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Research Article

Prevalence and Blood Group-related Distribution of Malaria among Febrile Patients Attending a Nigerian Military Hospital, Jos, Nigeria

Njila, H.L[1]*, Ayeyemi BO[1], Valentine CC[1], Ombugadu. A[2], Idoko JE[3] and Levi RY[4]

[1]Department of Science Laboratory Technology, University of Jos, Nigeria
[2]Department of Zoology, Faculty of Science, Federal University Lafia, Nigeria
[3]Chengdu Institute of Biology, Chinese Academy of Science, China
[4]Faculty of Science, Department of Zoology, Adamawa State University Mubi, Nigeria

***Corresponding author:** Njila, HL, Department of Science Laboratory Technology, University of Jos, P.M.B. 2084 Jos, Plateau State, Nigeria, E-mail: njilahl@gmail.com

1.Abstract

There is increasing evidence that malaria is associated by blood groups. Thus, this study was to investigate the distribution of malaria parasitaemia in relation to blood groups among febrile patients who sought medical attention at a Nigerian Military Hospital, Jos, Plateau State, Nigeria. Thick and thin blood films were made from each blood sample and blood groups were determined by a standard tube agglutination technique. Out of 246 blood samples examined, 172 (69.92%) were infected with malaria parasites, while 74 (30.08%) were not infected. There was a significant difference $p < 0.05$ in the distribution of malaria parasitaemia in relation to blood groups. The malaria parasitaemia was highest in blood group O^+ with 31.71%. There was no significant difference $p > 0.05$ in malaria parasitaemia in relation to sex. The females had the highest malaria parasitaemia of 36.99%. The malaria parasitaemia in relation to age groups had no significant difference $p > 0.05$. Age group 41 years and above had the highest malaria parasitaemia of 19.92%. There was a significant difference $p < 0.05$ in the malaria parasitaemia in relation to *Plasmodium* species. *Plasmodium falciparum* was the most occurring species (67.07%) among the patients with parasitaemia. *Plasmodium falciparum and P. vivax* were found to infect more females than males. There was a significant difference $p < 0.05$ in the severity of malaria parasitaemia among the patients. The mild level of the infection was the highest with 36.59%. This work revealed that both males and females of all blood groups are at risk of malaria. Therefore, malaria prophylactic and therapeutic strategies should be directed at all patients without any discrimination of blood groups.

2.Keywords:

Distribution, Malaria, Parasitaemia, Blood groups, Patients

3.Introduction:

Malaria is a life-threatening blood disease caused by the *Plasmodium* parasites and transmitted to humans by infected female *Anopheles* mosquito [1]. Malaria is said to be one of the world's oldest diseases, which has often decimated populations with greater efficiency than wars [2]. Majority of the malaria in Africa are caused by Plasmodium falciparum, which is the most dangerous of the human malarial parasites. It is responsible for most of the mortality and morbidity associated with the disease. The interplay between malaria parasites and blood group antigens remains a fascinating subject with potential to contribute to the development of new interventions to reduce the global burden of malaria [2]. In 2013, 584,000 people globally died from malaria. About 90% of the deaths occurred in Sub-Saharan Africa where *P. falciparum* is the most prevalent of the malaria

parasites and the leading cause of malaria deaths [3]. *Plasmodium falciparum* has been called "the strongest known force for evolutionary selection in the recent history of the human genome" [4]. The signature of *P. falciparum* has been its enormous toll on human life, especially children where untreated children have a 20-fold higher fatality rate than adults. Malaria, like other infectious diseases that kill children selects for survival genes and effectively prevents transmission of genotypes unfavorable for survival. One such gene that is selected for by malaria parasites is the ABO blood group gene which has three alleles namely, A, B and O, coding for different types of agglutinogens attached to the surface of red blood cells and hence determining an individual's blood group [3]. The *Plasmodium* parasite has established a close relationship between itself and the red blood cells [5]. In fact, severe pathophysiological manifestations of malaria caused by *P. falciparum* are a direct consequence of the parasite's blood stage replication cycle, during which merozoites repeatedly invade, multiply within, and destroy red blood cells. Consequently, red blood cells have evolved spe4 VBGVFCGCMO specific receptor-ligand interactions, some of which involve the ABO blood group antigens, to facilitate their adherence and invasion by merozoites [6]. Therefore, any variation in the erythrocyte ABO antigens can change the penetration and establishment of the merozoites. In terms of severity, *P. falciparum* is the most severe of the human malarial parasites [6]. There is strong epidemiological evidence that the ABO phenotype may modulate disease severity and outcome of *P. falciparum* malaria, with blood groups A and B associated with increased disease severity compared to blood group O [7]. The Plasmodium parasite has been observed to have a reduced capacity to invade group O erythrocytes [8], while macrophages targeting *P. falciparum* infected erythrocytes have been shown to clear infected O erythrocytes more avidly than infected A and B erythrocytes [9]. This could indicate some resistance of group O to the severe presentation of malaria.

4. Materials and Methods

4.1. The study area

The Military Hospital is located on Latitude 9° 52' 13" N and Longitude 8° 53' 30" E along plot 330, Ray field road, Jos North LGA, Plateau State. The Military Hospital was established in the early 80's.

4.2. Ethical clearance

The study protocol was approved by the Military Hospital Ethical Review Committee, before the commencement of the study.

4.3. Study population

A total number of 246 blood samples were considered for the study. Patients across all age groups who sought for medical attention in the Military Hospital. Sample size was estimated using the formula recommended by Charan & Biswas [10].

4.4. Consent of study population

Before blood samples were collected, explanation about the study was given and a written informed consent forms were issued to adult patients above 18 years of age and assent forms were issued to the parents or guardians of children between the ages of 6-18-years to consent on their behalf.

4.5. Inclusion criteria

Patients who were suspected to have malaria and tested for malaria parasites using thick and thin film blood smear and microscopy.

4.6. Exclusion criteria

Patients whose blood was not tested for malaria and febrile patients who had taken any antimalarial drugs within the last two weeks before the blood test. Patients who did not consent or assent to the study were excluded.

4.7. Clinical and laboratory diagnosis of malaria parasites

Two hundred and forty-six (246) capillary blood samples were collected by finger pricking using a sterile disposal lancet for each patient after disinfecting the finger with 70% isopropanol. Heel puncture was used for infants. Immediately, thick and thin blood films were prepared. The films were stained with 10% Giemsa for 15 minutes. The stained films were washed in distilled water and allowed to air dry. Examination of the films was done using an oil immersion objective (100x). Febrile patients who tested positive for *Plasmodium* parasites, the number of parasites was counted (asexual forms only) against 200 white blood cells (WBC). The counting was done using hand tally counters. The number of parasites per microliter was calculated.

4.8. Determination of blood groups

Blood grouping was performed on each of the 246 blood samples taken using agglutination of antigens A, B, and D (Biotech Laboratories monoclonal, UK). Each blood sample was placed at three distinct spots on the slide on a white sterile title. Antigen A (blue), antigen B (yellow), and antigen D (colorless) were inserted and then mixed using an applicator stick. The slides were then rocked for a few minutes to detect any agglutination, and the results were recorded appropriately [11].

4.9. Statistical analyses

Data obtained were analyzed using R (Version 2.9.2). Proportions were compared using Pearson's Chi-square test. The P-values < 0.05 were considered statistically significant.

5. Results

Out of 246 samples examined, 172 (69.92%) were infected with malaria parasites, while 74 (30.08%) were not infected (Figure 1). There was a significant difference (X^2 = 7.8015, df = 7, p < 0.001) in the distribution of malaria parasitaemia in relation to blood groups (Figure 2). The parasitaemia was highest in blood group O+ with 31.71%, while blood groups A- and AB- were the least with occurrences of 0.41% each as shown in Figure 2. There was no significant difference (X^2 = 1.9524, df = 1, P = 0.1623) in the distribution of malaria parasitaemia in relation to sex (Figure 3). The females had the highest parasitaemia rate of 36.99% compared to males with 32.93%. Similarly, the distribution of malaria parasitaemia in relation to age groups showed no significant difference (X^2 = 12.946, df = 8, P = 0.1137) as depicted in Figure 4. Age group 41 and above had the highest parasitaemia rate of 19.92%, while 36 – 40 years had the least of 3.25% (Figure 4). There was a significant difference (X^2 = 145.14, df = 1, p < 0.001) in the distribution of malaria parasitaemia in relation to Plasmodium species (Figure 5). Out of the 172 patients infected with malaria parasites, 165 (67.07%) were infected with *Plasmodium falciparum*; while 7 (2.85%) were infected with *Plasmodium vivax. Plasmodium falciparum* was found to infect more females than males in the order of 35.37% and 31.71% respectively, while P. vivax showed similar infection trend of 2.03% in females and 0.81% in males (Figure 5). There was a significant difference (X^2 = 48.012, df = 2, p < 0.001) in the severity of malaria in the patients (Figure 6). The mild level of the infection was the highest with 36.59% and the severe level was the least with 6.91%.

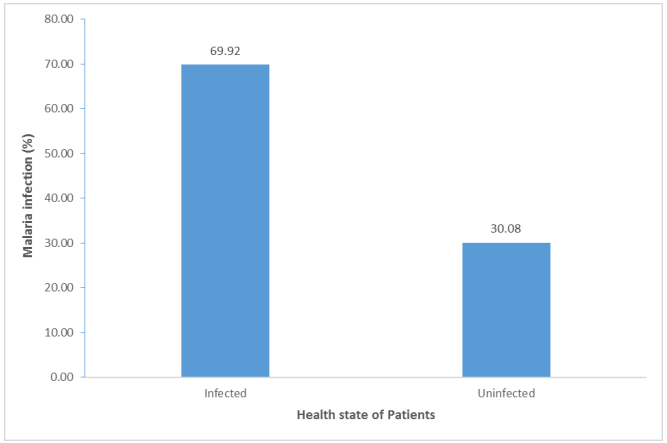

Figure 1: Malaria among patients attending Nigerian Military Hospital, Jos.

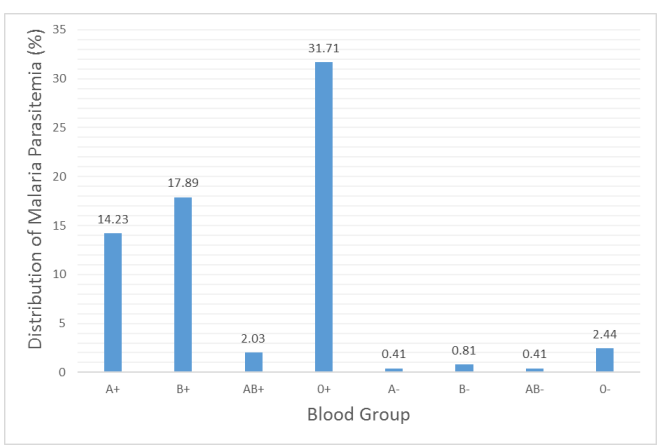

Figure 2: Distribution of malaria parasitaemia in relation to blood groups.

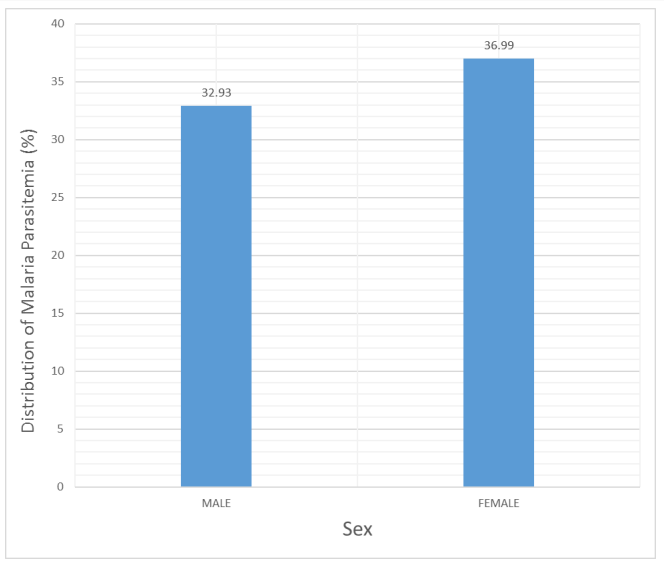

Figure 3: Distribution of malaria parasitaemia in relation to Sex.

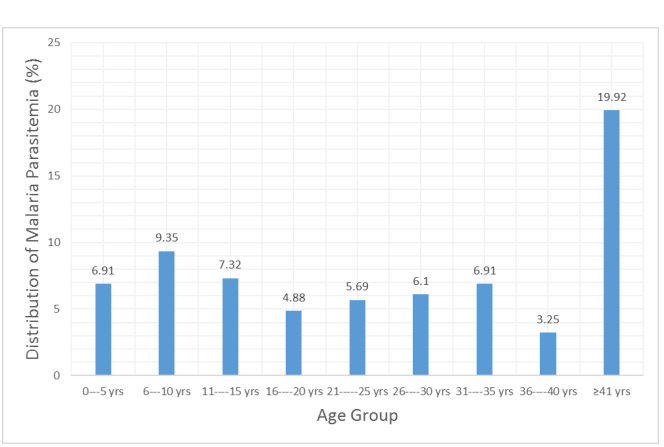

Figure 4: Distribution of malaria parasitaemia in relation to age groups.

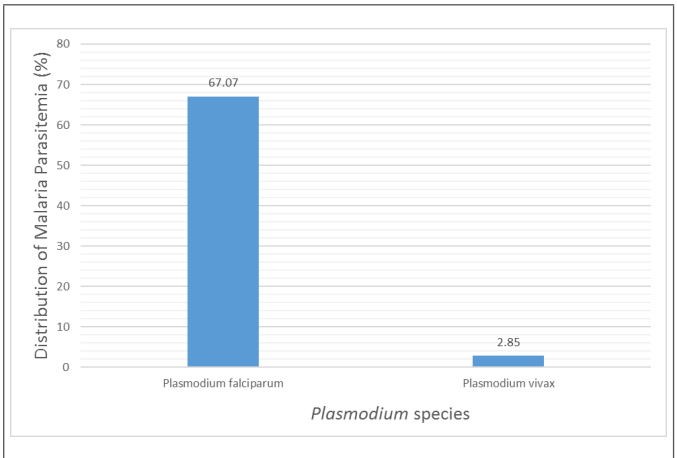

Figure 5: Distribution of malaria parasitaemia in relation to Plasmodium species.

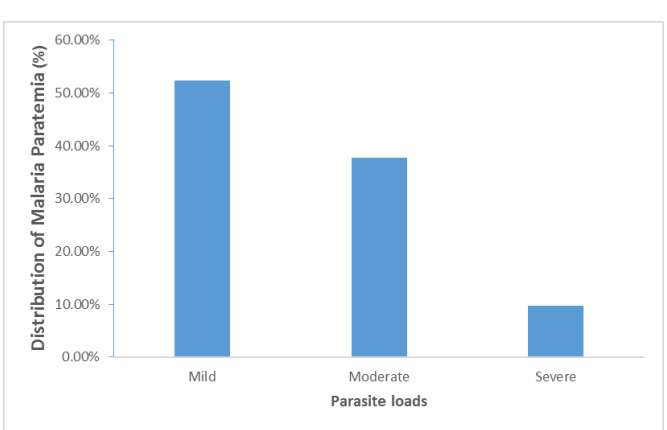

Figure 6: Distribution of malaria parasitaemia in relation to severity of the infection.

6. Discussion

Malaria accounts for 40% of public health expenditure, 30% of in-patient admission and up to 50% of out-patient visits in areas with high malaria transmission [12,13]. The overall prevalence of 69.92% reported in this study is lower compared to the overall prevalence of 83.98% reported by Ito, et al. [14] among patients in Ethiope East, Delta State, Nigeria. However, the overall prevalence in this study was higher compared to the overall prevalence of 51.5% reported by Epidi, et al. [15] among blood donors in Abakaliki, southeastern Nigeria. Malaria being highly prevalent in the patients attending a Nigerian Military hospital at this time can be attributed to the end of wet season, in which the bite of female *Anopheles* mosquitoes are at the peak. Though the raining season is almost ending, rains are usually at their peak in early October. During this period, water accumulates in gutters, pits, containers, abandoned tyres, leaves, and water reservoirs around homes, offices, market places and schools, create conducive breeding sites for malaria vectors. People living in close proximity to these breeding sites are more prone to bites from female Anopheles mosquitoes. It is evident that the patients who sought medical attention at the Nigerian Military Hospital, Jos come from areas with abundant breeding sites for mosquitoes. This study revealed that blood group O+ significantly had the highest malaria parasitaemia compared to other blood groups. This observation is not surprising, as similar thing had been reported in other parts of Nigeria and other African countries. This corresponds with the report of Rowe, et al. [16] in Mali, where blood group O had the highest parasitaemia rate of uncomplicated malaria. This corresponds to the expected distribution of blood group O in malarious populations. Natural selection for resistance against malaria favours blood group O as it is protected against severe *P. falciparum* malaria, which is the most common in Africa [1]. Gender specific distribution of malaria parasitaemia showed that there was no significant difference between males and females patients. However, the distribution of malaria parasitemia was slightly higher in female. This correlates with the findings of Vlassoff and Bonilla [17] and [18] who reported that females are more infected than males. This high distribution of malaria parasitemia in females than males recorded in this work could be due to the fact that females expose their bodies more often than the males and thus increasing their chances of being bitten by the vectors [19].

The present study however, was in contrast to that of Bonilla and Rodriguez [20] and Muntaka and Opoku-Okrah [5] where males had a higher parasitaemia rate than females. This study also revealed that malaria parasitaemia could be age-related. A progressive increase in the distribution of the parasitaemia was observed as the age increases. This is consistent with the reports of some earlier studies in Nigeria [5,21,22]. The distribution of malaria parasitaemia was highest in the age group 41-years and above. This is in contrast with the findings of Nebe, et al. [23] who reported highest parasitaemia in adolescents. Alli, et al. [24] and Akanbi, et al. [19] reported that the degree of immunity is related to the duration of exposure to *Plasmodium* species which is longer for older persons. In this study *Plasmodium falciparum* was predominantly the species responsible for malaria. This is similar to the findings of Tidi, et al. [25]; Brooks, et al. [26] and Aliu, et al. [6]. The low prevalence of other *Plasmodium* species may be because they tend to be selective to the type of blood cells they infect. *Plasmodium* species infect red blood cells and young red blood cells than the old blood cells [27]. In this study, the mild cases of malaria infection were the highest followed by the moderate case and severe or chronic levels.

7. Conclusion and Recommendation

The prevalence of malaria in this study was 69.92%. The high prevalence of malaria parasitaemia encountered was due to socioeconomic factors, such as sanitary conditions, low standard of living, and inadequate use of insecticide treated nets in the study area. Both males and females

with blood groups A, B, AB and O are equally at risk under any given circumstance. Consequently, administration of anti-malarial drugs (both prophylactic and therapeutic regimens) by Government and Non- Governmental health agencies should be directed at individuals of all groups without any discrimination or preference. Also, there is need for the government to incorporate control programs such as public enlightenment, free intensive distribution of insecticide treated nets (ITNs) and definitive diagnosis of malaria which will help to reduce the morbidity and mortality of the disease.

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