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# Evaluation of the Haematological Profile of Children Under Five (5) Years Infected with Malaria Attending Murtala Muhammad Specialist Hospital, Kano-Nigeria

***Adama Ibrahim Jibril[1], Khadija Umar Tela[1], Safiyyu Mujitapha Umar[1], Iman Maikano Khalid[2] and Muhammad Adamu Abbas[2]**

[1] Department of Human Physiology, Faculty of Basic Medical Sciences, College of Health Sciences, Bayero University Kano

[2] Department of Medical Microbiology and Parasitology, Faculty of Clinical Sciences, College of Health Sciences, Bayero University Kano

*Corresponding Author ✉: maabbas.mph@buk.edu.ng

***Abstract***

***Malaria is a serious public health concern worldwide, particularly in hyper endemic areas of tropical and subtropical regions, including Nigeria. This study investigated haematological profile of children under five (5) years infected with malaria attending Murtala Muhammad Specialist Hospital, Kano-Nigeria. Venous blood was aseptically collected from the ante-cubital vein. Thick and thin blood films were prepared and viewed under a light microscope to identify and quantify the malaria parasites. The study involved 160 children randomly selected: comprising of 80 malaria positive and 80 negative children. Full blood count was estimated using SYSMEX auto-hematology analyzer (Lincolnshire, Illinois U.S.A.). The results showed that red blood cells were statistically lower in malaria infected ($3.64\pm1.09\times10^6/\mu L$) compared to the controls ($4.16\pm0.86\times10^6/\mu L$). Haemoglobin concentration (HGB) of malaria infected children was also lower (8.78±3.14g/dl) than that of the control group (10.56±2.33g/dl). Similarly, hematocrit percentage of the infected children was significantly lower (25.58±6.28%) compared to the controls of (27.03±7.35%). The platelet count (PLT) of the malaria children were also lower in the case group ($172.27\pm120.65\times10^3/\mu L$) compared to the controls with ($240.73\pm143.23\times10^3/\mu L$), ($P>0.05$). While the total White Blood Cell counts (WBC) and its differentials did not show any statistically significant difference between the malaria infected and the controls ($p>0.05$). This study clearly demonstrated that malaria significantly affects the haematological profile of children under five years of age leading to anemia and thrombocytopenia, with no effects on the white blood cells and differentials.***

***Keywords: Malaria, Children, Morbidity, Haematological profile.***

## INTRODUCTION

Malaria is an infectious disease caused by one or more of the following *Plasmodium* species; *Plasmodium falciparum* (*P. falciparum*), *P. vivax, P. ovale, P. malariae* and *P. knowlesi,* transmitted through the bite of an infected female anopheles mosquito (WHO, 2015). It is widely distributed around the globe, being mostly endemic in Sub-Saharan Africa, Asia and the Americas. It is a major public health burden in Africa (Bawah *et al.,* 2018). The Africa region of the WHO accounted for 95% of global malaria cases and 96% of malaria deaths in 2020, where children under five years of age accounted for 80% of all malaria mortality in the region (WHO, 2020). Malaria is especially a major public health problem that requires most attention in Nigeria, where reports revealed that it accounted for about 27% and 23% of all malaria cases and deaths worldwide, respectively (WHO, 2020). Despite interventional programs such as the National Malaria Elimination Programme (NMEP) which involve modalities such as insecticide-treated nets usage, intermittent preventive treatment in pregnancy, effective case management, and indoor residual spraying, malaria continues to be a major health problem in Nigeria (Oluwaseun *et al.,* 2021).

Malaria in children can result in many complications (Conroy *et al.,* 2019, Waris *et al.,* 2021). Among the many complications of malaria in children is haematologic complications (Jiero and Pasaribu 2021).

Hematological alterations that are thought to characterize malaria are related to the significant biochemical changes believed to occur during the asexual stage of the life cycle of the malaria parasite (Muwonge *et al.,* 2013). Malaria positive patients present with significantly lower platelet, leukocyte, lymphocyte, eosinophil, red blood cell, and hemoglobin (Hb) counts, (Arévalo-Herrera *et al.,* 2017, Jiero and Pasaribu 2021). The number of monocytes and neutrophils tend to be higher than in non-malaria-infected patients (Bakhubaira *et al.,* 2013). The pathological manifestation of malaria infection in children solely depends on many factors including; parasite infectiveness, host susceptibility as well as geographical factors. Example; during the rainy seasons children are infected with the malaria parasite, which destroys erythrocytes causing significant changes in hematological parameters (Wickramasinghe *et al.,* 2000, Ntenda *et al.,* 2019). Hematological alterations may be inducted by several other factors including time after infection, intensity and pattern of transmission of the parasite in the area as well as the strength of host immunity (Bawah *et al.,* 2018).

Due to its importance, many studies on malaria abound in Nigeria, particularly regarding its clinical effects, morbidity and mortality and risk factors (Morakinyo *et al.,* 2018). This study seeks to complement the existing pool of data by looking at the possible hematological impact of malaria disease among children under 5 years of age in Kano state-Nigeria, this may provide insight into proper patient management that may lead to a better clinical outcome.

## MATERIALS AND METHODS

This cross sectional study was carried out among children under the age of five years with primary diagnosis of malaria at Murtala Muhammad Specialist Hospital, Kano state-Nigeria.

**Inclusion and Exclusion Criteria**: Children under 5 years diagnosed with or without malarial infection at paediatrics of Murtala Muhammad Specialist Hospital Kano were included in this study, while other children above 5 years of age were excluded.

**Ethical Consideration**: Ethical clearance for the study, with number MOH/OFF/797/T.I/1392 was obtained from the Research Ethics Committee, Kano state Ministry of health. Ascent was sought from the guardians of the participating children, having explained to them the purpose of the research and its relevance.

**Blood sample collection:** Blood samples were collected using 5 ml syringes from each of the participants, via ante-cubital vein into ethylene diamine tetra acetic-acid (EDTA) test tubes for laboratory analyses. .

**Malaria microscopy analysis:**

**Slides Preparation and Microscopic View:** Slides for microscopy were prepared after specimen collection, thick and thin blood smear were made with the help of a spreader, air-dried then stained with Giemsa stain. The presence or absence of plasmodia parasites and the number of asexual parasites per 200 WBCs were determined using the WHO standard guidelines modified (Bawah *et al.,* 2018). After microscopy and using simple random sampling, 80 malaria positive children were selected as experiment group and 80 age-matched non-malaria infected children as control group.

**Hematological Profiling**

**Full blood count**: Total white blood cell count (TWBC), differential WBC count, Hemoglobin level (Hb), red blood cell count (RBC), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and platelet count (PLT) were estimated using SYSMEX auto-hematology analyzer (Lincolnshire, Illinois U.S.A.).

**Statistical Analysis**

Data were obtained and analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 22 (IBM Inc., Chicago, IL, USA). The results were summarized as frequencies, and mean ± standard deviation in tables and charts. Mean values of total blood count were compared between the malaria positive and control groups using student's t-test. P-value of $<0.05$ was considered level of significance at 95% confidence interval.

## RESULTS

The results showed that the mean Haemoglobin concentration (HGB) of malaria infected children was significantly lower (9.08±2.30g/dl) compared to that of the control group (10.77±3.24g/dl), ($p<0.05$) Table 1. Similarly, the hematocrit of the infected children was significantly lower (25.58±6.28%) than that of the controls of (29.97±7.58%), ($p<0.05$). The Mean Corpuscular Haemoglobin Concentration (MCHC) of malaria infected group was also found to be significantly lower (31.03±8.05g/dL) compared to the controls (35.77±4.75g/dL), $p<0.05$. However, there was no significant difference in the mean values of MCV was 70.50±7.04 and 72.16±11.6 for the

cases and control respectively, p>0.05. The mean value for MCH in the malaria infected group was 25.77±4.48 while that of control group was 32.45±7.54. The difference was also not statistically significant, p>0.05.

**Table 1**: Haematological profile of malaria positive and malaria negative patients attending Murtala Muhammad Specialist Hospital Kano.

| Parameter | Controls | Cases | *p* value |
|---|---|---|---|
| HGB(g/dL) | 10.77±3.24 | 9.08±2.30 | 0.046 |
| HCT(%) | 29.97±7.58 | 25.58±6.28 | 0.042 |
| MCV(fl) | 72.16±11.64 | 70.50±7.04 | 0.062 |
| MCH(pg) | 32.45±7.54 | 25.77±4.48 | 0.056 |
| MCHC(g/dL) | 35.77±4.75 | 31.03±8.05 | 0.032 |

HGB=Heamoglobin, HCT=Haematocrit, MCV=Mean Corpuscular Volume, MCH=Mean Corpuscular Heamoglobin, MCHC=Mean Corpuscular Heamoglobin Concentration

The results of the WBC count among the malaria infected children was (9.13±3.24×$10^3$/µL) while that of the controls was (8.94±4.08×$10^3$/µL) with no statistically significant difference between the groups, p>0.05, figure 1. The RBC counts were lower in malaria infected (3.64±1.09×$10^6$/µL), compared to the controls with (4.16±0.86×$10^6$/µL) there was no statistically significant difference between the groups too, p>0.05. The platelet count (PLT) of the malaria children was however statistically significantly lower in the cases (172.27±120.65×$10^3$/µL) than the controls (240.73±143.23×$10^3$/µL), (*P*<0.05).

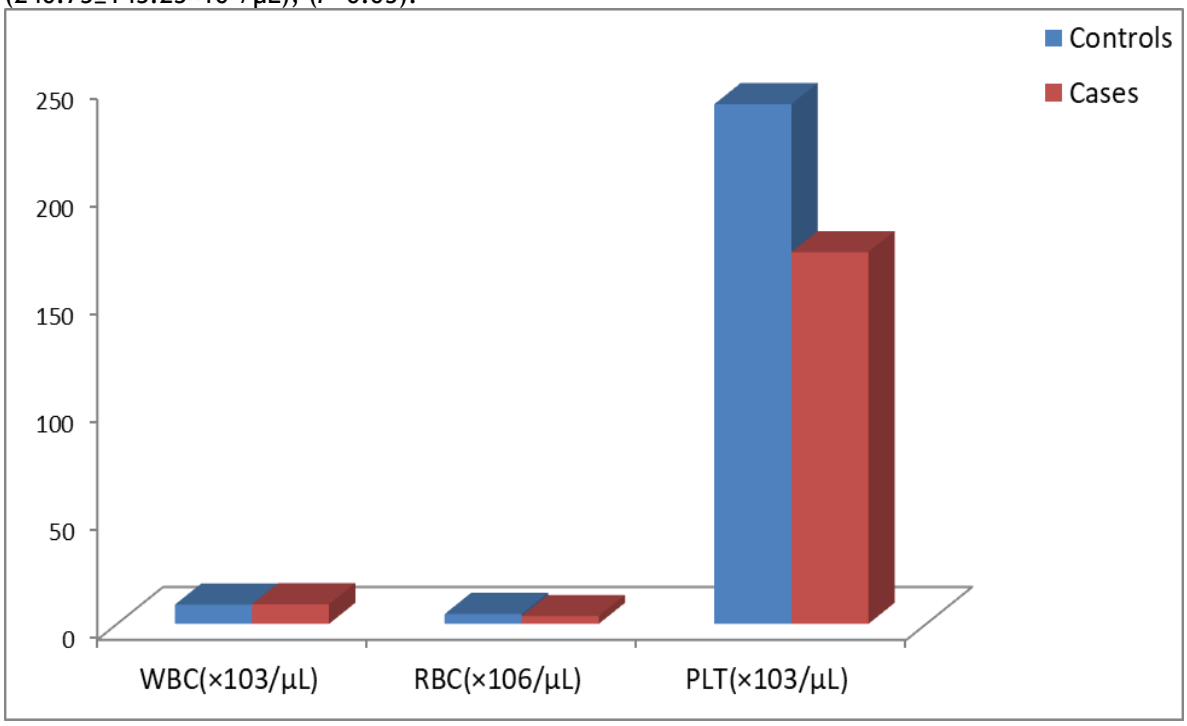


Figure: 1 Comparisons of WBC, RBC and PLT of the malaria positive and negative patients attending Murtala Muhammad Specialist Hospital Kano.

The WBC diffrentials (figure 2) showed that the Lymphocytes of the infected were (54.89±13.79%) compared to the controls of (57.55±24.42%) the differences were not signiicant (*P*>0.05). Similarly, monocytes (MXN) of the malaria infected groups were (5.90±4.54%) compared to the controls with (5.91±5.26%), and the neutrophils (NEUT) of the infected were (43.46±12.72%) compared to the control with mean value of (36.54±24.48%). There were no significant difference in the mean values in both cases (*P*>0.05).

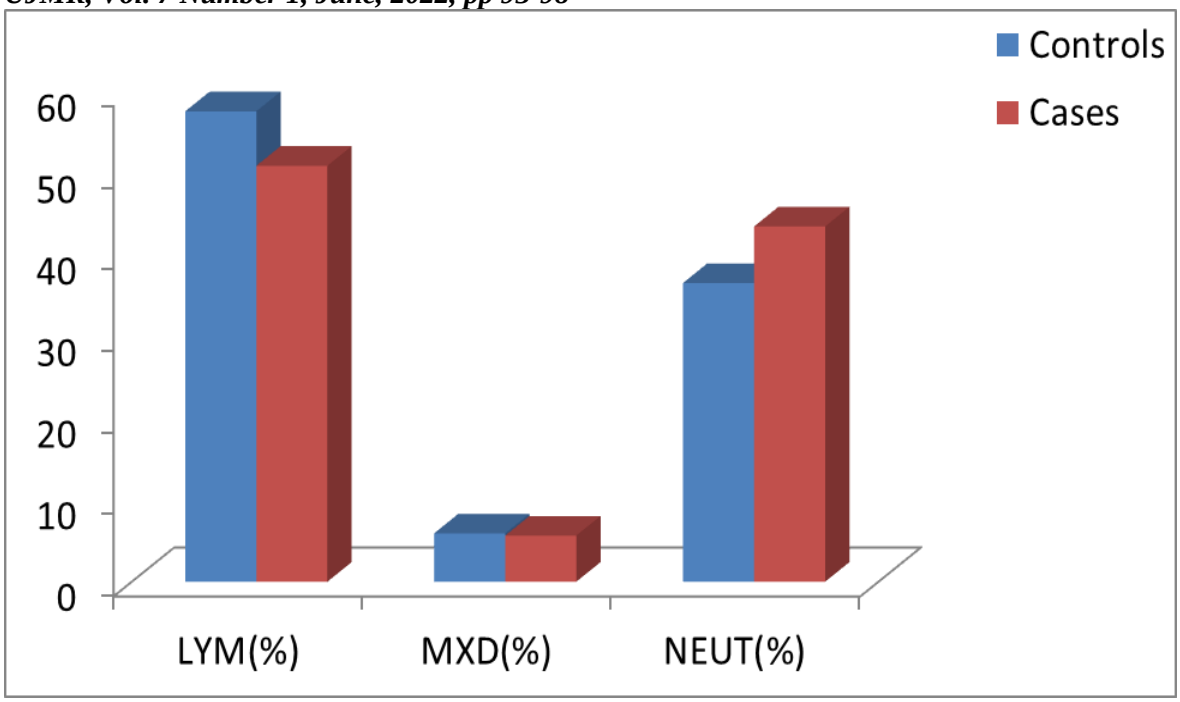


**Figure 2:** Percentages Lymphocytes (LYM), Monocytes (MXD) and Neutrophils (NEUT) of malaria positive and negative patients attending Murtala Muhammad Specialist Hospital Kano

## DISCUSSION

Children, especially under five years, are usually susceptible to malaria infection which can result in anaemia that may easily cause death. It has been reported that malaria has multifactorial mechanisms through which it leads to anemia. For example; increased damage of parasitized and non-parasitized RBCs, is the primary factor leading to anemia development in malaria (White, 2018). Suppressed erythropoiesis during days and or weeks after acute malaria also contributes to anemia (Balarajan *et al.*, 2011) and also do shortened red blood cells lifespan and increased red cell clearance (White, 2018).

In this study the results showed significant decreases in RBC, HCT, MCHC and haemoglobin concentration in the malaria positive group compared to the control group. Reduction of these values reflected anaemia as stated by (Francis *et al.*, 2014). These results were in line with those reported by (Bawah *et al.*, 2018; Awoke and Arota, 2019). Malaria has been implicated as a cause of severe anemia, in association with severe complications, including death (White 2018, Camila *et al.*, 2019).

White blood cells play crucial role in the body's defense against malaria. This study found an overall increase in white blood cell count among the malaria infected children compared to those without malaria, though the increase was not statistically significant. This was consistent with the findings of Bawah *et al.*,(2018) which found increase in WBC count in children with malaria compared to the controls in a cross-sectional study among children in a Municipality in Ghana. White blood cell changes in malaria depend on factors like; parasitaemia, host immune status and the presence of co-infections (Abdalla and Pasvol 2004, Faga *et al.*, 2020, Xin-zhuan *et al.*, 2020). The body's immune response to infections such as malaria may involve neutrophils, macrophages or Natural killer (NK) cells (Vivier *et al., 2011)*. Findings in this study showed no significant changes in monocyte count in parasitemic patients compared to the non-parasitemic patients. This was in contrast to a previous study which found monocytosis as one of the most significant observations of hematological changes among children infected with malaria (Bawah *et al.*, 2018).. Neutrophil counts were also analysed in this study. The results showed that the mean neutrophil count between the parasitemic and non-parasitemic children was not significantly different. These findings were similar to those from previous studies in Ghana (Bawah *et* al., 2018), India (Akhtar *et al.*, 2012) and Singapore (Wickramasinghe *et al.*, 2000) respectively, where they reported no significant increase in neutrophil count between those with malaria and those without malaria. The pathophysiological processes of neutropenia in malaria has been reported to involve amplified margination and sequestration of neutrophils resulting from the augmented expression of cell adhesion molecules (ICAM-1 and VCAM-1) that occurs in malaria (Clark *et al.*, 2006).

Our results also showed no significant difference in the total lymphocyte count in malaria parasitaemia, similar to some previous studies which found lymphocyte count remaining unchanged during an acute malaria infection (Abdalla *et al.*,1988; Adedotun *et al.*, 2013).

Thrombocytopenia, a condition of low platelet count, is one of the most commonly reported hematological abnormalities in malaria patients. Thrombocytopenia is said to occur probably as a result of destruction and removal of platelets by spleen, in addition to platelet depletion by disseminated intravascular coagulopathy (Bidaki *et al.*, 2003, Kassa *et al.*, 2005 Rasheed *et al.*, 2009). Our study found a strong relationship between thrombocytes count and plasmodium infection. The children with malaria infection had statistically significantly lower levels of platelets compared to those free of malaria infection. This result was in consonant with that of Oluwaseun *et al.*, (2021) and Bawah *et al.*, (2018) who also reported a significant decrease in platelets counts in malaria positive patients compared to control group.

## CONCLUSION

This study has clearly demonstrated that malaria significantly affects the hematopoieitic system in children under five years living in Kano state-Nigeria. The most important effects on hematological parameters observed in the study were anemia and thrombocytopenia both of which can result in catastrophe if not properly managed. The importance of the two haematologic derangements would mean that all children under the age of five who reported with malaria should be closely monitored and a full blood count be carried out in cases of moderate to severe malaria.

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