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Assessment of prevalence of malaria infection among individuals of different blood groups: An observational study

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Abstract
Aim: The aim of the present study was to assess the prevalence of malaria infection among individuals of different blood groups.
Materials and Methods: The study enrolled individuals aged six months and above, presenting at outpatient departments with symptoms of malaria and/or testing positive for uncomplicated malaria by rapid diagnostic test after providing written informed consent or assent. A total of 200 participants were enrolled in the study.
Results: The present study consisted of a greater percentage of females compared to males, with the bulk of the participants being youngsters aged above 5 years. 45% of the individuals were classified as having the O blood type, with the A blood group being the next most common. The laboratory data, which included leukocyte counts, haemoglobin levels, platelet counts, and C-reactive protein levels, did not show any statistically significant differences between malaria patients and ABO blood types. The prevalence of blood type O was shown to be the least common among malaria patients with haemolytic-uremic syndrome and cerebral malaria. However, no statistically significant association was seen between particular issues and ABO blood types.
Conclusion: Ultimately, there were no fatalities seen among the individuals diagnosed with malaria in this research investigation. There was no discernible correlation between ABO blood types and malaria infection. Nevertheless, individuals with blood group O have a higher prevalence of less severe malaria, making it the most prevalent blood type among malaria sufferers. Thus, individuals with blood type O who have malaria seem to have less severe clinical manifestations.

Keywords: ABO, *Plasmodium falciparum*, Malaria, Blood group

Introduction
Malaria is a highly prevalent and severe parasitic disease that affects humans. The clinical signs of malaria are produced when parasites infiltrate and grow within human red cells. This disease is classified as a vector-borne illness, meaning it can be spread through blood transfusion. Other vector-borne diseases include chagas, toxoplasmosis, leishmaniasis, babesiosis, and microflariasis [1]. The Plasmodium species, namely *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi*, are the causative organisms responsible for malaria. Each of the four human malaria parasites, namely *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*, has the potential to be transmitted via blood transfusion [2]. Certain Plasmodium species have the ability to endure in stored blood for a duration ranging from seven to 40 days, contingent upon the specific species. Malaria parasites extensively invade red blood cells (RBCs) and undergo significant growth inside them during a significant portion of their life cycle [3]. The invasion of red blood cells (RBCs) is facilitated by parasite adhesins and their binding receptors on the surface of the red cell. This process involves a variety of signalling pathways within the RBC, which modify the physical properties of the cell and aid in invasion [4]. The rate at which parasites invade erythrocytes depends on the presence of specific blood group antigens and certain genes related to haemoglobin, specifically haemoglobin C (Hbc) and hemoglobin E (HbE).

These genes have been found to determine the level of susceptibility to *Plasmodium falciparum* infection [5]. Blood group 'A' individuals have shown a higher incidence of malaria episodes compared to individuals with other blood groups [6]. Additionally, a significant number of severe malaria cases have been reported among individuals with blood group 'A'. [7, 8]. Individuals with blood groups A, B, and AB exhibit a higher severity of *P. falciparum* infection compared to those with blood group O [9]. Specifically, blood groups A, B, and AB delay clearance of parasitized RBCs by promoting rosetting and cytoadherence, while blood group O increases clearance of RBC by reducing resetting and cytoadherence [10]. The ABO blood groups have exerted evolutionary pressure [11, 12]. in humans resulting in the natural selection of numerous polymorphisms in the genes encoding for erythrocyte surface proteins, haemoglobin, and immunity [13, 14]. The malaria-associated deaths in endemic areas have been shown to favour selection and retention of individuals bearing infection-resistant genetic variant erythrocytes affecting Plasmodium species invasion and replication within the RBC [15]. Multiple red blood cell (RBC) variants are associated with protection against severe *Plasmodium falciparum* malaria.

Hence the aim was to assess the prevalence of malaria infection among individuals of different blood groups.

Materials and Methods

The study enrolled individuals aged six months and above, presenting at outpatient departments with symptoms of malaria and/or testing positive for uncomplicated malaria by rapid diagnostic test after providing written informed consent or assent. A total of 200 participants were enrolled in the study.

The demographic data and vital signs of each participant were entered in a case report form. 5 mL of venous blood was collected for RDT testing, smear preparation, blood group typing as well as the assessment of other study outcomes including sterile parasite culture. All malaria positive cases were treated according to the case management guidelines for uncomplicated malaria recommended by Ministry of Health. Immediately after the blood draw, the attending clinician administered and directly observed taking the first dose of AL based on the patient's weight. Each patient was given the remain- der of the full dose of AL and advised to take the next dose after eight hours then follow up with the remaining doses at 12 hourly intervals till completion of the dose. Further, they were encouraged to return to the hospital should symptoms persist. Individuals with recurrent parasitaemia during the study period were treated but not re-enrolled.

Malaria diagnosis

The number of parasites in each sample was estimated by examining Giemsa-stained thin and thick blood smears in 200 high-power fields. For quantification, parasite density per microlitre was estimated from the number of parasites counted per 2000 RBCs [16].

ABO Typing

ABO blood group typing was done. One drop of whole blood from each participant was placed in three different spots on a grease-free clean glass slide. Three drops of blood group A, B, and Rhesus factor (D) anti-sera were applied onto each of the three different spots on the glass slide. The blood cells and the antigens were mixed with an applicator stick to homogeneity. The slide was then tilted to detect any agglutination and the results were recorded accordingly [17].

Blood typing

The ABO system categorizes blood into four main groups. In blood group A, the red blood cells have A antigens and the plasma contains anti B antibodies. Blood group B, on the other hand, has B antigens on the red blood cells and A antibodies in the plasma. Blood group O does not have any antigens, but it does have both anti A and anti B antibodies in the plasma. Lastly, blood group AB has both A and B antigens but no antibodies. If agglutination is observed when an individual's blood is mixed with anti A reagent, it indicates that the individual has blood group "A". If agglutination is observed when an individual's blood is mixed with anti B reagent, it indicates that the individual has blood group "B". If agglutination is observed when an individual's blood is mixed with anti-A and anti-B reagents, it indicates that the individual has blood group "AB". If there is no agglutination observed when an individual's blood is mixed with anti-A and anti-B reagents, then the individual is classified as having blood group "O".

Data management and analysis

The data, which included blood group, parasite density, and demographic information for each participant, was entered into Microsoft Excel. It was carefully checked for accuracy and then exported for analysis using SPSS version 22. The density of the malaria parasite was standardized by converting the values into percentages. The association between blood groups and malaria infection was determined using the chi-square ($\chi 2$) test. The difference between means was analyzed using statistical tests such as the students t-test and one-way ANOVA test. Significance was attributed to p-values less than 0.05.

Results

In the current investigation, the number of girls exceeded that of men, and the majority of the youngsters were older than 5 years. 45% of the individuals belonged to the O blood type, with the A blood group being the second most common.

Table 1: Demographic characteristics of the study participants

Participants		N	Blood groups				p-value
			A	AB	B	O	
		200	60 (30%)	10 (5%)	40 (20%)	90 (45%)	
Sex	Male	90	36	4	15	35	0.612
	Female	110	25	5	20	60	
Age Groups	< 5 years	96	36	4	20	26	0.252
	> 5 years	104	25	5	20	54	

Table 2: Laboratory data of different ABO blood types in malaria patients

Laboratory data		A	ABO blood types		AB	*P* value
			B	O		
Leukocyte counts ($\times 10^9$/L)	5.63±2.27	5.48±2.07	4.86±1.84	6.14±2.68	6.04±1.08	0.17
Haemoglobin (g/L)	102.29±31.91	101.46±28.20	105.95±28.42	99.81±32.58	104.86±41.08	0.86
Platelets ($\times 10^9$/L)	71.54±45.07	73.57±50.62	62.66±36.94	68.92±42.28	99.00±62.62	0.49
C-reactive protein (mg/L)	78.27±47.28	67.43±48.22	92.28±41.62	78.92±48.38	89.89±55.66	0.28

The laboratory data, including leukocyte counts, haemoglobin levels, platelet counts, and C-reactive protein levels, did not exhibit any statistically significant disparities between malaria patients and ABO blood types.

Table 3: The distribution of ABO blood types in malaria patients with haemolytic-uremic syndrome and cerebral malaria

Blood group	N	Complications			P Value
		Haemolytic-uremic syndrome	P Value	Cerebral malaria	
A	60	4	0.770	3	0.85
B	40	3	0.939	4	0.89
O	90	4	0.825	2	0.36
AB	10	1	0.991	1	0.54

The incidence of blood type O was found to be the lowest among malaria patients with haemolytic-uremic syndrome and cerebral malaria. Nevertheless, there was no statistically significant correlation seen between specific problems and ABO blood types.

Discussions

Malaria is a potentially fatal parasitic illness that is spread by mosquitoes. Positive prevention and treatment for malaria have resulted in a wide-scale decrease in incidence and mortality; yet, 198 million cases (uncertainty range: 124–283 million) and 584,000 deaths (range: 367,000–755,000) still occur annually [18]. The association between ABO blood types and malaria susceptibility has been explored by various researchers; nevertheless, the findings have been conflicting. Bayoumi *et al.* [19] found no correlation between the prevalence of malaria and ABO blood types in central Sudan. Similarly, a study conducted in Nigeria found no substantial correlation between ABO blood types and the occurrence of malaria infection [20]. Twenty Nevertheless, additional research has demonstrated a noteworthy correlation between malaria and ABO blood types. Bedu-Addo *et al.* [21] demonstrated a distinct safeguarding impact of blood group O against malaria in primipara. A study conducted in Gabon revealed a notable correlation between blood group A and severe malaria [22].

Toure *et al.* [23] and Hegde *et al.* [24] discovered the same phenomena compared with other blood types, blood group O is less prone to rosetting, which leads in lower complications in malaria patients. In the current research, there were more females as compared to men and majority of the children were >5 years of age. 45% belonged to O blood group followed by A blood group. The blood group "O" was the most prevalent, while the blood group "AB" was the least prevalent. Our analysis was consistent with most publications demonstrating the preponderance of blood type O among blood donors. All positive malaria cases were among blood group O persons [25, 26].

The laboratory results, which comprised leukocyte counts, haemoglobin, platelets, and C- reactive protein, exhibited no statistically significant differences between malaria patients and ABO blood types. Among the malaria patients who had haemolytic-uremic syndrome and cerebral malaria, the blood type O had the lowest prevalence. However, no statistically significant association was discovered between specific problems and ABO blood types. data from research revealed in Douala Cameroon, that indicated blood type A and B persons were more prone to malaria infections than blood group O+ [27].

Conclusion

Ultimately, there were no deaths observed among the malaria patients in this study. Furthermore, no significant correlation was found between ABO blood types and malaria infection. However, it is worth noting that individuals with blood type 'O' are the most prevalent among malaria patients and tend to experience less severe cases of the disease. Consequently, it appears that malaria patients with blood type 'O' generally have milder clinical outcomes.

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