Daniel and Vandi (2023)
Biological and Environmental Sciences Journal for the Tropics 20(3) December, 2023
ISSN 0794 – 9057; eISSN 2645 - 3142
BEST JOURNAL 20(3): 138 - 148
Date received: 11/09/2023
Date accepted: 31/11/2023
https://dx.doi.org/10.4314/bestj.v20i3.14

Haematological Parameters Associated With Malaria in Pregnant Women Attending General Hospital Kaltungo, Gombe State, Nigeria

[1]Daniel, J. L. and [2]Vandi, P*
[1]Department of Zoology, School of Life Sciences, Modibbo Adama University, P.M.B. 2076, Yola, Nigeria.
[2]Department of Science Laboratory Technology, Gombe State Polytechnic, P.M.B. 0190, Bajoga, Gombe State
*Corresponding Author**:** vandiphilips@yahoo.com

ABSTRACT
Malaria during and after pregnancy remained a major public health concern in the tropics and subtropics. This becomes necessary to investigate the anaemic level of pregnant women attending General Hospital Kaltungo, Gombe State. The study was conducted in General Hospital, Kaltungo, Kaltungo Local Government Area of Gombe State. Cross-sectional survey was conducted on consecutive pregnant women attending ante-natal over a period of 6 months (January to June); in 2018. Data was obtained from 300 pregnant women. The pregnant women were between the ages of 17 to 45 years. About 5 ml of venous blood samples were taken from each patient in EDTA tubes for malaria parasite and haematological examinations. Analysis of Malaria parasites was done using microscopy techniques, while haematological indices (Packed Cell Volume, Haemoglobin and White Blood Cell) were analyzed. Out of the 300 pregnant women that took part in the study only 17 (5.67%) had malaria parasites. The haematological parameter of the pregnant women infected with malaria parasites; showed that those with normal PCV range in relation to age, (37 ≥ years and above); had the highest number of pregnant women 2 (100%). The same pattern was also observed with similar age range on normal haemoglobin. The low prevalence of malaria parasites among pregnant women in Kaltungo, Gombe state, showed that the intervention programme is effective.

Keywords: Malaria; Pregnancy; Aanemia: Kaltungo; Gombe

INTRODUTION
Anemia in pregnant women is often caused by iron deficiency, which is the most common nutrient deficiency in the world. It has been estimated that, in developing countries, half of the population (mainly children and women of reproductive age) is affected by anemia (Meseret *et al.,* 2013). Infections including malaria are also involved in the pathogenesis of anaemia in pregnancy (Glover *et al*., 2005). Anaemia in pregnancy is an important cause of maternal morbidity and mortality, preterm birth, low birth weight and poor iron status in the infant (de Benoist *et al.,* 2008). Anaemia could be classified as mild (10.0- 10.9 g/dl), moderate (8.0- 9.9 g/dl) and severe (< 8.0g/dl), amongst these categories, severe anaemia induces the most dramatic consequences which are increased risk of maternal morbidity and mortality, poor intrauterine growth, abortion, preterm and low birth weight (Bodeau-Livinec *et al*., 2011). *Plasmodium* infection is a very common occurrence in Africa and several studies have reported the relationship between malaria during pregnancy and low birth weight, anaemia, splenomegaly and congenital transmission (Ekejindu *et al.,* 2006). The factors above result in higher perinatal morbidity, mortality and subsequently higher infant mortality (Brabin *et al*., 2004).

Maternal anaemia may also lead to fetal anaemia and subsequently to infant anaemia as well as long-term childhood morbidities, including impaired neuro developmental outcomes (Koura *et al.,* 2012)

Malaria during pregnancy can have devastating consequences to both mother and developing foetus and is associated with mild to severe maternal illness, maternal anaemia, spontaneous miscarriage, stillbirth, preterm delivery and foetal growth retardation (Desai *et al.,* 2007). Malaria is the most important preventable cause of low birth weight in malaria-endemic areas in sub-Saharan Africa, which in turn is associated with increased susceptibility to illness and death in early life (Desai *et al.,* 2007).

Approximately 30% of total global cases of anaemia during pregnancy are reported in sub-Saharan Africa (World Health Organization [WHO], 2008). This becomes necessary to investigate the anaemic level of pregnant women attending General Hospital Kaltungo in Gombe State.

MATERIALS AND METHODS

Study Area

This study was conducted in General Hospital, Kaltungo, Kaltungo Local Government Area of Gombe State, which lies within Latitudes 9°45' N and 9°47' 44" N and within longitudes 11°13' 28"E and 11°16' 48" E. The area has an estimated population of 149,805 which comprises of 80,377 males and 69,428 females (NPC, 2006). The area lies within the Sudan savannah zone, with marked dry and wet season, annual rain fall is from April to October. Ranging between 39 to 66 mm, the relative humidity is between 44 to 68 %, while the temperature ranges fluctuate between 22 to 29 °C (Fig. 1). The topography of this area is characterized by hilly features, with an average height of 600 m altitude above sea level. The drainage system in the area is dendritic. The vegetation cover consists of shrubs and short grasses and scattered trees described as a sub-Sahara savannah (Obaje and Hamza, 2000).

Ethical consideration

A letter of introduction was obtained from the Department of Zoology, Modibbo Adama University of Technology, Yola, Adamawa State, and it was taken to Gombe State Ministry of Health and the Hospital Management Board. Verbal informed consent was obtained from each study participant and participant's right to refuse participation in the study or withdraw at any time during the course of the interview was respected. Maximum effort was made to maintain confidentiality of the information obtained.

Sample Size

A total of 300 sample size of the pregnant women was estimated using the standard formula of Sarmukaddam and Garad, (2006),

$$n = \frac{Z^2 PQ}{d^2}$$ Where

n = the desired sample size (when population is greater than 10,000).

z = the normal standard deviation, usually set at 1.96 (or 2.0) which corresponds to 95 % confidence level.

P = the proportion in the target population estimated to have a particular characteristic. If there is no reasonable estimate then use 50 % (i.e. 0.50).

d = degree of accuracy desired set at 0.05 q = 1.0 – p.

A total of 300 pregnant women were used for this research work.

Laboratory procedures

Collection of blood sample

With the help of the medical team 5ml venous blood was obtained from each pregnant woman after cleaning the site with spirit and put in Ethylene Diamine Tetra acetic Acid (EDTA) bottle to avoid clotting and ensure preservation of the samples from the 300 pregnant women. The samples were kept in cold box and transported to the laboratory for analysis.

Determination of Malaria Parasites

A drop of blood samples was deposited on the slide and then spread to make a thick smear with the corner of another slide to a diameter of about 1-2 cm. It was allow to air dry in a flat position on a staining rack and stained with Giemsa`s stain for 20 minutes. A buffered water of pH 6.8 was used to washed out the stain, the slide was allowed to stand upright to dry in the air, and viewed under x 100 objective (oil immersion) lens. The smear was used to confirm the presence or absence of malaria parasite. The degree of parasitaemia was graded according to the number of parasite per micro litre (Cheesbrough, 2006).

Determination of Packed Cell Volume (PCV) Estimation

The EDTA-mixed blood specimen was poured into a capillary tube. One end of the tube was sealed with flame from a bursen burner. The set up was spinned in a haemotocrit centrifuge at speed of 12000 rpm for 5 minutes. PCV value was read off using PCV reader inbuilt on the haematocrit centrifuge. Pregnant women whose PCV was less than 33 % was considered anaemic and further categorized as mild (26 – 32 %), moderate (19 – 25 %) or severely anaemic (≤ 18 %) (Sood, 2006).

Determination of Haemoglobin (Hb) estimation

This was done according to standard procedures (Bisseru, 1985). Briefly, four (4) milliliters of Drabkin's solution was transferred into a test tube and 20 µL of venous blood samples in EDTA was added and thoroughly mixed. This was allowed to stand for 10 mins at room temperature and read in a spectrophotometer. The test and standard were then recorded.

Determination of White Blood Cell (WBC) Estimation

White Blood Cell was estimated by diluting 0.02 ml of EDTA - mixed blood in 0.38 ml Turke's solution. Using a plain capillary tube, the diluted blood sample was used to charge the improved Neubauer`s counting chamber. The white blood cells present in 4 corners 1 mm^2 area of the chamber was counted with x 10 low power objective of the microscope. The numbers of white blood cells seen was multiplied by the blood dilution and chamber depth divided by the area of the chamber counted. This gives the value of WBC/mm^3 of blood (Sood, 2006).

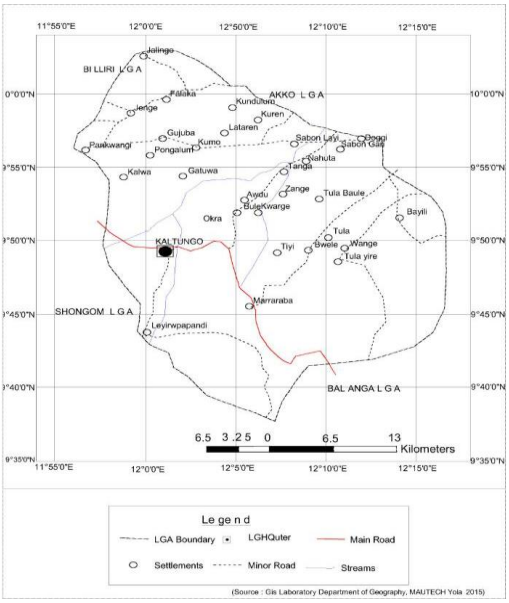

Figure 1: Map of Gombe State showing the study area. (Source: GIS Laboratory, Department of Geography, MAUTECH, Yola, 2015).

Data Analysis

Chi square was used to compare the differences within the parameters

RESULTS

Out of the 300 pregnant women that took part in the study only 17 (5.67 %) had malaria parasites. The haematological parameter of the pregnant women infected with malaria parasites; showed that those with normal PCV range in relation to age, the age ranges 37 years and above, had the highest with 2 (100 %) while the least was recorded in age range 17-21 years with 2 (40.00 %) women. There is no significant difference in relation to age ($p<0.05$). The ranges of PCV in relation to occupation shows that the highest number of women with normal PCV were found in civil servants and students with 2 (100 %) each, and the least were in business women with 1 (33.33 %). There is no significant difference in relation to occupation ($p<0.05$). The distribution in relation to educational level shows that those with tertiary school level of education had the highest number of women with normal PCV range, with 4 (80.00 %), while those with primary school level of education had the least with only 1 (50.00 %) woman. There is no significant difference in relation to educational status ($p<0.05$). The haematological parameter of the pregnant women not infected with malaria parasites; showed that those with normal PCV range in relation to age, the age range 27-31 years had the highest with 53 (18.79 %) women, the least was recorded in the age range 37 years and above with 16 (5.67 %). There is no significant difference in relation to age ($p<0.05$). The ranges of PCV in relation to occupation among those not infected showed that the highest number of women with normal PCV were found in housewife with 81 (28.72 %), while the least were in farmers with 10 (3.55). There is no significant difference in relation to occupation ($p<0.05$). The distribution in relation to educational level shows that those with secondary school level of education had the highest number of women with normal PCV range, with 109 (38.65 %), while those with primary school level of education had the least with only 13 (4.61 %) woman There is no significant difference in relation to educational status ($p<0.05$) (Table 1).

The haematological parameter of the pregnant women infected with malaria parasites, the distribution in relation to age shows that the age ranges 37 years and above had the highest with 2 (100 %) pregnant women, while nothing was recorded for women of the age range 17-21 years. There is no significant difference in relation to age ($p<0.05$). The distribution in relation to occupation shows that housewife had the highest with 3 (37.50 %), while nothing was recorded for those that farm as an occupation. There is no significant difference in relation to occupation ($p<0.05$). The distribution in relation to educational level shows that those with tertiary level of education had the highest number of women with normal haemoglobin range, with 3 (60.00 %), while those with primary school level of education had nothing recorded. There is no significant difference in relation to educational status ($p<0.05$). The haematological parameter of the pregnant women not infected with malaria parasites, the distribution in relation to age showed that among those with normal haemoglobin the age range 22-26 years had the highest with 34 (12.06 %), while the age range 37 and above had the least with 9 (3.19 %). There is no significant difference in relation to age ($p<0.05$). The distribution in relation to occupation showed that among those not infected, the highest number of women with normal haemoglobin level are found in housewife with 54 (19.15 %), while the least were in farmers with 4 (1.42 %).

There is no significant difference in relation to occupation ($p<0.05$). The distribution in relation to educational level showed that among those not infected, the highest number of women with normal haemoglobin level are found in those with secondary level of education with 72 (25.53 %), while the least were in those with primary level of education with 6 (2.12%) There is no significant difference in relation to educational status ($p<0.05$) (Table 2).

The White Blood Cell (WBC) count of the infected pregnant women showed that the distribution of those with normal range in relation to age, 22-26 years and 32-36 years had the highest with 2 (100.00 %) each, while nothing was recorded for the age range 37 years and above. There is significant difference in relation to age ($p>0.05$). The WBC count distribution in relation to occupation showed that among those with normal WBC count, business women had the highest with 2 (66.67 %) women, while, civil servants, farmers and students had only 1 (50.00 %) woman each. There is no significant difference in relation to occupation ($p<0.05$). The WBC count distribution in relation to educational levels showed that, among those with normal WBC count, secondary school level had the highest with 6 (60.00 %) women, while those with primary school level of education had the least with only 1 (50.00 %) woman. There is no significant difference in relation to educational status ($p<0.05$). The WBC count of the pregnant women not infected with malaria parasites, the distribution in relation to age showed that among those with normal WBC the age range 27-31 years had the highest with 63 (22.34%), while the age range 37 and above had the least with 18 (6.38%). There is no significant difference in relation to age ($p<0.05$). The distribution in relation to occupation showed that among those not infected, the highest number of women with normal WBC level are found in housewife with 90 (31.91 %), while the least were in farmers with 10 (3.55 %). There is no significant difference in relation to occupation ($p<0.05$). The distribution in relation to educational level showed that among those not infected, the highest number of women with normal range of WBC level are found in those with secondary level of education with 119 (42.19 %), while the least were in those with primary level of education with 14 (4.96 %). There is no significant difference ($p<0.05$) in relation to educational status (Table 3).

Table 1: Distribution of Packed Cell Volume among Pregnant Women in General Hospital, Kaltungo

Variable	Positive with malaria				Not infected			
	Normal 33% ≥	Mild 26-32%	Moderate 19-25%	Severe ≤18%	Normal 33% ≥	Mild 26-32%	Moderate 19-25%	Severe ≤18%
Age								
17-21	2(40.00)	3(60.00)	0 (0.00)	0 (0.00)	31 (10.99)	16 (5.67)	3 (1.06)	0 (0.00)
22-26	1(50.00)	1(50.00)	0 (0.00)	0 (0.00)	52 (18.79)	21 (7.44)	2 (0.71)	0 (0.00)
27-31	4(66.66)	2(33.33)	0 (0.00)	0 (0.00)	53 (18.79)	31 (10.99)	4 (1.48)	0 (0.00)
32-36	1(50.00)	1(50.00)	0 (0.00)	0 (0.00)	28 (9.93)	13 (4.61)	0 (0.00)	0 (0.00)
37 ≥	2(100)	0 (0.00)	0 (0.00)	0 (0.00)	16 (5.67)	9 (3.19)	2 (0.71)	0 (0.00)
Occupation								
Business	1(33.33)	2 (66.66)	0 (0.00)	0 (0.00)	16 (5.67)	15 (5.32)	0 (0.00)	0 (0.00)
Civil servant	2(100)	0 (0.00)	0 (0.00)	0 (0.00)	34 (12.05)	11 (3.90)	2 (0.71)	0 (0.00)
Farmers	1 (50)	1 (50.00)	0 (0.00)	0 (0.00)	10 (3.55)	7 (2.48)	0 (0.00)	0 (0.00)
Housewife	4(50.00)	4 (50.00)	0 (0.00)	0 (0.00)	81 (28.72)	47 (16.67)	7 (2.48)	0 (0.00)
Student	2 (100)	0 (0.00)	0 (0.00)	0 (0.00)	40 (14.18)	10 (3.54)	2 (0.71)	0 (0.00)
Educational status								
Primary	1(50.00)	1(50.00)	0 (0.00)	0 (0.00)	13 (4.61)	8 (2.84)	0 (0.00)	0 (0.00)
Secondary	5(50.00)	5(50.00)	0 (0.00)	0 (0.00)	109 (38.65)	56 (19.86)	6 (2.12)	0 (0.00)
tertiary	4(80.00)	1(20.00)	0 (0.00)	0 (0.00)	59 (20.92)	26 (9.22)	5 (1.77)	0 (0.00)
Total	**10 (58.82)**	**7 (41.18)**	0 (0.00)	0 (0.00)	**181 (64.18)**	**90 (31.91)**	**11 (3.90)**	0 (0.00)

χ^2 infected women Age =2.41; Occupation = 3.93; Education = 1.31
χ^2 not-infected women Age =4.83; Occupation = 12.60; Education = 2.11

Table 2: Distribution of Haemoglobin among Pregnant Women in General Hospital, Kaltungo

Variable	Positive with malaria			Not infected		
	Normal >12.0 g/dl	Moderate anaemic 7.0-11.0 g/dl	Severe anaemic < 7.0g/dl	Normal >12.0 g/dl	Moderate anaemic 7.0-11.0 g/dl	Severe anaemic < 7.0g/dl
Age						
17-21	0 (0.00)	5(100)	0 (0.00)	22 (7.80)	27 (9.57)	1 (0.35)
22-26	1 (50.00)	1(50.00)	0 (0.00)	34 (12.06)	42 (14.89)	0 (0.00)
27-31	2(33.33)	4(66.66)	0 (0.00)	31 (10.99)	57 (20.21)	0 (0.00)
32-36	1(50.00)	1(50.00)	0 (0.00)	16 (5.67)	25 (8.87)	0 (0.00)
37 ≥	2(100.00)	0 (0.00)	0 (0.00)	9 (3.19)	17 (6.03)	1 (0.35)
Occupation						
Business	1(33.33)	2(66.66)	0 (0.00)	6 (2.13)	25 (8.87)	0 (0.00)
Civil servant	1(50.00)	1(50)	0 (0.00)	20 (7.09)	26 (9.22)	1 (0.35)
Farmers	0 (0.00)	2(100)	0 (0.00)	4 (1.42)	13 (4.61))	0 (0.00)
Housewife	3(37.50)	5(62.50)	0 (0.00)	54 (19.15)	80 (28.37)	1 (0.35)
Student	1(50.00)	1(50.00)	0 (0.00)	28 (9.93)	24 (8.51)	0 (0.00)
Educational status						
Primary	0 (0.00)	2(100)	0 (0.00)	6 (2.12)	15 (5.32)	0 (0.00)
Secondary	3(30.00)	7(70.00)	0 (0.00)	72 (25.53)	99 (35.11)	0 (0.00)
tertiary	3(60.00)	2(40.00)	0 (0.00)	34 (12.06)	54 (19.15)	2(0.71)
Total	**6 (35.29)**	**11 (64.71)**	**0 (0.00)**	**112 (39.72)**	**168 (59.57)**	**2(0.71)**

$\chi^2_{\text{infected women}}$ Age = 6.78; Occupation = 1.49; Education = 2.55

$\chi^2_{\text{not-infected women}}$ Age = 8.45; Occupation = 13.95; Education = 5.83

Table 3: Distribution of White Blood Cell among Pregnant Women in General Hospital, Kaltungo

Variable	Positive with malaria			Not infected		
	Low range <400 cell/µl	Normal range 4500-10000 cell/µl	High range ≥ 11000 cell/µl	Low range <400 cell/µl	Normal range 4500-10000 cell/µl	High range ≥ 11000 cell/µl
Age						
17-21	0 (0.00)	1(20.00)	4(80.00)	0 (0.00)	39 (13.83)	11 (3.90)
22-26	0 (0.00)	2(100)	0 (0.00)	0 (0.00)	48 (17.02)	28 (9.93)
27-31	0 (0.00)	5(83.33)	1(16.66)	0 (0.00)	63 (22.34)	25 (8.86)
32-36	0 (0.00)	2(100)	0 (0.00)	0 (0.00)	25 (8.86)	16 (5.67)
37 ≥	0 (0.00)	0 (0.00)	2(100)	0 (0.00)	18 (6.38)	9 (3.19)
Occupation						
Business	0 (0.00)	2(66.66)	1(33.33)	0 (0.00)	23 (8.16)	8 (2.84)
Civil servant	0 (0.00)	1(50)	1(50)	0 (0.00)	32 (11.35)	15 (5.32)
Farmers	0 (0.00)	1(50.00)	1(50.00)	0 (0.00)	10 (3.55)	7 (2.48)
Housewife	0 (0.00)	5(62.50)	3(37.50)	0 (0.00)	90 (31.91)	45 (15.96)
Student	0 (0.00)	1(50.00)	1(50.00)	0 (0.00)	38 (13.47)	14 (4.96)
Educational status				0 (0.00)		
Primary	0 (0.00)	1(50.00)	1(50.00)	0 (0.00)	14 (4.96)	7 (2.48)
Secondary	0 (0.00)	6(60.00)	4(40.00)	0 (0.00)	119 (42.19)	52 (18.44)
tertiary	0 (0.00)	3(60.00)	2(40.00)	0 (0.00)	60 (21.27)	30 (10.64)
Total	0 (0.00)	**10 (58.82)**	**7 (41.18)**	0 (0.00)	**193 (68.09)**	**89 (31.56)**

$\chi^2_{\text{infected women}}$ Age = 10.26; Occupation = 0.31; Education = 0.07

$\chi^2_{\text{not-infected women}}$ Age = 4.59; Occupation = 1.92; Education = 0.27

DISCUSSION

The overall prevalence of malaria from our study was lower when compared to the finding of Ndamukong-Nyanga *et al.* (2020) who recorded 35.51% prevalence in pregnant women. This prevalence as recorded in the present study may be due to adherence to measures in the use of insecticides treated bed nets (ITNs) and anti-malaria drugs given to the women. Our finding further reveals high prevalence of malaria in younger women, this corroborate the findings of Haruna and Daskum, (2018) who reported a higher prevalence in pregnant women between the ages of 25-29 years than older women, and Dicko *et al.* (2003) who revealed that teenagers and young adult pregnant women were more susceptible to malaria than older pregnant women. Dicko *et al.* (2003) further attribute the development of immunity to malaria in older women as a result of frequent infections as the cause of leading to low parasitaemia in adult women.

According to Garba *et al.,* (2015) haematological parameters such as PCV, TWBC and PLC are very important in the management of malaria infected patients. Malaria causes high incidence of morbidity and mortality in people living in the highly affected zones of Sub-Sahara. The disease causes alteration in different body components among which are the haematological indices (Anionye *et al.,* 2012). The report of the present study differ from the report of Garba *et al.* (2015), who reported that the PCV value is slightly lower in malaria infected subjects (about 38%) and Samje *et al.,* (2009) who recorded 45% decrease in PCV level among malaria infected patients in the University of Buea Cameroon. This decrease in PCV level (anaemia) may be due to some degree of haemolysis in malaria infected patients (Hoffbrand *et al.,* 2005). It may also be due to Normocytic, Normochromic anaemia (anaemia of chronic disease) seen in malaria infected subjects (Hoffbrand *et al.,* 2006). According to the WHO, anaemia is defined as Hb values of <12 g/dL in women. This is based on average Hb values in healthy individuals (Okafor *et al.,* 2016). In the present study more of the malaria infect women had moderate anaemia, this agrees with the report of Okafor *et al.* (2016) who found that malaria-infected participants were anaemic, with a low Hb value of 9.2 g/dL. This is also in agreement with the studies of Bhawna *et al.* (2013).

In this present study, the pregnant women infected with malaria parasites had normal range of White Blood Cell (WBC) count which is similar with the report of Okafor *et al.* (2016), who reported that, the mean WBC counts in the malaria-positive groups was near-normal, this contradict the report of Auta *et al.* (2016), who reported higher lymphocyte count among malaria infected subjects. Akinyele *et al.* (2016) also observed that there was decrease in total WBC count in the malaria patients compared to the control individuals. Garba *et al.* (2015) who showed that white cell count is slightly increased in malaria infected patients. The TWBC mean value of malaria infected patients was about 2 x 109/L greater than that of non-malaria infected students. Rise in white cell count was also reported in severe malaria (Hoffbrand *et al.,* 2005). This increase may also be due to neutrophilia reported in most cases of acute haemorrhage or due to monocytosis as seen in most cases of malaria infection (Cheesbrough, 2000). The high level of leucocytes in the present study could be due to its distribution into the peripheral blood during malarial infection. The findings of this study is in line with WHO (2005) report, which stated that the highest proportion of individuals affected by anemia were in Africa in both pregnant and non-pregnant women of childbearing age.

The anemic prevalence recorded among infected pregnant women in the present study is higher when compared with the prevalence of anemia reported in China 58.6% (Ma *et al.*, 2009). This might be due to the administration of iron supplement in health centers which is helpful in combating anemia during pregnancy or differences in study area

CONCLUSION

The study highlights the haematological parameters of pregnant women infected with malaria parasites. It showed that few women (5.67 %) had malaria parasites, among these infected women; the highest percentage of those with normal range of PCV and haemoglobin are the older women (37 ≥ years and above)

REFERENCES

Akinyele, O. O., Isoje, A.O. Onumaegbu, P.U., Omokaro E. U., Anioye C. J. and Oghagbon, S.E. (2016). Effect of Antimalarial Drugs on Haematological Indices of Malarial Patients. *African Journal of Basic and Applied Sciences,* 8 (1): 01-12.

Anionye, J.C., Edosa, R.O., Omorowa, E.F. Onyeneke, E.C. Dunkwu, J., Onovughakpo-Sakpa O.E. (2012). Oxidative stress in human malaria patients. *Nigerian Society for Experimental Biology Journal,* 12(2): 74-80.

Auta, T., Runka, J.Y., Bawa, J.A. and Sa'adatu, S.K. (2016). Haemoprevalence of malaria and haematological parameters of febrile patients in a hospital in Dutsin-Ma town, North Western Nigeria. *Biosciences Research in Today's World*, 2: 8-14.

Bhawna, S., Bharthi, A., Yogesh, K., and Reena, A. (2013). Parasitemia and hematological alterations in malaria: A study from the highly affected zones. *Iranian Journal of Pathology*, 8(1):1-8.

Bisseru R (1985) Chloroquine Resistant in Africa Post Graduate Doctor. Africa Fed 58-64.

Bodeau-Livinec, F., Briand, V., Berger, J., Xiong, X., Massougbodji, A., Day, K.P. and Cot, M. (2011). Maternal Anaemia in Benin: prevalence, risk factors and association with low birth weight. *American Journal of tropical Medicines and Hygiene,* 85: 414-420.

Brabin, B.J., Eggelte, T.A., Parise, M. and Verhoeff, F. (2004). Dapsone therapy for malaria during pregnancy: maternal and fetal outcomes. *Drug Safety*, 27(9): 633-648.

Cheesbrough, M. (2000). District Laboratory Practice in Tropical Countries. Cambridge, UK: Cambridge University Press; Part (2) 314-318.

Cheesbrough, M. (2006). District Laboratory Practice in Tropical Countries: Cambridge University Press. 116-130.

de Benoist, B., McLean, E., Egli, I. and Cogswell, M. (2008). Worldwide prevalence of anaemia 1993–2005. WHO Global Database on Anaemia. Geneva: World Health Organization.

Desai, M., ter Kuile, F.O., Nosten, F., McGready, R., Asamoa, K., Brabin, B. (2007). Epidemiology and burden of malaria in pregnancy *Lancet Infectious Disease,* 7:93-104

Dicko, O.A., Hawley, W., and Vulule, J, (2003) Factors affecting the use of Permethrin treated Bed nets during a Randomized Controlled trial in Western Kenya. Am J Trop Med Hyg 68: 432-440

Ekejindu, I.M., Udigwe, G.O. and Chijioke, I.R.C. (2006). Malaria and anaemia in pregnancy in Enugu Southeastern Nigeria. *African Journal of Medical Science*, 13: 351-353.

Garba, N., Danladi, S.B. and Muhammad, A. (2015). Determination of some haematological parameters in malaria Infected subjects in Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 8(1): 80 – 83

Glover-Amengor, M., Owusu, W. B. and Akanmori, B. D. (2005). Deteriments of Anaemia in Pregnancy in Sekyere West District, Ghana. *Ghana Medical Journal,* 39(3): 102-107.

Haruna, A. and Daskum, A.M. (2018) Malaria and Haematological Parameters of Pregnant Women Attending General Hospital Geidam, Yobe State, Nigeria. *Vector Biol J* 2(2):54-57

Hoffbrand, A. Victor, D. and Edward, G.D.T. (2005). Postgraduate Haematology. 5th ed. Massachusetts, USA: Blackwell publishing Ltd; 976, 981-2, 985.

Koura, G.K., Ouedraogo, S., Le Port, A., Waiter, L., Cottrell, G., Guerra, J. (2012). Anaemia during pregnancy: impact on birth and infant haemoglobin level during the first 18 months of life. *Tropical Medicine of International Health*, 17:283-291.

Ma, A.G., Schouten, E., Wang, Y., Li, Y., Sun, Y.Y. and Wang, Q.Z. (2009). Anemia prevalence among pregnant women and birth weight in five areas in China. *Medical Principle Practice*, 18:368-372.

Meseret, A., Bamlaku, E., Aschalew, G., Tigist, K., Mohammed, S. and Yadessa, O. (2013). Prevalence of anemia and associated risk factors among pregnant women attending antenatal care in Azezo Health Center Gondar town, Northwest Ethiopia. *Journal of Interdisciplinary Histopathology*, 1(3): 137-144

Ndamukong-Nyanga, J.L., Gisele, C., Miangu, W., Nyanga, B.Y., Nchangsen, J. and Ngum, C.N. (2020). Malaria Parasitaemia and Variations in Haematological Parameters among Pregnant Women in Buea. *International Journal of Pathogen Research.* 4(3): 8-16

Obaje, N. G. and Hamza, H. (2000) Liquid hydrocarbon sourcerock potential of mid-Cretaceous coals and coal measures in the Middle Benue Trough of Nigeria. *International Journal of Earth Sciences* 89, 130–139.

Okafor, U. E. Tsoka-Gwegweni, J. M., Bibirigea, A., Irimie, A., Tomuleasa, C. S. (2016). Parasitaemia and haematological changes in malaria-infected refugees in South Africa. *African Medical Journal*, 106(4): 413-416.

Samje, M., Sumbele, I.U., Nkuo-Akenji, T. (2009). A longitudinal study on anaemia in children with *Plasmodium falciparum* infection in the Mount Cameroon region: prevalence, risk factors and perceptions by caregivers. *BMC Infect Dis.* 13:123. doi: 10.1186/1471-2334-13-123

Sarmukaddam, S. and Garad, S. (2006). On validity of assumptions while determining sample size. *Indian Journal of Community Medicine*, 29:87-91

Sood, R. (2006). Textbook of Medical Laboratory Technology. First Edition. Jaypee Medical Publisher, New Delhi, India.

World Health Organization. (2005). Deworming for health and development. Report of the Third Global Meeting of the Partners for Parasite Control, Geneva, 29-30 Nov 2004. Geneva: World Health Organization.

WHO. (2008). United Arab Emirates. Statistics. Total Population. Available from: http://www.who.int/countries/are/en