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Impact of *Plasmodium falciparum* infection on some haematological parameters in a malaria endemic population, Southeastern Nigeria

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ABSTRACT

Objective: To compare changes in some haematological parameters among malaria positive and negative subjects in a malaria endemic community, Southeastern Nigeria.
Methods: Haematological parameters of 443 subjects including 234 confirmed malaria infected and 209 non-malaria infected patients who attended various hospitals in selected communities of Ezinihite L.G.A, Southeastern Nigeria between January and June 2014 were evaluated.
Results: Total white blood count and two of its differentials (lymphocytes and granulocytes), red blood cell and platelet counts were significantly lower among malaria-infected subjects compared to the non-infected subjects ($P < 0.05$)
Conclusions: Haematological parameters of malaria infected subjects were significantly lower than that of uninfected individuals. This present research adds to the fact that haematological parameters is a good and reliable indicator for the early and prompt diagnosis of malaria in patients.

1. Introduction

In the present time, there has been continued and sustained effort at eradicating malaria globally. Despite all strategies employed, the disease is still a major health challenge mainly in tropical and subtropical regions of the world. Globally, approximate 214 million cases of malaria have been reported yearly not including 3.2 billion people that are at risk of the infection. The World Health Organization attributes 438 000 deaths specifically to malaria in the year 2015. Nigeria is known to account for the World's greatest malaria burden accounting for 26%–29% of the global deaths and 55% of estimated malaria cases[1]. Most times disease conditions such as malaria tend to influence haematological parameters, which presents itself with various clinical presentations depending on the severity of the infection on the human body. During the pathogenesis of malaria infection in the body of humans, some of the complications that usually occur include haematological changes that involve the major cell types such as red blood corpuscles (RBCs), leucocytes and thrombocytes[2,3]. Quite a numbers of malaria induced complications that includes anaemia, thrombocytopaenia and leukocytosis have been established[4]. The degree of alterations of these complications will usually be connected to the level of malaria in the body system, endemicity of the infection in the area concerned, the nutritional status of the individual, background haemoglobinopathy, demographic factors and the level of immunity to malaria infection[5]. Although some studies have been done in some parts of Nigeria on the haematological indices of malaria infected individuals[6-9], there is

however no information on the impact of *Plasmodium falciparum* on haematological indices of malaria infected individuals in the study area. The present paper aimed to investigate the impact of *Plasmodium falciparum* on haematological parameters among inhabitants of Ezinihite Local Government Area, Imo State, Nigeria.

2. Materials and methods

2.1. Description of study area

This investigation was carried out in four communities under Ezinihite Local Government Area, Imo State, Nigeria (Longitude 6°50' E and latitude 7°25' E) namely Umuevu, Umuawadu, Umuoma, and Umuekpeke. The area experiences two main climate regimes: a dry season that is from November to April and rainy season that starts in April and ends in October (detailed characteristics of the area have been presented by Ukpai *et al*.[10]. The mean annual rainfall is between 1 500 and 2 800 mm per year while the relative humidity ranges between 77% and 86%. The temperature ranges from 22.2–24.1 ℃ (minimum) to 29.1–32.1 ℃ (maximum)[11]. The area being a rain forest zone favors the breeding of mosquito vectors. The area experiences stable malaria transmission all year round with an entomological inoculation rate of 15.0 lying on an altitude of 182 m above sea level. The inhabitants are mostly farmers and few civil servants and artisans.

2.2. Ethical considerations

The study protocol was approved by the post graduate committee of the Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike before commencing the work. Ethical approval was sought from the Health Department of Ezinihite Local Government Area and gotten. The researcher conducted meetings with local leaders and community members in all the study communities during which the objectives and study procedures were properly explained in the local Igbo language for proper understanding. The participants were also informed that they could withdraw from the study at will without any consequence. Written and verbal consents were gotten from all the participants before commencing the study. Individuals less than 16 years of age had their parents and guardians approval on their behalf.

2.3. Haematological determination

All the subjects enrolled in the study had a complete blood count (CBC) performed for each of them. The full blood count was carried out using Haematology Auto Analyzer. About 2 mL of blood in the EDTA tubes was mixed thoroughly to avoid blood clotting. The Mindray Auto Haematological Analyser was started after plugging to a power source and allowed to boot completely until analysis work background appeared. Sample mode for whole blood was

selected and the EDTA tubes with the samples were gently lowered under the probe ensuring proper immersion of the probe into the blood samples. The aspiration button behind the probe was pressed gently for aspiration of the blood samples. After 90 s, a complete analysis of the blood sample was done and the results appeared on the auto analyzer screen. A copy of the result was printed out. These parameters, total white blood cells (TWBC) and its differentials, red blood cells (RBC), haemoglobin (Hb), platelets, mean corpuscular volume (MCV) in malaria positive subjects were compared with negative subjects to determine the impact of malaria on the parameters.

2.4. Analysis of data

All data were entered into an SPSS package version 16.0 sheet. Haematological parameters of the negative and positive malaria subjects were compared using the *t*-test to test for significant differences ($P = 0.01$).

3. Results

Haematological results of the malaria-positive subjects were compared with the non-parasitized subjects (controls) and presented in Table 1. The means of TWBC and two of its differentials (lymphocytes and granulocytes), RBC and platelet count were significantly lower among malaria-infected subjects compared to non-infected controls at ($P < 0.05$) and ($P < 0.01$).

Table 1
Haematological parameters of the malaria positive subjects compared to the negative subjects (control).

Haematological parameters	Mean value of malaria positive subjects	Mean value of malaria negative subjects	t-value	P-value
TWBC (10^9/L)	5.93	9.50	3.44	0.01
Lymphocytes (10^9/L)	1.84	3.38	3.61	0.01
Monocytes (10^9/L)	0.53	0.66	1.00	0.32
Granulocytes (10^9/L)	3.41	5.48	2.89	0.01
HB(g/dL)	12.80	13.20	0.86	0.39
Platelets ($\times 10^9$/L)	130.9	183.20	4.53	0.01
RBC (10^{12}/L)	4.98	5.41	1.70	0.05
MCV(fL)	89.30	89.30	–0.01	0.49

TWBC: Total white blood cell; HB: Haemoglobin; RBC: Red blood cells; MCV: Mean corpuscle volume.

4. Discussion

Haematological changes are key indicators of complications encountered in severe malaria[12]. A variety of haematological alterations such as progressively increasing anaemia, thrombocytopenia, leukocytosis or leukopenia have been reported in cases of malaria[13]. In the present study it was observed that malaria exerted a significant reduction in TWBC, platelets and RBC. This is consistent with the reports of[8,14]. Thrombocytopenia

(an abnormally low number of platelets in the blood) is one of the significant haematological challenges associated with malaria infection in children. It has been advocated that thrombocytopenia be included in severe malaria criterion described by World Health Organisation. A mean of 130×10^9/L observed in this study agrees with the results of previous studies[14], thus thrombocytopenia emerged as a strong predictor of malaria in the study area. The mechanisms leading to thrombocytopenia in malaria is thought to include immune mechanisms, oxidative stress, alterations in splenic functions and direct interaction between *Plasmodium* and platelets[15]. The RBC is another parameter usually studied in malaria subjects. The 4.98×10^{12}/L mean of parasitized subjects showed statistical reduction at $P < 0.05$. This could be attributed to a low parasitaemia which has not invaded many red blood cells to cause their destruction. Although a low parasitaemia in falciparum malaria does not exclude a serious infection, it can occur when most parasitized red cells disappear from peripheral circulation and subsequently adhere to the walls of venules and capillaries in internal organs like kidney, lungs and placenta[15]. Leucopenia [an abnormally low count of leucocytes (WBCs) in the blood] is a common finding in malaria cases although leukocytosis (raised WBC count above the normal range) is also seen. Leucopenia is thought to be due to the localization of leucocytes away from the peripheral circulation, splenic sequestration and other marginal pools rather than actual depletion or stasis[16]. From this study a mean of 5.93×10^9/L suggests leucopenia as a statistically significant variable in malaria. The differentials of the WBC had shown that lymphocytes and granulocytes had a significant reduction in malaria positive subjects when compared to negative subjects whereas the monocytes had no significant reduction. This contrasts with the work of Zeeba *et al*.[14] who reported normal WBC differentials except for the monocytes. The Hb and MCV (mean corpuscle volume) were also parameters studied in this work. The HB value showed no statistical reduction compared to the normal. This is also reflected in the RBC parameter which confirms that low parasitaemia and non-invasion of many RBCs to degrade the haemoglobin have not had much effect on this parameter. Therefore any occurrence of anaemia could possibly be by autoimmune mechanisms and decreased erythropoiesis. This differs from the reports of Erhabor *et al*.[8] and Zeeba *et al*.[14] who reported a significant reduction with the parameter. The MCV alone has not been found to be different between the positive and negative subjects in the present study. This agrees with the reports of Erhabor *et al*.[8] and Koltas *et al*.[13].

Conflict of interest statement

We declare that we have no conflict of interest.

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