

# Severity and Prevalence of Malaria Infection and Effect of Anti-Malaria Drugs on Gender Differences Using Some Haematological Parameters

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**Abstract** Malaria is a major cause of morbidity and mortality in developing countries, accounting for an estimated of 300 to 500 million morbid episodes and 2 to 3 million death per year worldwide. The aim of the study is to determine severity and prevalence of malaria infection and effect of anti-malaria drugs on gender differences using haematological parameters. 202 confirmed malaria infected patients were recruited for the study between the ages of 15 – 64 years of both sexes at the general outpatient clinic of the Federal Medical Centre, Ido-Ekiti, Ekiti State, Nigeria. 4 ml of blood sample was collected twice from the same patient before and after taking anti-malaria drug into di-potassium ethylenediaminetetraacetic acid (K2EDTA) vacuitaner bottles for haematological analysis using haematology analyzer. Malaria parasite detection, malaria parasite count and malaria parasite species identification were also carried out. Out of the 202 malaria infected patients 129 (63.9%) were males and 73 (36.1%) were females. Mean+ SD of RBC, HB, PCV, MCV and MCHC in male were lower compared to female in pre and post anti malaria drug treatment; however, in control subjects mean+ SD of RBC, HB, PCV, MCV and MCHC in male were higher compared to female, the comparism shows significant difference ( $P<0.05$ ). Severity and prevalence of malaria infection is more observed in male compared to female these might be as a result of different exposure to malaria vector.

**Keywords:** malaria parasite, gender, anti-malaria drug

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## 1. Introduction

Malaria is a major cause of morbidity and mortality in developing countries, accounting for an estimated of 300 to 500 million morbid episodes and 2 to 3 million death per year worldwide [1,2,3]. There are four main types of parasite that cause human malaria - *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale* and *Plasmodium falciparum*. *Plasmodium falciparum* malaria is the most deadly and is most common in sub-Saharan Africa, accounting in large part for the extremely high malaria-related mortality in this region [4]. Artemisinin is widely used as an agent to treat malaria; during recent years this compound and several derivatives have emerged as the most potent anti-malaria agents, being especially active against chloroquine-resistant malaria strains [5]. The mode of action of artemisinin on *plasmodium falciparum* has been associated with the generation of oxidative stress. Artemisinin-based combination therapies (ACTs) are the best anti-malaria drugs available now. World Health Organization has recommended that artemisinin combination therapies (ACT) be first-line therapy for malaria worldwide [6]. Combinations are

effective because the artemisinin component kills the majority of parasites at the start of the treatment while the more slowly eliminated partner drug clears the remaining parasites [7]. Artemisinin enhances efficacy and has the potential of lowering the rate at which resistance emerges and spreads. The anti-malaria activity of artemisinin and its derivatives is extremely rapid and most patients show clinical improvement within 1-3 days after treatment. All artemisinins used today are pro-drugs of the biologically active metabolite di-hydro artemisinin, which is active during the stage when the parasite is located inside red blood cells. When the parasite that causes malaria infects a red blood cell, it consumes haemoglobin within its digestive vacuole, liberating free haeme, an iron-porphyrin complex. According to one theory about the action of artemisinin, the iron of the haeme reduces the peroxide bond in artemisinin, generating high-valent iron-oxo species and resulting in a cascade of reactions that produce reactive oxygen radicals which damage the parasite and lead to its death [8]. Despite prevention and control efforts, malaria still remains a leading cause of morbidity and mortality worldwide. The true burden of malaria is difficult to estimate as many people are treated at home and no proper post-mortem diagnosis is made in the case of death. As a result, many malaria cases go

unreported. A gender approach contributes to both understanding and combating malaria. Gender norms and values that influence the division of labour, leisure patterns, and sleeping arrangements may lead to different patterns of exposure to mosquitoes for men and women. In some societies, men tend to sleep outdoors and this may increase their risk of exposure to mosquitoes [9]. There are also gender dimensions in the accessing of treatment and care for malaria, and in the use of preventative measures such as mosquito nets. A thorough understanding of the gender-related dynamics of treatment-seeking behaviour, as well as of decision-making, resource allocation and financial authority within households is key to ensuring effective malaria control programmes. Therefore, gender and malaria issues are increasingly being incorporated into malaria control strategies in order to improve their coverage and effectiveness in different contexts. In some societies, men have a greater occupational risk of contracting malaria than women if they work in mines fields or forests at peak biting times, or migrate to areas of high endemicity for work [10]. Women who get up before dawn to perform household chores may also be exposed to mosquitoes and consequently to malaria infection [11]. In other societies, the activities of men and women during peak biting times may result in equal risks of infection. For example, a study in Myanmar on activities that enhance human-vector contact revealed that gender-specific patterns of both leisure and work activities during peak biting periods by men and women placed them at equal risk of contracting malaria through exposure to mosquitoes [12]. The division of labour as a result of gender roles may play a significant part in determining exposure to mosquitoes. Understanding how gendered patterns of behaviour influence exposure to mosquitoes can therefore assist in developing more-effective recommendations for preventing malaria infection. Microscopic examination of stained blood films is the gold standard for routine malaria diagnosis. Parasite density has to be reliably evaluated in order to deal with discriminatory thresholds of parasitemia. Besides, parasite counts are important especially in *Plasmodium falciparum* infections, which are always considered as potentially dangerous because *Plasmodium falciparum* infects erythrocytes of any age with the potential of development of high-grade parasitaemia, due to the rapid multiplication of this parasite, the parasite count can increase up to 20-fold over a period of 48 hours without treatment. For continued survival and reproduction, plasmodium parasites need to infect the red blood cells of their human host. Consequently, changes in the red blood cell indices are some of the commonest observations seen in malaria. Anaemia, which is a fall in haemoglobin level below the normal range for age, sex, race or pregnancy status, is the most frequent outward manifestation of such changes. Malaria is the most common cause of severe anaemia in endemic area [13]. Anaemia in malaria is believed to occur due to haemolysis of parasitized and non-parasitized red blood cells peripheral removal or sequestration of red blood cells and ineffective erythropoiesis (due to high circulating tissue necrotic factor) [13,14]. In malaria endemic areas, the prevalence and severity of anaemia are usually determined by a number of interacting factors; these include, among others, the parasite species, level of parasitemia, age of

host, host genetic factors (e.g. co-existing red blood cell polymorphisms like haemoglobinopathies, G6PD) and non malaria cases of anaemia (e.g. infections, malnutrition) [13]. In the clinical setting, the level of parasitaemia is useful as one of the criteria in defining “severe *P. falciparum* malaria” and to monitor the effect of anti-malaria therapy [15]. A clinical malaria was defined as *Plasmodium falciparum* parasitaemia  $>2,500$  parasites/ $\mu$ l and axillary temperature  $\geq 37.5^{\circ}\text{C}$  or reported fever over the previous 24 hours. Haematological changes are some of the most common complications in malaria and they play a major role in malaria pathology. These changes involve the major cell lines (red blood cells, leucocytes and thrombocytes) [16,17]. An understanding of these haematological changes will help in diagnosis, treatment and may also serve to predict and prevent various complications. Haematological parameters alterations that are thought to characterize malaria may be related to the overt biochemical changes that occur during the asexual stage of the life cycle of the malaria parasite. Entry of *Plasmodium falciparum* into erythrocytes usually leads to a marked increase in secretion of inflammatory cytokines (TNF IL-1, IL-10 and IFN), endothelial cell activation (due to over expression of cell adhesion molecules, ICAM-1, VCAM-1), activation of the coagulation cascade (due to platelet consumption and endothelial damage) and sequestration of parasitized red blood cells (due to over expression of cell adhesion molecules, pfEMP). These along with other mechanism set in motion events that ultimately result in morphological and numerical changes in the different blood cell lines. During the past decades, various efforts to replace the traditional blood film for the diagnosis of malaria have revived interests in the possibility of using routine haematological blood parameters to aid the presumptive diagnosis of malaria infection [18]. Alterations in the haematological parameters are also thought to have the capacity to act as an adjuvant tool in strengthening the suspicion of malaria, thereby prompting a more meticulous search for malaria parasites [19]. Although the diagnostic implications of the changes in haematological parameters of patients with severe *Plasmodium falciparum* malaria have been clearly mentioned from prior studies, there is still a lack of evidence regarding their diagnostic relevancy in uncomplicated *Plasmodium falciparum* malaria. The aim of the study therefore is to determine severity and prevalence of malaria infection and effect of anti-malaria drugs on gender differences using haematological parameters in adult patients with acute uncomplicated malaria attending our hospital facility.

## 2. Materials and Methods

### 2.1. Study Location

The study site was Ido town, the headquarters of ido-osi local government in Ekiti State, Nigeria. The secretariat is sited in between Ido town and Usi town. It is very close to other local government districts, (Moba, Ijero, Ilejemeje and Ado). The local government comprises rural towns: Aaye, Ido, Usi, Ayetoro, Ilogbo, Osi, Ifaki, Orin, Ora, Igbole and some other smaller villages, inhabited mainly by the Ekitis, but with some non-Ekitis living

peacefully among the people. People in Ido - Osi cherish farming, education, trading and practicing majorly Christianity religion. According to 1991 Census, the Local government has a total population of 107,000 people with eleven electoral wards in the Local government. The climate is characterized by two main seasons; the rainy and the dry season, the rainy season starts in March to October while the dry season is between November to February. The total rainfall in the area is 450 mm giving a mean monthly rainfall of 121 mm. There is a sharp fall in rainfall at a period between July and August. Temperature in the region is high throughout the year with a means monthly temperature of 27°C and a range of 3.7°C between the month of highest temperature (February) and the month of lowest (August).

## 2.2. Subjects Selection

Two hundred and two confirmed malaria infected patients were recruited for the study between the ages of 15 – 64 years of both sexes at the general outpatient clinic of the Federal Medical Centre, Ido-Ekiti, Ekiti State, Nigeria. One hundred and two apparently healthy malaria negative subjects were used as control from hospital staff at Federal Medical Centre, Ido-Ekiti which serves as study control group and comprising both sexes between the ages 15 – 64 years; dosage of anti-malaria drug was prescribed by the physician. The study was conducted with an informed consent of the patients, ethical approval was obtained from ethical committee of Federal Medical Centre, Ido-Ekiti, Ekiti State.

## 2.3. Sample Collection

About 4 ml of blood sample was collected from each subject on the first day of visiting hospital as baseline sample grouped as pre anti-malaria drug treatment sample, after the patient has been clinically diagnosis for malaria infection and confirmed using malaria rapid kit, another 4ml of blood sample was collected on the second or third day from the same patient after taking anti-malaria drugs then grouped as post anti-malaria drug treatment sample. Blood sample collected was dispensed into di-potassium ethylenediaminetetraacetic acid (K<sub>2</sub>EDTA) vacuitaner bottles used for haematological parameters analysis using haematology analyzer (Sysmex model KX-21N) and to screen for malaria parasite using commercially prepared malaria rapid test kit; also thick and thin blood film was made for microscopic gold standard diagnosis of malaria parasite infection; for malaria parasite detection, malaria parasite count and malaria parasite species identification.

Questionnaire was used to obtain the demographic characteristics and other relevant information for the study.

## 3. Methodology

### 3.1. Diagnosis of Malaria Parasite Using a Rapid Diagnostic Kit Test

Malaria *plasmodium falciparum* was screened for using commercially prepared malaria rapid test kit. The test device is a rapid chromatographic immunoassay for the qualitative detection of circulation of *plasmodium falciparum* in whole blood.

#### 3.1.1. Principle

The malaria *plasmodium falciparum* rapid test device (whole blood) is a qualitative, membrane based immunoassay for the detection of *plasmodium falciparum* antigen in whole blood. The membrane is pre-coated with anti-HRP-II antibody. During testing, the whole blood specimen reacts with the dye conjugate, which has been pre-coated in the test strip. The mixture then migrates upward on the membrane chromatographically by capillary action and reacts with anti-HRP-II antibody on the membrane on the test line. If the specimen contains HRP-II, a coloured line will appear in the test region. The absence of the coloured line in the test region indicates that the specimen does not contain HRP-II. To serve as a procedure control, a coloured line will always appear in the control region indicating that proper volume of specimen has been added and membrane wicking has coloured.

#### 3.1.2. Procedure

The procedure was as described by the manufacturer of the kit (Acon Laboratories, Inc.). 20 ul of whole blood was pipette into clean labelled test tube, 120 ul of buffer solution was added and waited for 1 minutes, contents in the test tube was mixed, 140 ul of mixed blood sample and buffer solution was pipette into specimen well on test device and wait for colour line(s) to appear. The result was read at 15 minutes. Interpretation of results: for positive result, two distinct coloured lines were appeared: one line was in control region and another line was in test region. For negative result: only one coloured line was appeared in the control region, result was invalid if control line fails to appear

### 3.2. Microscopic Diagnosis of Malaria Parasite Using Thick And Thin Stained Blood Film

#### 3.2.1. Thick and Thin Stained Blood Film

Thick blood film was made from EDTA blood sample and stained using Giemsa's staining technique for malaria parasite detection and malaria parasite count. However, thin blood film was also made from well mixed anticoagulated EDTA blood sample and stained with Leishman staining technique for plasmodium species identification. Changes in parasitized red cells help to identity plasmodium species and to detect mixed infection of malaria parasite. The number of asexual *P. falciparum* and other species per 200 leukocytes were counted and if ten or more parasites were identified, then the number was recorded, a blood sample was regarded as negative if the examination of thick films failed to show the presence of asexual parasites. The parasite count in relation to the leukocyte count was converted to parasite per micro litre of blood using this mathematical formula;

$$\frac{\text{Number of parasites}}{\text{Number of leukocytes}} \times \text{Total WBC count} \\ = \text{Parasite per micro litre of blood.}$$

#### 3.2.2. Principle of the Staining

Staining usually take place at a neutral pH. pH of blood is 7.4, when buffered at pH 6.8, it brings the pH to neutral

pH i.e. pH 7.0. Unlike charges of stain and blood will attract, the basic part of stain methylene blue stained the acidic part of the cell i.e. the nucleus while the acidic part of stain eosin stained the basic part of the stain i.e. cytoplasm.

### 3.2.3. Procedure for Staining Thick Blood Film

The procedure was described by Monica Cheesbrough, 2005 [20]. 3% of stock Giemsa stain was diluted in buffered water immediately before use. Thick blood film was made on clean grease free glass slide, allowed to air-dry and stained with prepared Giemsa stain for 30 minutes. Stained slide was rinsed in clean water and allow air-drying before examined under microscope using X100 objective lens. Chromatin of malaria parasite stained dark red and cytoplasm stained blue with Giemsa's stain. The diagnosis of malaria was made with certainty on identification of malaria parasite together with other symptoms associated with malaria infection. The signs and symptoms of malaria infection in humans are caused by the asexual blood stage of the parasite which includes: fever, headache, joint pains, abdominal upset, nausea, vomiting, diarrhoea, and digestive disorders.

The presence of malaria parasite, identification of the species of human parasites and relative malaria parasite count in each blood sample was determined from Giemsa stained thick films and Leishman stained thin blood film. Malaria Parasitaemia was confirmed by microscopic examination using X100 objective lens (oil immersion lens). Malaria Parasitaemia was graded as + = 1 – 10 parasites per 100 thick film field, ++ = 11 – 100 parasites per 100 thick film field, +++ = 1 – 10 parasites per single thick film field, ++++ = more than 10 parasites per single thick film field after staining for 30 min. Identification of the species of human parasites in the blood films was carried out according to WHO method. A slide was scored as negative when 100 high power fields had been examined for about 30 minutes without seeing any parasites. The amount of relative parasite count in positive smears was done using a simple code from one to four crosses (+ - ++++) [21].

### 3.2.4. Procedure for Staining Thin Blood Film

Thin blood film was made on clean grease free glass slide and stained using Leishman staining technique; the procedure was described by Monica Cheesbrough, 2005 [20]. Thin blood film was made from well mixed EDTA anticoagulated blood; the film was allowed to air dry and flooded with Leishman stain for 3 minutes. The slide was diluted with buffered distilled water and allowed to stain for 10 minutes. Slide was rinsed with water; back of the slide was cleaned with dampened cotton wool in ethylated spirit. The slide was allowed to air dry and examined under microscope using X100 objective lens.

## 3.3. Malaria Parasite Count

The determination of the number of circulating parasites is exceedingly important for clinical purposes to monitor the evolution of the disease and the efficacy of therapy. Quantitative parasitaemia count (Parasite density) was determined by counting the number of asexual parasites (trophozoites, schizonts) present in as many microscopic fields (100x) necessary to count 200

leukocytes in each thick blood film and multiplies by the total white blood cells count of each blood sample. Parasitaemia was graded as low (parasite  $<1000 \mu L^{-1}$ ), moderate ( $>1000-9,999 \mu L^{-1}$ ) and high ( $>10,000 \mu L^{-1}$ ). [22].

$$\text{parasites / ul of blood} = \frac{\text{Number of observed asexual parasites} \times \text{total WBC count / ul}}{200(\text{Number of leucocytes counted})}$$

## 3.4. Haematological Parameters Analysed Using Haematology Analyser (Sysmex Automated Haematology Analyser Model Kx-21n, Manufactured by Sysmex Co-Operation Kobe, Japan)

### 3.4.1. Principle

The aspirated blood sample is measured to a predetermined volume diluted at the specified ratio and then fed into each transducer chamber, which has a minute hole aperture and also contains electrodes through which direct current flows. Blood cells suspended in the diluents sample, pass through the aperture, causing direct current resistance to change between the electrodes, blood cell size is detected by electric pulses. Blood cell count is calculated by counting the pulses and the histogram determined by the pulse sizes

### 3.4.2. Procedure

Sysmex machine was inspected (for instrument, reagents, waste bin and printer paper) before switch on the machine from power source, machine was calibrated before used and control sample was run along each batches of sample analysis. Well mixed EDTA blood sample was used for the analysis of complete blood count, blood sample was aspirated through the sample probe one after another by pressing start switch, sample was analyzed, rinsed and display the result on the LCD screen of the machine also printed the results out. After the analysis, machine was shut down by aspirating cell clean which washed and rinsed the machine before finally shutdown and switch off from the power source

## 4. Statistical Analysis

Results obtained were analyzed using student t-test to compare the means. Analysis was performed using computer database software from the statistical package for social sciences (version 16.0 SPSS). A P-value of  $< 0.05$  was considered statistically significant in all clinical comparisons at 95% confidence interval.

## 5. Results

Most of the participants were from rural residence and all of them were infected with *Plasmodium falciparum* species; patients without malaria parasite in their blood were disqualified from the study. Out of the 202 malaria infected patients 129 (63.9%) were males and 73 (36.1%)

were females; in control subjects 58 (56.9%) were males and 44 (43.1%) were females. Mean $\pm$  SD of red blood cell count (RBC), haemoglobin concentration (HB), packed cell volume (PCV), mean corpuscle volume (MCV) and mean corpuscle haemoglobin concentration (MCHC) in male were lower compared to female in pre and post anti malaria drug treatment; the difference was significant ( $P<0.05$ ) except in red blood cell (RBC) post anti-malaria treatment; however, in control subjects mean $\pm$  SD of red blood cell (RBC), haemoglobin concentration (HB), packed cell volume (PCV), mean corpuscle volume (MCV) and mean corpuscle haemoglobin concentration (MCHC) in male were higher compared to female. The difference was significant ( $P<0.05$ ) except in mean corpuscle volume (MCV) and mean corpuscle haemoglobin concentration (MCHC). Mean $\pm$  SD of red blood cell, haemoglobin concentration, packed cell volume, mean corpuscle volume and mean corpuscle haemoglobin concentration in both sexes for post anti-malaria drug treatment was lower compared to pre anti-malaria drug treatment and control subjects. Mean $\pm$  SD of mean corpuscle haemoglobin in male was lower compared to female in pre and post anti-malaria drug treatment; the difference was not statistically significant ( $P>0.05$ ), also in control subjects, Mean $\pm$  SD

of mean corpuscle haemoglobin in male was higher compared to female, the difference was not significant ( $P>0.05$ ). The Mean $\pm$  SD of mean corpuscle haemoglobin in both sexes for post anti-malaria drug treatment was lower compared to pre anti-malaria drug treatment and control subjects. Mean $\pm$  SD of WBC in male was higher compared to female in pre, post anti malaria drug treatment and control subjects. The difference was significant ( $P>0.05$ ) except in control subjects. Mean $\pm$  SD of WBC in both sexes for pre anti malaria drug treatment was higher compared to post anti malaria drug treatment and control subjects. Mean $\pm$  SD of MPC in male was significantly ( $P<0.05$ ) higher compared to female in pre and post anti- malaria drug treatment. Mean $\pm$  SD of MPC for pre anti-malaria drug in both sex was significantly ( $P<0.05$ ) higher compared to post anti-malaria drug treatment. Since control subject were at infected with malaria, hence MPC was null. The Mean $\pm$  SD of RDW in male was higher compared to female in pre and post anti-malaria drug treatment; the difference was not statistically significant ( $P>0.05$ ), however in control subjects; mean $\pm$  SD of RDW in male was significantly ( $p<0.05$ ) lower compared to female as shown in Table 1.

**Table 1. mean $\pm$ sd of gender differences on haematological parameters in pre treatment, post-antimalaria drug treatment in malaria infected subjects and controls**

Parameters	Pre Treatent			Post Treatment			Control		
	Male (N=129)	Female (N=73)	P value	Male (N=129)	Female (N=73)	p. value	Male (N=58)	Female (N=44)	p. value
RBC $\times 10^9/L$	4.22 $\pm$ 0.52	4.64 $\pm$ 0.42	0.03*	4.01 $\pm$ 0.49	4.42 $\pm$ 0.48	0.49	4.93 $\pm$ 0.66	4.27 $\pm$ 0.36	0.00*
HB g/dl	11.16 $\pm$ 1.82	12.88 $\pm$ 1.63	0.01*	10.12 $\pm$ 1.99	12.24 $\pm$ 1.77	0.00*	14.17 $\pm$ 1.52	13.19 $\pm$ 0.67	0.00*
PCV%	33.56 $\pm$ 5.47	38.69 $\pm$ 4.81	0.00*	30.33 $\pm$ 5.98	36.55 $\pm$ 5.19	0.00*	42.79 $\pm$ 4.26	39.50 $\pm$ 1.84	0.00*
MCV fl	76.68 $\pm$ 5.85	81.79 $\pm$ 4.63	0.02*	74.53 $\pm$ 5.71	79.42 $\pm$ 4.80	0.04*	83.42 $\pm$ 10.55	79.87 $\pm$ 11.33	0.81
WBC $\times 10^9/L$	6.82 $\pm$ 1.81	6.45 $\pm$ 1.37	0.00*	6.08 $\pm$ 2.14	5.44 $\pm$ 1.52	0.00*	4.49 $\pm$ 0.30	4.33 $\pm$ 0.35	0.24
MPC $\mu/l$	2643.00 $\pm$ 474.85	2602.20 $\pm$ 281.73	0.00*	2373.40 $\pm$ 625.99	2184.50 $\pm$ 300.35	0.00*	-	-	-
RDW%	14.45 $\pm$ 2.03	13.28 $\pm$ 1.90	0.72	13.75 $\pm$ 1.97	12.64 $\pm$ 1.94	1.00	12.69 $\pm$ 1.38	14.31 $\pm$ 0.85	0.00*

$P<0.05$  significance,  $P>0.05$  no Significant, F (P-value) = mean + SD of parameters compared using ANOVA

## 6. Discussion

Previous studies involving patients with malaria had demonstrated that a reduced platelet count, reduced white blood cell counts and decrease red blood cell indices had relatively good sensitivities and specificities in predicting the presence of malaria infection [16,23]. However, results from this present study is similar to this fact, with a reduction in haematological parameters in malaria infected adult individuals compared to non-malaria adult individuals (control subjects) which showed sensitivities and significant in the haematological parameters. Severity and prevalence of malaria infection is more observed in male compared to female these might be as a result of different exposure to malaria vector, this was supported by Akanbi *et al.*, 2010 [28] stated that, the prevalence of *Plasmodium* infection was reportedly higher in male than in female malaria infected patients, He concluded that the cause could be due to the fact that males expose their bodies more than females when the weather is hot and thus increases their chances of being bitten by the mosquito. Females, on the other hand, are usually not

naked and tend to stay indoors, helping out with household chores. This reduces their contact with the malaria vector. Also, studies have shown that females have better immunity to parasitic diseases and this was attributed to genetic and hormonal factors [25]. The observed significantly lower malaria infection severity and prevalence among females compared to males in this present study also consistent with finding from other studies; although the cause of these sex differences merits further investigation; including the possibility that males produce more attractive chemicals for mosquitoes, the production of estrogens by females have been shown to augment anti-plasmodia immune response [26] whereas, testosterone suppresses anti-plasmodia immune responses [27]. In our society, men have a greater occupational risk of contracting malaria than women; work in mines fields or forests at peak biting times, or migrate to areas of high endemicity for work might contributed to high prevalence and severity of malaria infection in men compared to women as observed in this study. Gender dimensions in the assessment of treatment and care for malaria, and in the use of preventative measures such as mosquito nets contributed to severity and prevalence of malaria among

the gender. The acceptability and use of Insecticide Treated Nets (ITNs) are strongly linked to culturally accept sleeping patterns, in which gender plays an important role. In some instances, young children sleep with their mother and are therefore protected by her bed net if she has one. Alternatively, hence men have very little access to ITNs if they predominantly sleep outside [28]. However, in some settings males utilize health care services less than females. For example, a study in Papua New Guinea found that adolescent (10-19 year-old) and adult (20-40 year-old) women were more likely than similarly aged men to walk long distances to obtain malaria treatment at a clinic [29]. The study estimated that 37% of infected adolescent males did not attend for care because of the distance to the clinic. Only 3.8% of infected adolescent females were deterred by distance. It was suggested that men may assign a low priority to their health, making them reluctant to spend much time walking to a health centre even when malaria is suspected. On the other hand, the same men indicated that they might readily attend a clinic if it was nearby; this fact is contrary to the prevalence of malaria infection recorded among the gender in this present study with more male than female visiting the hospital. Severity of malaria infection during post anti-malaria drug treatment on haematological parameters in this present study was observed higher compared to pre anti-malaria drug treatment due to effect of anti-malaria drug which cause red blood cell destruction leading to haemolysis of parasitized red blood cells, accelerated removal of both parasitized and innocently un-parasitized red blood cells causing an increased rate of red blood cells clearance from the circulation [30,31]. The wide-spread use of more effective anti-malaria would probably result in greater clinical and haematological benefits. After the recovery period of malaria infection, MCV, MCHC and MCH are expected to be decrease as artemisinin drugs are reported to cause less anti-malaria drug-related falls in haematocrit during treatment [32].

## 7. Conclusion

Severity and prevalence of malaria infection is more observed in male compared to female, these might be as a result of different exposure to malaria vector. However, effect of anti-malaria drug causes red blood cell destruction leading to haemolysis of both parasitized and some un-parasitized red blood cells causing an increased rate of red blood cells clearance from the circulation, resulting into reduction of haematological parameters during anti-malaria drug treatment.

## 8. Recommendation

Men and women should be meaningfully involved in advocacy and education around malaria infection through participatory approaches such as peer education initiatives. Education sessions should be developed alongside treatment, with messages targeted at different groups including men, women, adolescents male, adolescents female, schoolchildren and pregnant women. Education sessions could focus not only on early recognition to

malaria infection, but also encourage prevention, more equitable household decision making and the sharing of care giving activities

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