Haematological Alterations in Malaria Parasitaemia: A Study at the Federal Teaching Hospital, Owerri, Nigeria.

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Abstract

Background: Malaria continues to pose a serious public health challenge, particularly in sub-Saharan Africa. It is a medical emergency that can quickly escalate into life-threatening complications if not properly treated. Like many infectious diseases, malaria has a significant impact on the haematological profile, which can provide useful diagnostic and prognostic insights. The liver, which plays a crucial role in protein synthesis and immune regulation, also influences haematological function. **Objective:** This study aimed to assess changes in selected haematological parameters total white blood cell (TWBC) count, differential white cell counts, and total protein levels in patients infected with malaria parasitaemia, and compare the values to those of healthy, non-infected individuals. **Methods:** A total of 100 participants were enrolled, consisting of 50 malaria-infected patients and 50 healthy controls. Informed consent was obtained. Blood samples were collected under aseptic conditions from the antecubital vein. Three milliliters of blood were placed into EDTA tubes for WBC and differential counts, while four milliliters were placed in plain tubes for serum total protein estimation using the Biuret method. Samples were stored appropriately until analysis. White cell counts were carried out using standard manual methods (Cheesbrough). Data were analyzed using SPSS version 27**. Results:** Malaria-infected patients had significantly reduced levels of TWBC ($4.96 \pm 1.48 \times 10^9$/L), lymphocytes ($28.22 \pm 8.07$)%, eosinophils ($1.45 \pm 0.98$)%, and total protein ($6.44 \pm 9.28$ g/L) compared to healthy controls ($9.07 \pm 2.29 \times 10^9$/L; 44.50 ± 13.86%; 2.21 ± 0.99%; 8.19 ± 1.27 g/L respectively) with p-values < 0.001. However, neutrophil counts were significantly higher in the malaria group (62.50 ± 8.96%) than in controls (45.06 ± 10.97%) ($p < 0.001$). No significant difference was found in monocyte levels between both groups. Gender comparisons among malaria patients showed no statistically significant differences in neutrophils, lymphocytes, eosinophils, monocytes, or total protein. However, male patients had significantly lower TWBC counts ($4.64 \pm 1.33 \times 10^9$/L) than females ($5.37 \pm 1.58 \times 10^9$/L) ($p < 0.05$). **Conclusion:** Malaria parasitaemia is associated with notable changes in haematological parameters, particularly lower TWBC, lymphocytes, eosinophils, and total protein, along with elevated neutrophil counts. These findings support the use of haematological assessments in the diagnosis and monitoring of malaria. Preventive strategies like the use of insecticide-treated bed nets and appropriate clothing remain essential tools in reducing malaria transmission.

Key words: Total White Blood Cell, Differential White Blood Cells, Total Protein, Malaria Parasitemia.

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Introduction

Malaria remains one of the world's most serious infectious diseases, particularly in Africa where the burden is highest. Nigeria, for instance, contributes significantly to the global malaria load, accounting for about 27% of global cases and 31% of deaths[2]. Several factors contribute to this high prevalence, including poor sanitation, stagnant water bodies that serve as mosquito breeding sites, inadequate healthcare access, climatic conditions favorable to mosquito survival, and limited public health education[1]. The disease is caused by Plasmodium parasites transmitted through the bites of infected female Anopheles mosquitoes[3].

Malaria affects multiple systems in the body, but its impact on the blood and immune systems is particularly notable[4]. These parasites invade red blood cells, leading to hemolysis, anemia, and immune system dysfunction[5]. One of the major effects of malaria is the disruption of normal haematological values. Changes in white blood cells, red blood cells, and protein levels often reflect the body's response to infection and inflammation[6]. Monitoring these parameters can help clinicians assess the severity of infection and guide treatment decisions, especially in resource-limited settings where advanced diagnostic tools may not be available[7].

This study focused on comparing the haematological profiles of individuals with malaria parasitaemia to healthy individuals, with particular attention to white blood cell count, differential cell counts, and total serum protein,will contribute to improved malaria management and may offer insights into disease prognosis and immune response.

Materials and Methods

Study Area

The study was conducted at the Federal Teaching Hospital Owerri (FTHO), located in Imo State, southeastern Nigeria, a region where malaria is endemic, from November to December, 2024.

Study Design

This was a cross-sectional, case-control study involving malaria-positive patients and healthy controls.

Study Population

The study involved 100 individuals: 50 confirmed cases of malaria parasitaemia and 50 apparently healthy controls matched by age and sex.

Ethical Consideration

Ethical clearance was obtained from the hospital's Ethics and Research Committee (October, 14, 2024: FTH/OW/4REC/VOL./110). Informed consent was received from all participants prior to sample collection.

Method of Recruitment

Patients were recruited from the outpatient clinic and diagnostic laboratory after testing positive for malaria using microscopic examination of stained blood films. Healthy individuals were selected after testing negative for malaria.

Sample Collection

A total of 7 mL of venous blood was collected from each participant using aseptic techniques. Three milliliters were placed in EDTA containers for WBC and differential counts, while 4 mL were placed in plain tubes to separate serum for total protein estimation.

Laboratory Procedures

White Blood Cell Count & Differential: Carried out manually using the improved Neubauer counting chamber and Leishman-stained blood smears, following Cheesbrough's standard method.

Total Protein Estimation: Conducted using the Biuret method, a colorimetric test for measuring protein concentration in serum.

Statistical Analysis

Data was analyzed using SPSS version 27. Independent sample t-tests were used to compare mean values between the malaria and control groups. A p-value < 0.05 was considered statistically significant.

Results

Table 1: Mean Values of Total White Blood Cell Count, Neutrophisls, Lymphocytes, Eosinophils, Monocytess and Total Protein in Patients with Malaria Parasitaemia and Healthy Control Subjects (Mean ± S.D).

Parameter	Test	Control N = 30	T-values N = 30	P-values
TWBC ($\times 10^9$/L)	4.95 ± 1.49	9.36 ± 2.15	10.200	0.0000*
Neutro (%)	62.33 ± 10.11	42.97 ± ± 12.45	6.407	0.0000*
Lympho (%)	27.86 ± 8.58	49.87 ± 12.37	7.364	0.0000*
Eosino (%)	1.17 ± 1.05	2.07 ± 1.08	4.062	0.0000*
Monocytes (%)	6.77 ± 4.32	5.16 ± 2.99	1.583	0.062
Total Protein (g/l)	5.19 ± 1.44	8.77 ± 1.200	12.301	0.000*

Key:
*: Significnt p value
Twbc: Total white blood cell count
Lympho: lymphocytes
Eosino: Eosinophils
Neutro: Neutrophils
S.D: Standard Deviation

The mean values of Twbc (4.95 ± 1.49) × 10^9 /l, lymphocytes (27.8 ± 8.6)%, eosinophils (1.16 ± 1.05)% and total protein (5.19 ± 1.44)g/l, were significantly reduced in patients with malaria parasitaemia when compared to the non-infected patients(9.36 ± 2.15) × 10^9/l, lymphocytes(49.86 ± 12.37)%, eosinophils(2.06 ± 1.06)% and total protein (8.77 ± 1.200)g/l respectively (t = 10.200, P = 0.00; t = 7.364, P = 0.00; t = 4.062, P = 0.00; t = 12.301, P = 0.00).

However, the mean value of neutrophils (62.33 ± 10.1) % was significantly increased in patients with malaria parasitaemia when compared to the non- infected patients (42.97 ± 12.45)%, (t = 6.409, P = 0.001). But there was no significant increase in the monocytes of malaria parasitaemia patients (6.77 ± 4.32)% when compared to the healthy control subjects (5.16 ± 2.99)%, (t = 1.583, P ≤ 0.062).

Table 2: Comparison of the Mean Values of Total White Blood Cell, Neutrophils, Lymphocytes, Monocytes, Eosinophils and Total Protein in Male and Female Patients malaria Parasitaemia (Mean ± S.D).

Parameter	Male	Female N = 18	T-values N = 12	P-values
Twbc (g/dl)	4.48 ± 1.15	5.66 ± 1.69	2.276	0.031*
Neutr ($\times 10^9$/l)	61.61 ± 10.58	63.42 ± 1.69	0.472	0.640
Lympho (%)	29.17 ± 9.78	25.75 ± 6.24	1.071	0.293
Monocytes (%)	6.17.74 ± 4.34	7.67 ± 4.36	0.701	0.483
Eosinophil (%)	1.06 ± 0.94	1.33 ± 1.23	0.926	0.36
Total protein (g/l)	4.93 ± 1.27	5.59 ± 1.63	1.252	0.221

Keys:

Parameter	Test N = 30	Control N = 30	T-values	P-values
TWBC (× 10^9/L)	4.95 ± 1.49			
Monocytes (%)	6.77 ± 4.32	5.16 ± 2.99	1.583	0.062
Total Protein (g/l)	8.77 ± 1.200	25.75 ± 6.24	0.221	0.000*

*Significant P-values Twbc: Total white blood cell count
Lympho: lymphocyte
Neutr: Neutrophils
Eosino: Eosinophils
S.D: Standard Devi

Discussion

The findings from this study indicate that malaria parasitaemia is associated with significant alterations in haematological parameters, particularly in total white blood cell (TWBC) counts, lymphocyte and eosinophil percentages, neutrophil counts, and serum total protein levels.

The observed reduction in TWBC among malaria-infected patients compared to healthy controls is consistent with earlier reports indicating leukopenia as a common feature in acute malaria infections[8]. This reduction may be attributed to sequestration of white blood cells in the spleen and margination along the vascular endothelium during infection[9].

Similarly, the significant decrease in lymphocyte count aligns with the lymphocytopenia frequently reported in both Plasmodium falciparum and Plasmodium vivax infections[10]. This immune suppression may reflect the parasite's modulation of host immunity, a phenomenon that facilitates its survival and disease progression[11].

The eosinophil count was also significantly lower in infected individuals, which is contrary to the elevated eosinophils typically seen in parasitic infections. However, in malaria, eosinopenia has been documented as part of the acute phase response, especially in non-allergic individuals[12].

In contrast, neutrophil counts were significantly higher in malaria-infected patients than controls. This neutrophilia may result from systemic inflammation and immune response activation triggered by the malaria parasite[13]. Neutrophils also play a direct role in parasite killing via phagocytosis and the release of reactive oxygen species[14].

The mean monocyte values did not differ significantly between patients and controls, suggesting that monocytes may be less affected or exhibit variable responses depending on the severity or chronicity of infection[15]. This observation supports the findings of other authors who noted inconsistent monocyte responses in malaria[16].

Furthermore, the reduced serum total protein observed in malaria patients may reflect hepatic dysfunction or increased catabolic activity induced by malaria-related stress and inflammation[17]. Hypoproteinaemia could also be influenced by poor nutritional status in endemic populations, which may coexist with malaria[18].

No statistically significant differences were found between male and female patients for neutrophils, lymphocytes, eosinophils, monocytes, or total protein values, suggesting gender may not play a dominant role in the immune cell response to malaria. However, a significantly lower TWBC count in males compared to females might imply a sex-based variation in haematological response, possibly due to hormonal influences or differing immunity thresholds[19].

These findings underscore the utility of basic haematological investigations in malaria diagnosis and prognosis, particularly in resource-limited settings where molecular testing may not be feasible. The alterations observed can aid in early identification and prompt management of malaria complications.

Conclusion

This study demonstrated that malaria parasitaemia is associated with significant alterations in haematological parameters. Infected patients showed lower levels of white blood cells, lymphocytes, eosinophils, and total protein, with increased neutrophils compared to healthy individuals. These findings underscore the importance of complete blood count and protein analysis in the early detection and management of malaria. Public health efforts should continue to emphasize malaria prevention through vector control, use of insecticide-treated bed nets, and timely treatment.

Conflicting Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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