was no significant difference in the prevalence of malaria infections in relation to gender ( $P > 0.05$ ).

The distribution of malaria infection in relation to age and sex at Gaya General Hospital, Kano State indicates that out of the total of 127 (79 males and 48 females) children examined for malaria infections, male patients had the highest proliferation of infections (33.9%) whereas the females had the least (20.8%). Similarly, the age group of 7-10 had the highest prevalence of infections (69.2%) among the males whereas the female in the same age range recorded the least prevalence (11.8%). The age group of 1-3 had mild prevalence of infections in both males (50.0%) and females (37.5%). Also, the age group of 4-6 shared near equal prevalence of infections (54.2%) for males and (13.3%) for females with the age group of 7-10 years (Figure 2). The difference in prevalence of malaria infections with regards to gender was statistically significant ( $P < 0.05$ ).

A summary of distribution of plasmodium species in malaria positive children attending Wudil and Gaya General Hospitals, Kano State is presented in Figure 3. Infections with two species (*P. falciparum* and *P. vivax*) of the parasite as well as a mixed type (*P. Falciparum*+ *P. Vivax*) were identified. However, infection with *P. Malariae* and *P. ovale* was not observed. The result also showed that infection with *P. falciparum* was more prevalent (89.6% and 50.9%) at both Wudil and Gaya General Hospitals respectively and this was found to be statistically significant ( $P < 0.05$ ). There was low prevalence (16.9% and 11.3 %) of *P. vivax* among children in both hospitals respectively. Mixed infections on the other hand, had the least prevalence (14.3% and 7.5%) in Wudil and Gaya General Hospitals, Kano State, respectively.

**2.1. Interpretation of Test Kits Results (For *P. falciparum*)**

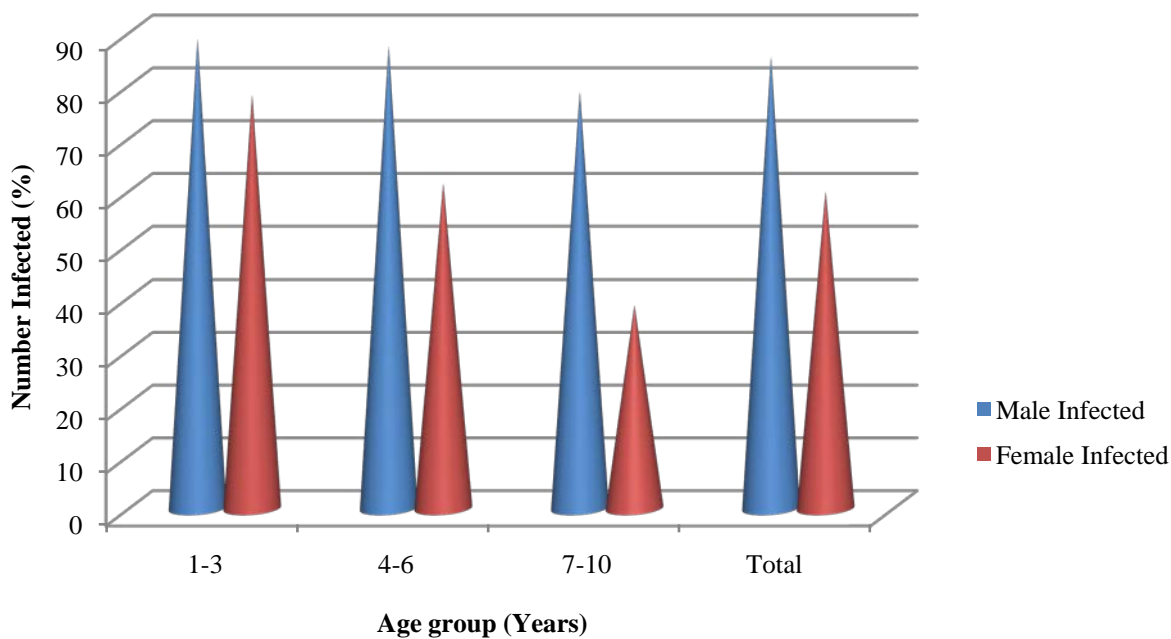
- **Positive Result:** - In addition to a pink coloured control (C) line, a distinct pink coloured line was also observed in the test (T) area.
- **Negative Result:** - Only one coloured line appears on the control (C) area. No apparent strip on the test (T) area.
- **Invalid Result:** - A total absence of colour line in both regions or only one colour line on the test area. It is an indication of procedure error and/or the test reagent has deteriorated.

**Table 1: Distribution of malaria infections in relation to age at Wudil General Hospital, Kano State, Nigeria.**

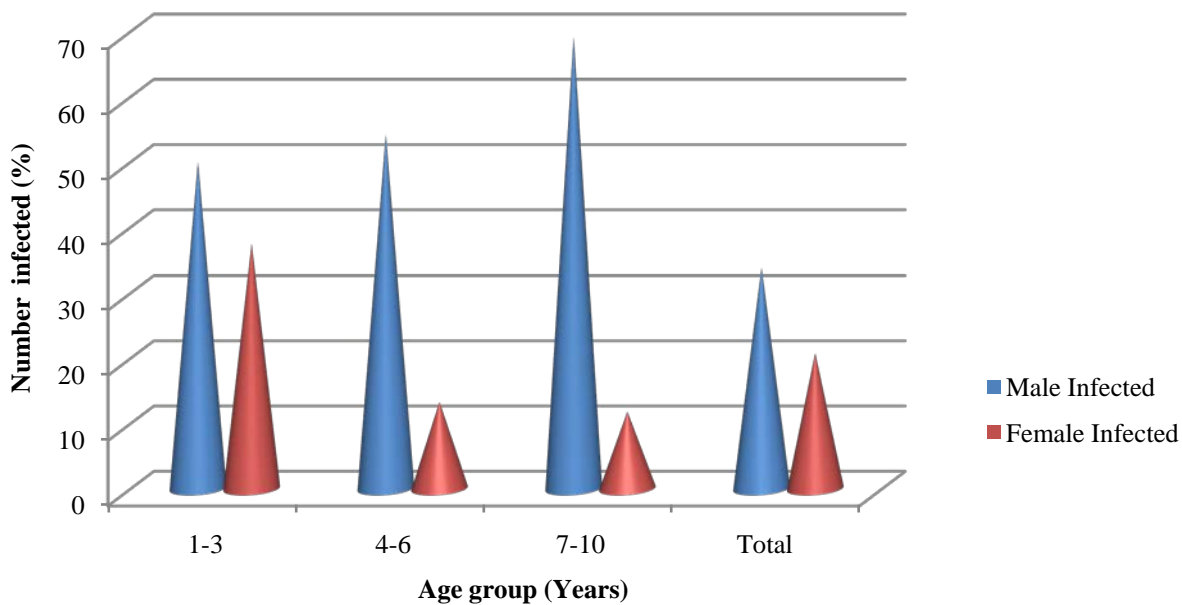
Age group (Years)	No. Examined	No (%) infected
1-3	41	35 (85.4)
4-6	29	22 (75.9)
7-9	32	20 (62.5)
<b>Total</b>	<b>102</b>	<b>77 (75.5)</b>

**Table 2: Distribution of malaria infections in relation to age at Gaya General Hospital, Kano State, Nigeria.**

Age group (Years)	No. Examined	No (%) infected
1-3	58	27 (46.6)
4-6	39	15 (38.5)
7-10	30	11 (36.7)
<b>Total</b>	<b>127</b>	<b>53 (41.7)</b>



**Fig. 1. Distribution of malaria in relation to age and sex at Wudil General Hospital, Kano State, Nigeria.**



**Fig. 2. Distribution of malaria infections in relation to age and sex at Gaya General Hospital, Kano State, Nigeria.**

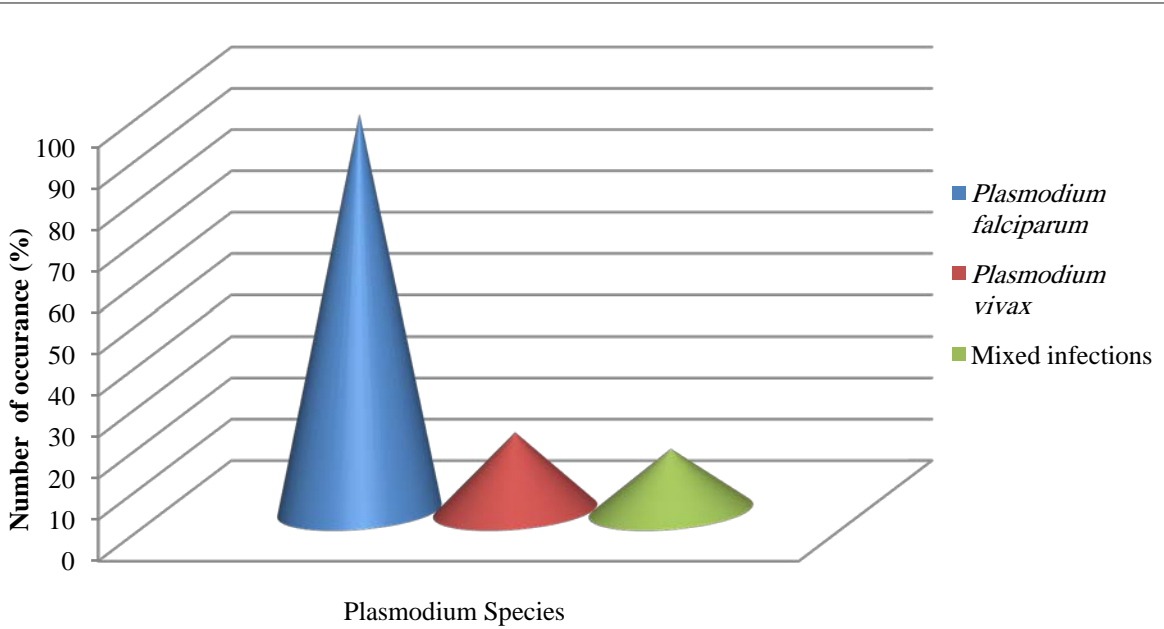
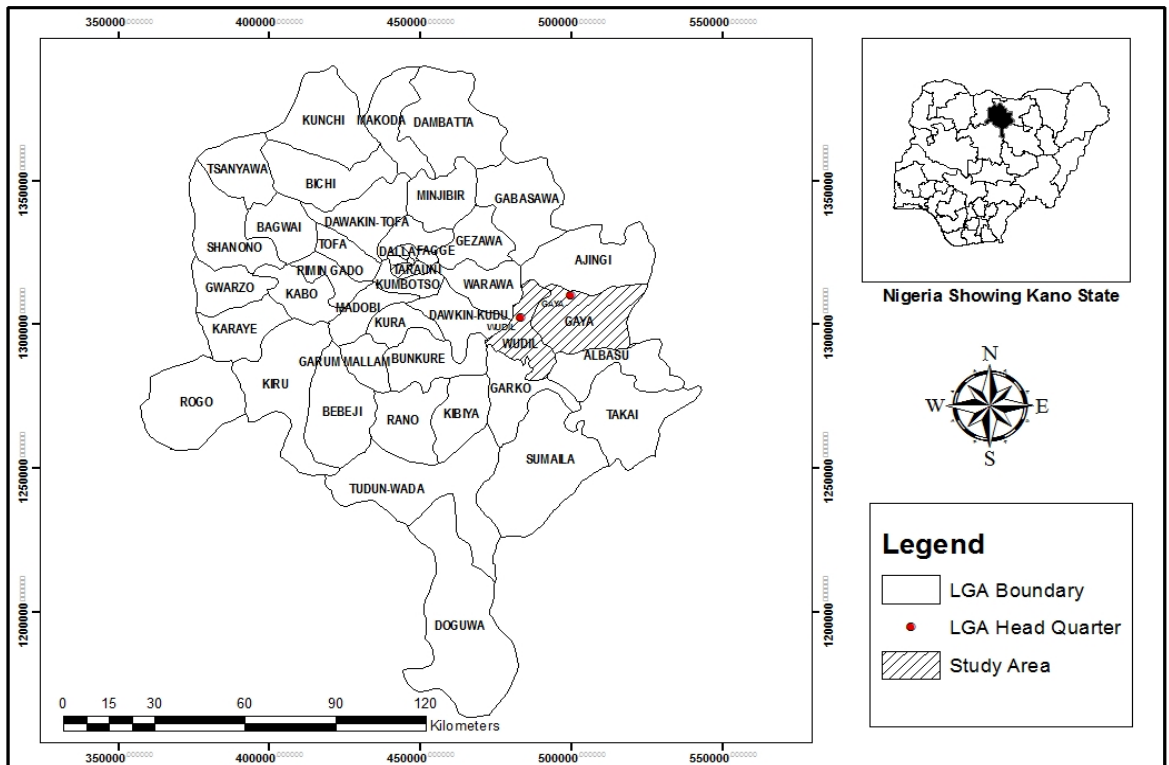


Fig. 3. Distribution of Plasmodium species in malaria Positive attending Wudil and Gaya General hospitals, Kano State, Nigeria.



Source: Geography Department BUK (2013)

Fig. 4. Map showing the location of the two study areas, Kano State, Nigeria.



### **3. Discussion**

This study revealed that malaria infections in children were prevalent in both Wudil and Gaya General Hospitals with overall prevalence of 75.5% and 41.7% respectively. The high prevalence of malaria infections recorded in Wudil is in line with previous works of various researchers such as that of [18] who reported as high as 80% malaria prevalence among school children in the malaria-endemic village of Erunmu in South Western Nigeria, [19] who reported a relatively higher prevalence among under 5 years than those above 5 and above age groups of patients attending Murtala Muhammad Specialist Hospital, Kano and also in children under 5 years and pregnant women attending selected hospitals in Ihitte Uboma Local Government Area, Imo State, Nigeria [20] among others. On the other hand, the relatively low prevalence of malaria infections recorded at Gaya General Hospital, Kano is in close conformity with the reported prevalence of 36% among children in tertiary institution in Benin City, Nigeria [21] as well as malaria prevalence of 34.8% among children in Quetta [22]. The relatively lower prevalence of malaria infections observed in Gaya General Hospital as compared to Wudil General Hospitals could be attributed to the preventive measures against malaria adopted by some people residing in the hospital catchment area. Consequently, the present work was carried out during the rainy season in the area between the months of April-August and this may have contributed to the high and moderate prevalence rates of malaria infections in the study areas. Rainfall is known to increase the prevalence of malaria infections since it provides more breeding sites for vectors of malaria as reported by [23], [24] and [25].

Malaria infections seem to be significantly common in male children than their female counterpart in this study. This result conforms to the observed higher prevalence of malaria infections in males than females in school children in Ebonyi and Edo State, Nigeria as reported by [26]. This scenario may be due to the fact that males usually expose their bare bodies more frequently than females especially when the weather is hot. Moreover, such males tend to be bitten by mosquitoes. Females on the other hand do not usually expose most of their body parts and mostly stay indoors. This reduces their contact with infective mosquito vector. Studies have shown that females usually have better immunity to parasitic diseases which is attributable to genetic factors [27]. Although, this could be contestable as at this age in the present study, hormonal influence is not marked. This view was also shared by [21].

Although not significant, the highest prevalence of malaria infections (85.4% and 46.6%) observed in children between the ages of 1-3 years as compared to other age groups in both hospitals could be due to the fact that at that age; their immunity to parasitic infections has not been fully developed [28]. This is in line with the reported high prevalence of malaria infections in younger children as observed by [26] and [21] who asserted that the prevalence of parasitic infections has been found to reduce with age. A similar scenario was also observed for children in Awka [29], in coastal dwellers of Lagos State [30], among children (6months-11years) in a tertiary institution in Benin City, Nigeria [21].

*Plasmodium falciparum* was more prevalent in the present study and this has thus, confirmed the earlier findings that; of the four species of malaria parasite, *P. falciparum* is the predominant in sub-Saharan Africa [31], [32] and [20].

#### **4. Conclusion**

This study has shown that malaria infections are more prevalent among children within 1-3 years than other age groups in Wudil and Gaya General Hospitals, Kano State, Nigeria. All children in this study seem to be vulnerable to malaria infections and males are mostly affected than their female counterpart.

Malaria infections mostly with *P. falciparum*, indeed constitutes a serious public health problem in Nigeria as this study has shown. In spite of all prevention and control efforts, malaria has remained a leading cause of morbidity and mortality worldwide. However, to reduce the overall risk of morbidity and mortality among infants, it is recommended that there should be complete mobilization and health education in the study areas in order to reduce man-vector contact as well as reduce frequent self-medication and prophylaxis, the Federal Government of Nigeria and its partners in the Roll Back Malaria (RBM) scheme should strive to ensure that these vital intervention measures are introduced into every nooks and cranny of this country especially in Wudil and Gaya Local Government Areas where the vectors of the disease abound. Government efforts towards treatment of malaria infections for every child with fever in government hospitals with artemisinin-based Combination Therapy (ACT) should be sustained.

Additionally, State ministry of health needs to continue its collaboration with ministry of environment on vector control programs through periodic spray of insecticides, use of insecticides treated bed nets (ITNs), treatment of stagnant water bodies including ponds, drainages in addition to refuse management in these communities. Targeted intervention programs such as public lectures, film shows on malaria control as well as health talks at out-patient Departments in all hospitals should be employed in our communities.

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#### **Competing interests**

All authors have declared that no competing interests exist and the manuscript has not been published before or submitted elsewhere for publication.

#### **Reference**

[1] W. H.O. "World malaria report" .*Fact sheet- World Health Organization*, 13 December, 2011.

- [2] C.F. Curtis. “*Control of Disease Vectors in the Community*”. Wolfe Publishing, London, 1991.
- [3] C. D. C. Malaria, anopheles mosquitoes”. *Nigeria Journal of Malaria*. 2006.
- [4] F. M. O. H. “Federal Republic of Nigeria training manual for management of malaria in Nigeria”. *Participants Manual. Federal Ministry of Health, National Malaria and Vector Control Division, Abuja- Nigeria*. 2009.
- [5] C. D. C. Department of Health and Human Services *Centres for Disease Control and Prevention*. 2000.
- [6] B. H. Oladeinde, R. Omoregie, M. Olley, J. A. Anunibe, A. A. Onifade, O. B. Oladeind. “Malaria and Anemia among Children in a Low Resource Setting in Nigeria”. *Iranian J. Parasitol*. 2012; 7 (3); .31 -37.
- [7] W. H. O. WHO, Geneva, World Malaria Report. 2005.
- [8] P. A. Holding, R. W. Snow. "Impact of *Plasmodium falciparum* malaria on performance and learning: review of the evidence". *Am. J. Top. Med. Hyg*. 2001. 64 (1-2 Suppl): 68–75.
- [9] S. C. Murphy and J.G. Breman. “GAPS in the childhood malaria burden in Africa: cerebral malaria, neurological sequelae, anaemia, respiratory distress, hypoglycemia, and complications of pregnancy,” *American Journal of Tropical Medicine and Hygiene*, 2001. Vol. 64, No. 1-2, 57-67.
- [10] M. Bonatti, M. “Once again. Children are the main victims of fake drugs”. *Arch. Dis Child*. 2009; 94:468. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/19460926>.
- [11] F. M. O. H. “National Guidelines and Strategies for Malaria Prevention and Control during Pregnancy”. *A Publication of the Federal Ministry of Health, Nigeria, 2005. Malaria Control Programme*. 40p.
- [12] W. H. O. Malaria in Africa. Roll Back Malaria Info sheet. *World Health Organization, Geneva*. 2006, *Fact Sheet 5*.
- [13] W. H. O. “World malaria report 2008”, WHO press, Geneva, Switzerland.
- [14] A. Arigbabuwo. “Malaria: Killer at large”. *Vanguard Newspaper Special report*. 26- September, 2010.
- [15] N. P. C. Census figures of 2006 in Nigeria. *National Population Commission, Nigeria*. 2006.
- [16] E. A. Olofin, A.B. Nabegu, A. M. Danbazau. “Wudil within Kano Region. A Geographical Synthesis”. *A publication of the Department of Geography, Kano University of Science and Technology, Wudil*, 2008. Pp. 1-52.
- [17] M. Cheesbrough. *Medical Laboratory Manual for Tropical Countries. Part 2, 2nd edition, University Press Cambridge*. 2000. 454pp.

- [18] A. A. Adeyemo, P. E. Olumese, O. K. Amodu, R. A. Gbadesin RA. “Strengthening health infrastructure: Correlates of hepatomegaly and splenomegaly among healthy school children in malaria-endemic village. *Niger. J. Paediatr.* 26: 1999 pp 1–3.
- [19] Y. Mustapha and B. S. Aliyu, B. S. “Prevalence of malaria parasite infection in Kano metropolis: a case study of patients attending Murtala Muhammad Specialist Hospital (MMSH), Kano, Nigeria”. *BEST J.* 1(1). 2004 pp143-146.
- [20] R. K. Obi, F. C. Nwanebu, C. C. Okangba, U. U. Ndubuisi and C. K. Nwanebu. “Malaria Prevalence in Children under 5 Years and Pregnant Women Attending Selected Hospitals in Ihetta Uboma LGA, Imo State, Nigeria”. *Nigerian Journal of Parasitology*, 33 (1): 2012 pp 73-76.
- [21] U. F. Okafor and Oko-Ose. “Prevalence of malaria infections among children aged six months and eleven years (6 months-11 years) in a tertiary institution in Benin City, Nigeria”. *Glo. Adv. Res. J. Med. Sci.* Vol. 1(10): 2012 pp.273-279.
- [22] A. Hussain, M. Shafee, N. Khan, S. Jan, A. M. Tareen, A. M. Khan. “Seroprevalence of paediatric Malaria in Quetta, Bolochistan, Pakistan”. *Iranian J. Parasitology*: Vol. 8, No.2, 2013 pp. 342-347.
- [23] A. Ayanlade, N. O. Adeoye, and O. Babatimelun. “Climate change/variability and Malaria transmission in Sub-Saharan Africa: A case of Nigeria”. *Report of the Royal Norwegian Society of Sciences and Letters*. 250 Anniversary Conferences. June 21-24, 2010 Trondheim, Norway. [Online] Available: <http://climsec.prio.no/papers/climate%20change-variability%20and%20malaria%20transmission%20in%20Subsaharan%20Africa%20A%20case%20of%20Nigeria.Pdf> (July 12, 2011).
- [24] L. M. Samdi, J. A. Ajayi, S. Oguche, A. Ayanlade. “Seasonal Variation of Malaria Parasite Density in Pediatric Population of North Eastern Nigeria”. *Global Journal of Health*. Vol. 4, No.2; March 2012.
- [25] A. Yahaya, F. Aminu and A. I. Tukur. “Seasonal Variation of Malaria Infection among Out-Patients Attending Wudil General Hospital, Kano State, Nigeria”. *International Journal of Applied Research and Technology*. 1(7): 2012 pp79 – 84.
- [26] O. C. Ani. “Endemicity of malaria among primary school children in Ebonyi State, Nigeria”. *Anim. Res. Inter.* 1: 2004 pp155–159.
- [27] M. Zuk and K. A. McKean. “Sex differences in parasite infections: Patterns and Processes”. *Inter. J. Parasitol.* 26: 1992 pp1009–1023.
- [28] D. Syafruddin, Krisin, A. Puji, Seratiutia, M. D. Rita, C. Farah *et al.* “Seasonal Prevalence of Malaria in West Samba District, Indonesia”. *Malaria Journal*. 8:8 doi: 2009, 10.1186/1475-2875-8.8

- [29] J. I. Mbanugo and D. O. Ejims. "Plasmodium infections in children aged 0-5 years in Awka Metropolis, Anambra State, Nigeria". *Niger. J. Parasitol.* 21: 2000 pp55-59.
- [30] O. J. Nebe, G. O. Adeoye, P. U. Agomo. "Prevalence and clinical profile of malaria among the coastal dwellers of Lagos State, Nigeria". *Niger. J. Parasitol.* 23: 2002 pp61-68.
- [31] E. Riley. "Malaria and People". Body Battleground. 2003. [http://www.wllcome.ac.uk/en/malaria/MalariaAndPeople/hb\\_imms\\_1.html](http://www.wllcome.ac.uk/en/malaria/MalariaAndPeople/hb_imms_1.html)
- [32] A. W. Taylor-Robinson. "Malaria in Endemic Human Populations: Clinical Disease, Immunity and Protection". 2003<http://mirrow.internux.co.id/med.sc.edu/www.med.sc.edu:85/parasitology/malaria-atr.htm>
- [33] W. H. O. "Malaria epidemics: forecasting, prevention, early detection and control: From policy to practice, report of an informal consultation". Leysin, *Document WHO/HTM/MAL/2004.1098 World Health Organization Geneva.* 2003.