

# Changes in White Blood Cells Differential associated with adult Malaria-infected Patients

## ABSTRACT

**Aims:** Malaria parasites are expected to impact the white blood cell differentials of malaria patients but reports on changes in white blood cell differentials of malaria patients are not well documented, hence this study was undertaken to determine changes in white blood cell differentials associated with male and female malaria patients.

**Study design:** Twenty male and twenty female malaria patients were divided into four groups made up of ten malaria positive males (MPM), ten malaria negative males (MNM), ten malaria positive females (MPF) and ten malaria negative females (MNF).

**Methodology:** The hematological parameters were evaluated using automated full blood count Sysmex machine.

**Results:** The result of changes in white blood cell differential associated with male and female malaria patients showed an increase in lymphocyte percentage (LYM%), mixed cell count percentage (MXD%), neutrophil percentage (NEU%), lymphocyte absolute value (LYM#), mixed cell count absolute value (MXD#) and neutrophil absolute value (NEU#) of both malaria positive males and females compared to malaria negative males and females ( $P < 0.05$ ).

**Conclusion:** This study has shown that malaria parasite increased significantly all white blood cell differential parameters in male and female patients examined. White blood cell differential in adult malaria-infected patients are associated with increase in white blood cell differential parameters irrespective of gender. Further studies should be carried out to determine the clinical relevance of this finding especially as it could assist in the diagnosis of malaria infection.

**Keywords:** White Blood Cell Differential, Malaria, Adult, Changes

## 1.INTRODUCTION

Haematological parameters are measurable indices of blood that serve as a marker for disease diagnosis [1]. Haematological abnormalities such as anaemia and thrombocytopaenia have been observed in patients with malaria [2,3]. In spite of intensive worldwide efforts to reduce its transmission, malaria remains the most serious and widespread protozoan infection of humans. Over 40% of the world's population is at risk of contracting the disease, which is endemic in 91 countries, mostly developing ones. Almost all cases of malaria are caused by four species of the genus *Plasmodium* – namely *vivax*, *falciparum*, *malariae*, and *ovale*. Malaria infection imposes a great socio-economic burden on humanity, accounting for 85% of global infectious disease

burden along with other diseases [4]. Approximately 1.2 billion people live in areas of high risk and 2.1 billion in low-risk areas and each year, there are nearly 247 million cases and 1 million deaths.

In Nigeria, there are over 100 million people at risk of malaria every year and it is estimated that about 50 % of the adult population experience at least one episode yearly [5]. In Nigeria about 96 million people are exposed to malaria and out of these 64 million people get infected and almost 300,000 deaths are reported annually in the general population, of which over 100,000 deaths are attributed to children [6]. Malaria causes a lot of debilitating effect in adults and the economic loss due to malaria in Nigeria has been put at 132 billion Naira comprising cost of treatment and transport to source of treatment, loss of man-hours, absenteeism from places of work and other indirect costs [5]. Malaria remains a major health concern worldwide, causing 216 million infections and approximately 655,000 deaths in the year 2010 [7]. About 91 percent of malaria-related deaths are in Africa with 86 percent of victims being children aged under 5years [8]. Malaria is responsible for a significant number of deaths in endemic countries particularly in sub-saharan Africa [9, 10]. It is one of the three killers among communicable diseases in Africa [11]. Hematological changes in the course of a malaria infection, such as anemia, thrombocytopenia and leukocytosis or leucopenia are well recognized. These alterations vary with the level of malarial endemicity, background hemoglobinopathy, nutritional status, demographic factors and also malaria immunity [12, 13, 14]. Haematological changes are some of the most common complications in malaria and they play a major role in malaria pathology [15, 16]. These changes involve the major cell lines such as red blood cells, leucocytes and thrombocytes [17, 18]. There appear to be a paucity of data on the changes in white blood

cell differentials associated with adult malaria patients hence the aim of this study is to determine changes in white blood cell differential associated with adult- malaria patients.

## **2. MATERIALS AND METHODS**

### **2.1 Sample Collection**

The study was carried out in the laboratory of the Living Word Mission Hospital Aba, Abia State, Nigeria. Oral consent was obtained from all patients. Thick and thin Giemsa stained blood films were made on a slide from 2ml of venous 100 blood samples collected and viewed under a light microscope. Forty (40) samples were selected by simple random sampling of patients aged between 21 to 60 years made up of four experimental groups which included ten (10) malaria positive males (MPM), ten (10) malaria negative males (MNM), ten (10) malaria positive females (MPF) and ten (10) malaria negative females (MNF). The blood from each experimental group was collected into Ethylene diamine-tetra-acetic acid (EDTA) bottle for laboratory investigations to perform full blood count. Patients suffering from malnutrition, hepatitis, smokers, HIV/AIDS patients, those on anti-malaria drugs, typhoid fever, dengue fever and meningitis patients were excluded from the study.

### **2.2 Evaluation of White Blood Cell Differential Parameters**

White blood cell differential parameters such as lymphocyte percentage (LYM%), mixed cell count percentage (MXD%), neutrophil percentage (NEU%), lymphocyte absolute value (LYM#), mixed cell count absolute value (MXD#) and neutrophil absolute value (NEU#) were determined with automated haematological analyzer Sysmex-KX-21N which provided a high level of accuracy through the use of automatic floating discriminators.

### **2.3 Statistical Analysis**

The data collected were pooled and analyzed for their central tendencies using descriptive statistics, values were given as mean  $\pm$  standard deviation of 10 observations. ANOVA and LSD were employed to test the significant differences ( $p < 0.05$ ) among treatment means. All analysis was performed using SPSS for windows statistical software package version 20. The resulting outputs were presented in tables.

### 3. RESULTS

#### 3.1 Changes in White Blood Cell Differential Associated with Male Malaria Patients

The changes in White Blood Cell differential associated with male malaria patients showed that lymphocyte percentage (LYM%) was increased from  $(29.0 \pm 5.44)$  to  $(56 \pm 6.50)$  and the difference was statistically significant at ( $p < 0.05$ ) (Table 1). Similarly, mixed cell count percentage (MXD%) and neutrophil percentage (NEU%) were increased from  $(16.64 \pm 3.26)$  to  $(35.04 \pm 7.08)$  and  $51.50 \pm 8.38$  to  $(83.30 \pm 4.77)$  respectively, both differences were statistically significant at ( $p < 0.05$ ) (Table 1). Furthermore, lymphocyte absolute value, (LYM#), mixed cell count absolute value (MXD#), and neutrophil absolute value (NEU#) were increased from  $(1.59 \pm 0.54)$  to  $(5.19 \pm 2.04)$ ,  $(-0.90 \pm 0.40)$  to  $(3.20 \pm 0.93)$  and  $(4.56 \pm 0.86)$  to  $(10.06 \pm 3.26)$  respectively, and these differences were statistically significant at ( $p < 0.05$ ) (Table 1).

#### 3.2 Changes in White Blood cell Differential Associated with Female Malaria Patients

The changes in White Blood Cell differential associated with female malaria patients showed that LYM % was increased from  $(33.33 \pm 7.80)$  to  $(61.0 \pm 10.59)$  and the difference was statistically significant at ( $p < 0.05$ ) (Table 2). Similarly, MXD% and NEU% were increased from  $(13.94 \pm 4.84)$  to  $(37.74 \pm 6.67)$  and  $(53.66 \pm 13.45)$  to  $(82.90 \pm 4.23)$  respectively, both differences were statistically significant at ( $p < 0.05$ ) (Table 2). Furthermore, LYM#, MXD# and NEU# were increased from  $(1.66 \pm 0.55)$  to  $(5.09 \pm 2.32)$ ,  $(0.98$

± 0.33) to (4.06 ± 3.26) and (4.33 ± 1.25) to (8.56 ± 1.51) respectively, and these differences were statistically significant at (p < 0.05) (Table 2).

**Table 1: Changes in White Blood Cell Differential Associated with Male Malaria Patients**

| Haematological Parameters | Malaria Positive Males  | Malaria Negative Males  |
|---------------------------|-------------------------|-------------------------|
| <b>LYM% (%)</b>           | 56.0±6.50 <sup>a</sup>  | 29.0±5.44 <sup>b</sup>  |
| <b>MXD% (%)</b>           | 35.04±7.08 <sup>a</sup> | 16.64±3.26 <sup>b</sup> |
| <b>NEU% (%)</b>           | 83.30±4.77 <sup>a</sup> | 51.50±8.38 <sup>b</sup> |
| <b>LYM# (/ul)</b>         | 5.19±2.04 <sup>a</sup>  | 1.59±0.54 <sup>b</sup>  |
| <b>MXD# (/ul)</b>         | 3.20±0.93 <sup>a</sup>  | 0.90±0.40 <sup>b</sup>  |
| <b>NEU# (/ul)</b>         | 10.06±3.26 <sup>a</sup> | 4.56±0.86 <sup>b</sup>  |

Values are given as Mean ± Standard Deviation of 10 observations (N= 10). Mean values in the same row with different superscripts differ significantly (p < 0.05). KEY: LYM%= Lymphocyte Percentage, MXD%= Mixed Cell Count Percentage, NEU%= Neutrophil Percentage, LYM#= Lymphocyte Absolute Value, MXD#= Mixed Cell Count Absolute Value, NEU#= Neutrophil Absolute Value.

**Table 2: Changes in White Blood Cell Differential Associated with Female Malaria Patients**

| Haematological Parameters | Malaria Positive Females | Malaria Negative Females |
|---------------------------|--------------------------|--------------------------|
| <b>LYM% (%)</b>           | 61.0±10.59 <sup>a</sup>  | 33.33±7.80 <sup>b</sup>  |
| <b>MXD% (%)</b>           | 37.74±6.67 <sup>a</sup>  | 13.94±4.84 <sup>b</sup>  |
| <b>NEU% (%)</b>           | 82.90±4.23 <sup>a</sup>  | 53.66±13.45 <sup>b</sup> |
| <b>LYM# (/ul)</b>         | 5.09±2.32 <sup>a</sup>   | 1.66±0.55 <sup>b</sup>   |
| <b>MXD# (/ul)</b>         | 4.06±3.26 <sup>a</sup>   | 0.98±0.33 <sup>b</sup>   |
| <b>NEU# (/ul)</b>         | 8.56±1.51 <sup>a</sup>   | 4.33±1.25 <sup>b</sup>   |

Values are given as Mean ± Standard Deviation of 10 observations (N= 10). Mean values in the same row with different superscripts differ significantly (p < 0.05). KEY: LYM%= Lymphocyte Percentage, MXD%= Mixed Cell Count Percentage, NEU%= Neutrophil Percentage, LYM#= Lymphocyte Absolute Value, MXD#= Mixed Cell Count Absolute Value, NEU#= Neutrophil Absolute Value.

## DISCUSSION

Malaria is a disease of tropical and sub-tropical countries particularly Africa and Asia which has continued to cause significant morbidity and mortality worldwide. More than 40% of the world population reside in malaria-endemic area and it is projected that 300-500 million cases and 1.5-2.7 million deaths occur each year due to malaria [19]. Hematological changes are the most common complications of malaria and hematological abnormalities that have been reported in malaria include anemia, thrombocytopenia, atypical lymphocytosis, infrequently disseminated intravascular coagulation, Leucopenia, leucocytosis, Neutopenia, Neutrophilia, Eosinophilia and monocytosis [20, 21, 22]. The changes in white blood cell differential associated with male and female malaria patients showed a significant increase ( $p < 0.05$ ) in lymphocyte percentage (LYM%), mixed cell count percentage (MXD%), neutrophil percentage (NEU%), lymphocyte absolute value (LYM#), mixed cell count absolute value (MXD#) and neutrophil absolute value (NEU #) of the malaria positive males compared to the malaria negative males. This result is in line with the reports of [23] and [24]. These works showed a significant increase in LYM%, NEU%, LYM# and NEU# respectively. The reason for the increase in these parameters may be as a result of the production of different kinds of white blood cells and antibodies to fight the impending infection or disease. In this study, significant increase in neutrophil level of individuals infected observed could be a representation of early release of neutrophil from the bone in response to the infection [24].

## 5. CONCLUSION

In conclusion, malaria infection is an important factor that causes changes in the white blood cell differential of adult. It can be safely concluded that malaria may not lead to leucopenia and immune deficiency in both males and females as it increased all white blood cell differential parameters studied. White blood cell differentials in adult malaria-infected patients are associated with increase in white blood cell differential parameters irrespective of gender.

161 Further studies should be carried out to determine the clinical relevance of this finding especially  
162 as it could assist in the diagnosis of malaria infection.

163 CONSENT

164 It is not applicable.

165 ETHICAL APPROVAL

166 It is not applicable.

167 COMPETING INTERESTS

168 Author have declared that no competing interests exist.

## 169 REFERENCES

1701. Petel U, Gandhi G, Friedman S. Thrombocytopenia in plasmodium malaria. *American Journal of*  
171 *Tropical Medicine and Hygiene*, 2004; 59(6):859-865.

1722. Ladhani S, Lowe B, Cole AO, Kowuondo K, Newton CR. Changes in white blood cells and  
173 platelets in children with falciparum malaria: Relationship to disease outcome. *Br J. Haematol.*,  
174 2002; 119: 839 – 47.

1753. **Ozougwu JC, Obimba KC, Obiukwu CE, Elom MO. Studies of the Effects of Malaria Parasite on**  
176 **Haematological Profile of Pregnant Malarious Women. *World Journal of Medical Sciences*,**  
177 **2015; 12(4): 383 – 386.**

1784. **Murray CJL, Lopez AD.** The global burden of disease 1990 - 2020: alternative projections of  
179 mortality and disability by cause for eight regions. *Lancet*,1997; 349: 1498-1504.

1805. **Federal Ministry of Health (FMOH).** National malaria and vector control division Abuja,  
181 Nigeria. 2005.

1826. **Alaribe AAA, Ejekie GC, Ezedinachi ENU.** The ecology of Bain BJ (1996). Ethnic and sex differences in the  
183 total and differential white cell count and platelet count. *J Clin Pathol.*, 2006 49: 664-666.

1847. **World Health Organization. World Malaria Report.** Geneva: WHO; 2011.

1858. **Mia MS, Begum RA, Er AC, Abidin RD, Pereira JJ.** Burden of malaria at household level: a  
186 baseline review in the advent of climate change. *J Environ Sci Technol.*, 2011; 5:1-15.

1879. **Ogbodo SO, Okeke AC, Obu HA, Shu EN, Chukwura EF.** Nutritional status of parasitaemic  
188 children from malaria endemic rural communities in Eastern Nigeria. *Curr Pediatr*  
189 *Res.*, 2010; 14: 131- 135.

19010. **Tchinda GG, Atashili J, Achidi EA, Kamga HL, Njunda AL.** Impact of Malaria on  
191 Hematological Parameters in People Living with HIV/AIDS Attending the Laquintinie  
192 Hospital in Douala, Cameroon. *PLoS ONE*, 2012; 7(7): 405- 53.
19311. **Greenwood B, Mutabingwa T.** Introduction Malaria in 2002. *Nature*,2002; 415: 670-672
19412. **Wickramasinghe, SN, Abdalla SH.** Blood and bone marrow changes in malaria. *Baillieres Best*  
195 *Pract Res Clin Haematol.*, 2000; 13: 277–299.
19613. **Price RN, Simpson JA., Nosten F, Luxemburger C, Hkirjaroen L, Ter Kuile, F.** Factors  
197 contributing to anemia after uncomplicated falciparum malaria. *Am J Trop Med Hyg.*  
198 2001; 65: 614 – 622.
19914. **Erhart LM, Yingyuen K, Chuanak N, Buathong N, Laoboonchai A, Miller RS.** Hematologic  
200 and clinical indices of malaria in a semi-immune population of western Thailand. *Am J*  
201 *Trop Med Hyg.*, 2004, 70: 8–14.
20215. **UNICEF (2009).** Partnering to Roll Back Malaria in Nigeria’s Bauchi State at a Glance. Abuja,  
203 Nigeria: Nigeria United Nations Children Fund; 2009.
20416. **Maina RN, Douglas W, Charla G, Gordon H, John W, Lucas O, Danel J, Bernhard RO.**  
205 Impact of *Plasmodium falciparum* infection in haematological parameters in children  
206 living in western Kenya. *Malaria Journal*, 2010; 9(3): 54.
20717. **Ovuakporaye SI.** Effect of malaria parasite on some haematological parameters: red blood cell  
208 count, packed cell volume and haemoglobin concentration. *Journal of Medical and*  
209 *Applied Biosciences*,2011; 3: 45-51.
21018. **Imoru M, Shehu, MA, Ihesiulor UG, Kwaru AH.** Haematological changes in malaria-infected  
211 children in North-West Nigeria. *Turk J Med Sci.*, 2013; 43: 838 - 842.
21219. **World Health Organization.** World malaria situation in 1994. Parts1-111.*Weekly Epidemiol Rec*,  
213 1997; 72: 269 - 90.
21420. **Facer CA.** Hematological aspect of malaria In: Infection and Hematology. *Oxford Butterworth*  
215 *Heinemann Ltd*, 1994; 259 - 94.
21621. **Murphy GS, Oldfeild EC.** Falciparum malaria. *Inf Dis Clin North Am*, 1996; 10: 747 - 75.
21722. **Jandle JH.** Hemolytic anemias caused by infection of red blood cells. *In: Blood. 2nd edition.* New  
218 *York: Little brown and company*, 1996; 473-501.
21923. **Francis U, Isaac Z, Yakubu A, Enosakhare A, Felix E.** “Haematological Parameters of  
220 Malaria Infected Patients in the University of Calabar Teaching Hospital, Calabar,  
221 Nigeria”, *Journal of Hematology and Thromboembolic Diseases*, 2014; 2(6): 1 – 4.
22224. **Al-Salahy M, Shnawa B, Abed G, Mandour A, Ali-Ezzi A.** “Parasitaemia and its Relation to  
223 Hematological Parameters and Liver Function among patients of malara in Abs,  
224 Hajjah, Northwest Yemen”, *Journal of Interdisciplinary Perspective on Infectious*  
225 *Diseases*, 2016; 1 (1): 1-5.