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Original Article

Haematological Profile Alteration in Malaria Infected Individual Attending Federal Polytechnic Medical Center, Bida, Niger Sate

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ABSTRACT

This study investigated the haematological changes associated with malaria infection among patients attending the Federal Polytechnic Medical Centre, Bida. A total of 150 patients were examined for malaria infection using microscopic blood film examination and haematological parameters were analyzed to determine the effects of malaria on red and white blood cells, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC). The results showed that 75% (112/150) of the participants were malaria-positive, with higher prevalence among males (85%) than females (70%). The highest infection rates (100%) were observed in the 1–10 and 11–20 years age groups, while the lowest prevalence (67%) occurred among those aged 21–30 years. Haematological analysis revealed that malaria significantly affected certain parameters, including white blood cell count ($p = 0.046$), mean corpuscular volume ($p = 0.049$), and mean corpuscular hemoglobin concentration ($p = 0.031$). However, no significant changes were observed in red blood cell count, packed cell volume, and mean corpuscular hemoglobin. Low infection rate observed in adults may be due to frequent infection by parasites which made their system acquired concomitant immunity. The finding indicates that malaria infection induces alterations in key haematological indices, suggesting that monitoring these parameters could aid in early diagnosis, treatment evaluation, and management of malaria patients.

Keywords: Haematological, Malaria-infected, Investigation, Polytechnic and Bida

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INTRODUCTION

Malaria is a parasitic disease transmitted to humans mainly through the bite of infected female Anopheles mosquitoes. It is caused by four species of *Plasmodium* parasites: P. *falciparum*, *P. vivax*, *P. malariae*, and *P. ovale* and the most common species are *P. falciparum* and *P. vivax* [1]. The infection spreads mainly when a mosquito carrying these parasites

bites a person. In rare cases, it can also be spread through blood transfusion or from mother to child during pregnancy [2]. After an infected mosquito bite, the parasite travels to the liver, where it multiplies before moving into red blood cells. Malaria continues to be one of the most prevalent infectious diseases globally, disproportionately affecting children under five years of age in sub-Sahara Africa [3]. Despite global control efforts, the disease remains a major cause of morbidity and mortality, with an estimated 249 million cases and 608,000 deaths recorded in 2022, most occurring in children [3]. The haematological changes induced by malaria such as anemia, thrombocytopenia and leukocyte alterations, are among the leading causes of malaria related complications and death in patients [4]

Globally, malaria continues to exert a heavy burden on health systems. In 2022, an estimated 249 million cases were reported worldwide, resulting in approximately 608,000 deaths, with most fatalities occurring in sub-Saharan Africa [3]. In Nigeria, malaria is hyper endemic in many states. The National Malaria Elimination Programme reports that the country accounts for a substantial portion of global malaria burden, with significant incidence in the Northern states. Including Niger state. (NMEP, 2022). Malaria infection in adults triggers a cascade of biological processes: replication of parasites in red blood cells (RBCs), destruction of infected [5]. These statistics highlight the urgent need for effective control and prevention strategies.

Hematological parameters refer to the measurable components of blood, including red blood cells (RBCs), white blood cells (WBCs), hemoglobin concentration, haematocrit, platelet count, and other indices derived from a complete blood count (CBC) test [6]. These parameters provide essential information about the physiological and pathological state of an individual's blood and are widely used in clinical practice to diagnose, monitor, and manage various diseases, including malaria infections and other haematological infections [4]. Blood is composed of different cellular elements suspended in plasma, each playing a vital role in maintaining homeostasis. Red blood cells are responsible for oxygen transport via the hemoglobin molecule, and their count and hemoglobin concentration can indicate conditions like anemia or polycythemia [6]. White blood cells, including neutrophils, lymphocytes, monocytes, eosinophils, and basophils, are key components of the immune system, and their count often reflects immune responses to infections or inflammation [7]. Platelets are crucial for blood clotting, and their reduction (thrombocytopenia) can lead to bleeding disorders [8].

In infectious diseases such as malaria, hematological parameters are particularly important for diagnosis and prognosis. Malaria parasites invade and destroy RBCs, causing anemia, while immune reactions can alter WBC counts and reduce platelet levels [4]. The assessment of these parameters, therefore, helps clinicians in identifying malaria complications, predicting disease severity, and evaluating treatment outcomes [9]. The study seeks to understand how malaria affects the blood profile of patients and to make use of haematological parameters as supportive diagnostic tools for early detection and effective management of malaria in patients.

MATERIALS AND METHODS

Study Area

The study was conducted at the Medical Centre of the Federal Polytechnic, Bida, located within Bida Local Government Area of Niger State, Nigeria. Bida lies approximately on latitude 9°05′N and longitude 6°01′E in the North-Central geopolitical zone of Nigeria. The town experiences a tropical climate characterized by two distinct seasons—the wet and dry seasons. The rainy season usually spans from April to October, with an average annual rainfall ranging between **1,200 mm and 1,500 mm**, while the dry season extends from November to March, often accompanied by the Harmattan winds [10]. The average annual temperature ranges from **28°C to 34°C**, with the hottest months occurring between February and April [11]. The town hosts several educational institutions, including the Federal Polytechnic, Bida, and various healthcare facilities, which contribute to moderate literacy levels and improved access to health services. However, challenges such as variable income levels, poor sanitation, and inconsistent public health awareness still persist, influencing disease prevalence and health-seeking behaviors in the area [12].

Sample collection

A total of 5 mL of venous blood was aseptically collected from each participant using sterile disposable syringe and needles and it was transferred into EDTA bottles to prevent coagulation. Each sample was properly labeled with the participant's code number and analysed. All safety precautions and biosafety procedures were strictly observed throughout the collection and in the process of analysis.

After sample collection, all blood samples were properly labeled and processed immediately to ensure accuracy. The samples were analysed in the Haematology Laboratory, Medical Centre, Federal Polytechnic Bida, during the study period. Thin blood films were prepared for each sample and fixed with absolute methanol for 1minute and stained with 10% Giemsa stain for 10 minutes. It was rinsed gently and allowed to air dry and was examined under the light microscope (×100 oil immersion) for the presence of *plasmodium* parasites.

Haematological analyses were carried out using automated coulter counter (STKS) model [13].

Data Analysis

The extracted data were entered into (SPSS version 23.0). Chi-square was used to analysed the relationship between different variables and degree of freedom were ascertain using Pearson chi-square. Comparative analysis between infected and non-infected participants was determined using descriptive frequency. The results are presented using tables from Microsoft word

RESULTS

Table1. The study revealed that out of total number of participants (150) examined, 112 (75.00%) were positive for malaria parasites. Gender showed high prevalence in both male 40 (85.00%) and female 72 (70.00%). The highest prevalence (100.00%) was observed among age group 1-10years and 11-20years. In age group 21-30years (67.00%) are positive of malaria while the age group of 31 years and above showed high prevalence of

(81.00%) Table2. These results statistically show relationship between malaria and age (p-value 0.00).

Table 3. The study revealed that higher number of participants (M 34, W 54), (M 31, W 57), (M 32, W 59), (M 32, W 44) shows normal red blood cell, white blood cell, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration respectively, majority of patients shows lower packed cell volume (M 20, W 42) and mean corpuscular volume (M 26, W 57), there was no statistical significant in red blood cell(p-value 0.41), packed cell volume (p-value 0.257) and mean corpuscular hemoglobin(p-value 0.59) compared to the normal value p-value 0.05), the study showed statistical significant in white blood cell (p-value 0.046), mean corpuscular volume(p-value 0.049) and mean corpuscular hemoglobin concentration (p-value 0.031) which is less than 0.05 indicating that there is a significant effect of *Plasmodium* infection, this indicates that prevalent of malaria is high with a p-value of 0.034. Table 4. Parameter alterations in age group 1-10 is minimal with none was recorded higher than the normal value. In age group 11-20, little changes were noticed in the alterations of blood profile compare to 1-10 with WBC having values in both lower and higher to normal value. Age groups 21-30 and 31 above both recorded values in lower and above the normal value for RBC and WBC.

Table 1: Prevalence of malaria in relation to gender among patients attending federal Polytechnic medical centre, Bida

Gender	Number examined	Number of positive	Percentage	P-value
Male	47	40	85.00%	
Female	103	72	70.00%	
Total	150	112	75.00%	0.034

Table 2: Malaria parasite with respect to age group

ge	Number examined	Number of positive	Percentage	P-value
1 - 10	3	3	100.00%	
11 - 20	9	9	100.00%	
21 - 30	81	54	67.00%	
31 - above	57	46	81.00%	0.00

Table 3: Effect of malaria infection on haematological parameters with respect to Gender

Parameter	Gender	Normal	Below	Above	Total	P-value

Red Blood Cell (RBC)	Male	34	4	2	40	
	Female	54	10	8	72	0.41
White Blood Cell (WBC)	Male	31	8	1	40	
	Female	57	6	9	72	0.046
Packed Cell Volume (PCV)	Male	20	20	0	40	
	Female	30	42	0	72	0.257
Mean Corpuscular Volume (MCV)	Male	13	26	1	40	
	Female	15	57	0	72	0.049
Mean Corpuscular Hemoglobin (MCH)	Male	32	8	0	40	
	Female	59	12	1	72	0.59
Mean Corpuscular Hemoglobin Concentration (MCHC)	Male	32	8	0	40	
	Female	44	28	0	72	0.031

Table 4: Effect of malaria infection on haematological parameters in relation to age group

Age	Parameters	Normal	Below	Above	Total
1 - 10	RBC	3	0	0	3
	WBC	3	0	0	3
	PCV	3	0	0	3
	MCV	1	2	0	3
	MCH	1	2	0	3
	MCHC	2	1	0	3
11 - 20	RBC	8	1	0	9
	WBC	7	1	1	9
	PCV	7	2	0	9
	MCV	2	7	0	9
	MCH	1	8	0	9
	MCHC	3	6	0	9
21 - 30	RBC	39	8	7	54
	WBC	44	4	6	54
	PCV	25	29	0	54
	MCV	9	44	1	54
	MCH	7	46	1	54
	MCHC	35	19	0	54
31 - above	RBC	40	3	3	46
	WBC	35	8	3	46
	PCV	22	24	0	46
	MCV	11	35	0	46
	MCH	10	36	0	46
	MCHC	35	11	0	46

DISCUSSION

The present study assessed the prevalence and haematological alterations in malaria-infected patients attending the Federal Polytechnic Medical Centre, Bida. The results revealed that malaria continues to be a public health concern in the study area, with an overall prevalence rate of 75.00%. This finding agrees with studies conducted by other researchers in Nigeria, which reported high malaria prevalence ranging from 60.00% to 80.00% in endemic regions, especially during peak transmission seasons [14].

Analysis of the gender distribution of prevalence revealed a higher infection rate among males (85.00%) than females (70.00%). This difference may be attributed to increased exposure of males to mosquito bites due to outdoor activities, such as evening social gatherings, farming, and night work. Females may have reduced exposure because of domestic responsibilities that keep them indoors, thus limiting contact with vectors. This finding corroborates the report by Bayene [15], who found higher malaria prevalence among males due to behavioral and occupational exposure. The p-value (0.034) indicates a statistically significant association between gender and malaria prevalence.

The study demonstrated that the prevalence of malaria varied across different age groups. The highest prevalence (100.00%) occurred among children aged 1–10 years and young adults aged 11–20 years. This trend may be due to developing immune system in children and adolescents, making them more susceptible to malaria infection. Adults aged 21–30 years showed the lowest infection rate (67.00%), possibly due to development of concomitant immunity from repeated exposure to the malaria parasite over time. However, the prevalence increased again among individuals aged 31 years and above (81.00%), likely due to declining immune functions and increased outdoor exposure. These findings agree with the work of [16], who reported that immunity against malaria tends to build up in early adulthood but decrease with age. The statistical analysis ($p = 0.00$) indicates a strong association between age and malaria prevalence.

Haematological changes are important indicators of malaria severity and disease progression. In this study, red blood cell count (RBC), packed cell volume (PCV), and mean corpuscular hemoglobin (MCH) did not show any significant differences, statistically ($p > 0.05$). However, many malaria-positive patients exhibited lower PCV and RBC counts compared to normal reference values. This observation may be attributed to hemolysis caused by Plasmodium infection, which destroys red blood cells and reduces oxygen-carrying capacity. The mild decline in these indices without statistical significance suggests that most patients presented are not with complicated malaria. White blood cell count (WBC) showed a statistically significant difference ($p = 0.046$) between infected and normal participants. While malaria is generally associated with leukopenia, variations occur depending on the immune response and disease stage. The observed differences in WBC may reflect the immune system's response to parasitic invasion, consistent with findings of Obonyo et al. (2007), who reported altered leukocyte levels in malaria patients. Similarly, mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC)

showed significant differences ($p = 0.049$ and $p = 0.031$, respectively). This indicates that malaria infection affects red blood cell morphology and hemoglobin content, potentially leading to microcytic and hypochromic changes. These alterations are consistent with the pathophysiology of malaria, where parasitic infection disrupts erythropoiesis and leads to anemia (WHO, 2022). The reduction in MCHC may reflect the combined effects of hemolysis and impaired erythropoietic recovery.

In relation to age, younger patients (1–20 years) showed the greatest deviation in haematological parameters, with more frequent reductions in PCV, MCV, and MCH values. This supports the observation that children and adolescents are more prone to anemia due to repeated malaria infections and nutritional deficiencies. Older adults (≥31 years) also demonstrated reduced PCV and MCV, possibly due to declining immunity and chronic exposure.[13].

Overall, these findings demonstrate that malaria infection significantly alters specific haematological parameters; especially those related to red blood cell morphology and white blood cell count and can serve as diagnostic indicators and aid clinicians in evaluating disease severity and treatment efficacy.

DECLARATION

Authors' Contribution

ZST and AYD conceptualized the study. AYD and SUM designed the study. SLA, SUM and ZST participated in bench work and data collection. AYD and HM performed the data analysis; AYD and HM interpreted the data. ZST and HM prepared the first draft of the manuscript. All authors reviewed the manuscript. All authors contributed to the development of the final manuscript and approved its submission.

Conflicts of Interest

None

Funding Source

No funds from external source for the study

Ethical Approval and Informed Consent

Ethical approval for this study was obtained from the Medical Director of the Centre, on behalf of the management board of the Centre, Federal Polytechnic, Bida, Niger. All participants were duly informed of the objectives of the study and the protocol for sample collection. Participation was on individual will by all participants.

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