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Malaria's association with abo blood groups in a tertiary institution in Ghana

George Ashorm[1*]; David Ntiamoah Ofosu[12]; Akwasi Asamoah[1]; Ransford Mawuli Tuekpe[1]; Saraphina Appiah[1]; Wisdom Selasi Asare [1]; Gift Osei Agyemang[1]; Albert Amoah[1]; Ganiwu Abdul[3]; Christian Obirikorang[2]

Abstract
Malaria is an endemic parasitic infection in Ghana and the world as a whole associated with many environmental, immunological, and economic factors. However, its association with the ABO blood group system has been less explored. This study investigated the association of ABO blood groups with malaria cases among students of the University of Energy and Natural Resource in Ghana. Two millilitres (2ml) of venous blood were collected from 384 asymptomatic patients suspected of malaria between March and August 2022. Malaria infection confirmation was tested by detecting Plasmodium falciparum in whole blood using a first response malaria antigen (HRP2) card test procured from Premier Medical Corporation, P113FRC25, India and also typed for ABO RhD blood group. In an increasing order, the blood groups AB, B, A and O occurred in 32(8.3%), 70(18.2%), 73(19.0%) and 209(54.4%) students respectively. Blood group "O" recorded the highest number of malaria cases (55.0%) and the least was seen in blood group AB (8.3%). There was no significant association between blood group (8.3%), age group ($p = 0.593$), sex ($p = 0.092$), ethnicity ($p = 0.799$), sickling status ($p = 0.249$) and Rh 'D' status ($p = 0.999$) and the incidence of malaria.

Keywords
Blood group, Malaria infection, Plasmodium falciparum, Rhesus factor

[1]Department of Medical Laboratory Science, School of Sciences, University of Energy and Natural Resources, Sunyani, Ghana.
[2]Department of Molecular Medicine, School of Medical Sciences, Kwame Nkrumah University of Science and Technology.
[3]University Health Directorate, University of Energy and Natural Resources, Sunyani, Ghana.
***Corresponding author**
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1. Introduction

Malaria is known to be a parasitic fatal disease which is caused by Plasmodium species and mostly endemic in Sub-Saharan Africa. Even though malaria infection could be caused by other species of Plasmodium; malaria caused by Plasmodium falciparum is considered most detrimental and could lead to death. It is still a major problem in Ghana, with 323 cases per 1,000 children especially < 5 years (Otajevwo, 2013). Despite the considerable progress made in malaria eradication, showing a significant reduction from 27% to 21% from 2015 to 2016, the burden of the disease is still high till date and is currently stated as one of the six major killer diseases in Ghana. The occurrence of malaria is promoted by conditions that tend to favour the creation of increased availability of breeding sites; The geographical setting of a town or community, the architectural layout of residences, and the extent of implementation of anti-mosquito strategies collectively impact the likelihood of individuals being exposed to the infection, as hygienic places and communi-

ties have less cases of malaria (Akowuah & Nsiah, 2019). Malaria resistance is also characterized by the establishment of an immunological response in the host, as well as innate traits that guard against infections (Aluoch, 1997). Examples of such characteristics include sickle cell trait (HbAS), sickle cell disease (HbSS), ABO blood group type, and the activity of Glucose-6-Phosphate Dehydrogenase (G-6-P-D) (Otajevwo, 2013). The individual's ABO blood type is anticipated to have a substantial impact in preventing severe malaria since the clinical manifestations arise directly from the parasite's blood stage replication cycle, during which merozoites consistently invade, proliferate, and lyse the RBCs (Gomerep et al., 2017). In Ghana, data on the general classification of blood groups of individuals across the country is limited, however, a study found the prevalence of blood types A, B, O and AB as 24.3%, 20.7%, 50.0%, and 5.0% respectively in the country's capital city (Doku et al., 2019). In a vibrant community such as the University of Energy and Natural Resources (UENR), where most admitted students and staff are required to go through mandatory health screening, like chest x-ray, haemoglobin level, body mass index (BMI), the blood group, and the blood pressure of students are well classified, however, little attention is paid to malaria testing. A study in the biggest public university in Ghana's second largest city found that 52.8% of students with malaria (Akowuah & Nsiah, 2019), however, circumstances contributing to students' susceptibility on campus are less explored. Exploring the potential relationship between ABO blood groups and malaria could offer valuable insights for efforts aimed at controlling the spread of malaria, especially in malaria-endemic communities (Bamou, 2016). Several studies done on the relationship between hemoglobin genotype, G6PD and malaria, have stated individuals with Heterozygous HbAS or G-6-P-D deficient acquire some form of immunity against malaria compared with other genotypes and those with G6PD (Ahmed et al., 2020; Nguetse et al., 2016; Okafor, Okoroiwu, & Ekechi, 2019). A recent study in Uganda among students stated that HbAS heterozygous are protected from blood-stage plasmodium infection, severe parasitemia, and the progression of infection to symptomatic malaria (Luzzatto, 2012). The same cannot be said for the ABO blood group system and the incidence of malaria in Ghana as most studies have not explored it, especially in an academic student-filled community. This study aimed to determine the prevalence of malaria at the University of Energy and Natural Resources and to investigate its potential association with the ABO blood groups (A, B, O and AB).

2. Materials and Methods

2.1 Study area

The research was carried out at the University of Energy and Natural Resources, Sunyani-Fiapre, in Ghana's Bono Region located at geographical coordinates, 7.34949°N 2.343501°W. UENR which began with 154 students in 2012, can now boast of over 6,000 students. The University comprises multiple campuses located in three areas: Sunyani, Nsuatre, and Dormaa Ahenkro with individual schools shared among the campuses.

2.2 Study Design and Population

The study was a cross-sectional carried out on both campuses (Sunyani and Dormaa) of the University between March and August 2022. All participants were students of UENR, who gave their consent for the study and were asymptomatic for malaria infection. Students who carried symptoms of malaria or were G6PD deficient were not included in this study.

2.3 Laboratory procedures

2.3.1 Sample collection

For all consented participants, 2ml of venous blood was drawn with a syringe and needle into an Ethylene Diamine Tetraacetic acid (EDTA) tube. The venipuncture procedure was carried out with strict aseptic techniques according to the standards described by WHO for collecting blood samples. All blood samples were taken at room temperature and worked on within 30 minutes of sample collection.

2.3.2 ABO-Blood Group

Forward blood grouping of samples was done using commercially prepared anti-sera (Precise MAXX diagnostic blood grouping Kit) via the tube method.

2.3.3 Malaria examination

Microscopic examination of malaria parasites was carried out, which is the gold standard for diagnosing malaria infections. However, malaria rapid diagnostic tests (mRDT) were used for diagnosing the malaria parasites, providing controlled and reliable results in the required period. In this study, the First Response malaria antigen Plasmodium falciparum (HRP2) RDT (Premier Medical Corporation, India, P113FRC25) kit was utilized for all malaria diagnoses. The immunochromatographic test kit meets the current WHO laboratory evaluation requirements with a panel detection score of 91.0% at 200 parasites/ul, a false-positive rate of 1.0% for clean negatives, and 0.0% for invalid rates. Five microliters (5 ul) of the anticoagulated blood was placed in the sample collection area of the RDT kit using a specimen transfer pipette and four separate drops of the mRDT assay diluent added were added to the buffer-designated part on the kit.

2.4 Ethical Statement

All study participants provided consent for the study. Ethical approval for this study was provided by the Com-

mittee on Human Research and Ethics (CHRE) of the University of Energy and Natural Resources, Sunyani – Ghana with reference number CHRE/AP/014/22

2.5 Statistical analysis

The data were analysed using the Statistical Package for Social Sciences (SPSS) for Windows version 16.0. Descriptive statistics, reported in percentages and frequencies, were employed to analyse the social demographics of the participants. Bivariate analysis, utilizing the chi-square test, was conducted to examine the relationship between each independent variable and the outcomes. Additionally, a multivariate logistic regression analysis, employing a stepwise backward elimination procedure, was utilized to control for confounders and their effects on the outcome variables, as well as to manage the simultaneous effects of multiple variables. P-value < 0.05 was regarded as significant in all tests.

3. Results

3.1 Sociodemographic characteristics of study participants

Of the 384 students recruited for this study, about three-quarters (72.9%), were aged 20-25 years and the least group recorded were 30-38 years (6.5%). There were more (56.8%) males than females (43.2%). Akans dominated in the study (70.3%) whilst the remaining were either Ewes and Ga-Adangbe (13.5%) or Northerners (16.1%). Most of the participants (89.1%) were sickle cell negative or Rh 'D' negative, and the same number (10.9%) were sickle cell positive or Rh 'D' positive.

Table 1. Sociodemographic characteristics of participants

Variable	Number of Students	Percentage (%)
Age group (years)		
15-20	48	12.5
20-25	280	72.9
26-30	31	8.1
30-38	25	6.5
Sex		
Females	266	43.2
Males	218	56.8
Ethnicity		
Akan	270	70.3
Northerner	62	16.1
Ewe/ Ga Dangme	52	13.5
Sickling Status		
Negative	342	89.1
Positive	42	10.9
Rh'D' status		
Negative	42	10.9
Positive	384	89.1

3.2 Distribution of ABO blood groups among students of UENR, Sunyani

The ABO-blood group of the participants were screened. A majority of the students, comprising 54.4%, had blood group O, followed by blood group A (19.0%), blood group B (18.2%) and blood group AB (8.3%).

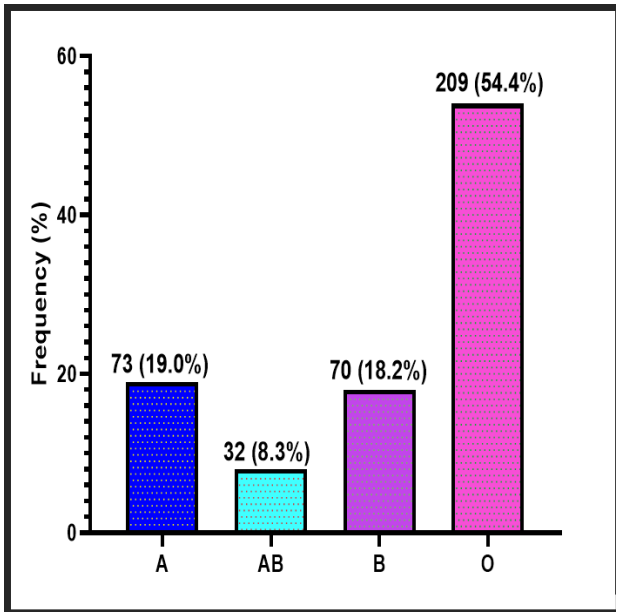

Figure 1. Distribution of ABO blood groups among students of UENR, Sunyani

3.3 Prevalence of malaria among students of the UENR.

Among the participants, 324 (84.4%) tested negative for malaria and the remaining 60 (15.6%) tested positive for malaria. Figure 2 displays the prevalence of malaria amongst students of the UENR.

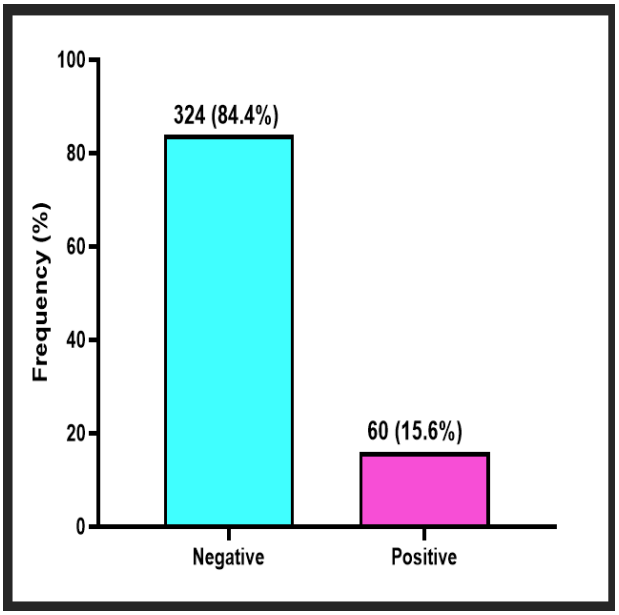

Figure 2. Prevalence of malaria amongst students of the UENR, Sunyani

3.4 Association between Blood Group and Malaria

The association between the ABO blood group and the prevalence of malaria was assessed using Pearson's chi-square test. Blood group AB reported the highest prevalence of malaria with 21.9% (n=7) followed by blood group A with 17.8% (n=13), blood group O with 15.8% (n=33) and lastly blood group B with 10% (n=7). However, the association was statistically insignificant (X^2=2.89, p = 0.408).

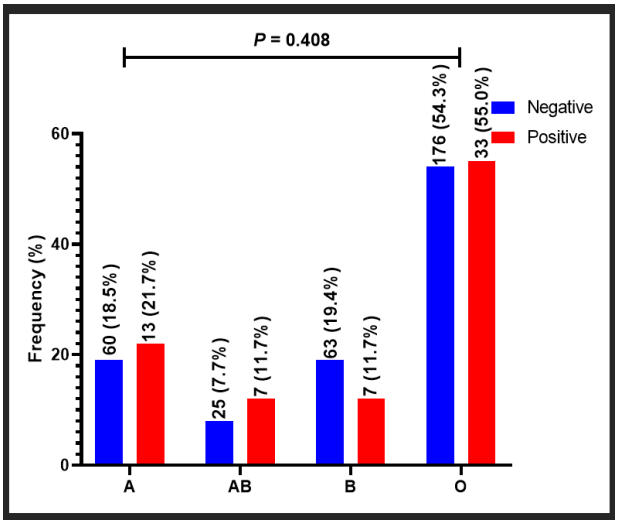

Figure 3. Association of ABO blood groups and malaria among the students of UENR, Sunyani

3.5 Factors associated with malaria among the participants

This study assessed the factors associated with malaria among students of UENR. There was no statistically significant association between the age group (p = 0.593), sex (p = 0.092), ethnicity (p = 0.799), sickling status (p = 0.249) and Rh 'D' status (p = 0.999) and the occurrence of malaria.

Table 2. Factors associated with malaria among the students of UENR, Sunyani

	Malaria Parasites Seen		
Variable	**No (n=324)**	**Yes (n=60)**	**p-value**
Age group (years)			0.593
15-20	41 (12.7)	7 (11.7)	
20-25	239 (73.8)	41 (68.3)	
26-30	25 (7.7)	6 (10.0)	
30-38	19 (5.9)	6 (10.0)	
Sex			0.092
Females	146 (45.1)	20 (33.3)	
Males	178 (54.9)	40 (66.7)	
Ethnicity			0.799
Akan	230 (71.0)	40 (66.7)	
Northerner	51 (15.7)	11 (18.3)	
Ewe/ Ga Dangme	43 (13.3)	9 (15.0)	
Sickling Status			0.249
Negative	286 (88.3)	56 (89.1)	
Positive	38 (11.7)	4 (6.7)	
Rh'D' status			0.999
Negative	36 (11.1)	6 (10.0)	
Positive	288 (88.9)	54 (90.0)	

4. Discussion

According to the findings from this study, the most predominant blood group among the students was "O" (54.4%) and the least was "AB" (8.3%) and this is consistent with most reports in malaria-endemic regions and most African countries (Gomerep et al., 2017; Bamou & Sevidzem, 2016; Otajevwo, 2013). Although there are variations in the figures, the observed variations can be attributed to ethnic, racial, and geographical disparities and in all cases abundance of the blood group O is consistent. The prevalence of malaria among the participants as seen in this study was minimal (15.6%), consistent with another study done in a public university in Ghana (Akowuah & Nsiah, 2019). The parasitemia rate in this study appears to be relatively low compared to studies conducted in universities in other African countries (Gomerep et al., 2017; Otajevwo, 2013). The somewhat low malaria parasitemia rate recorded in this study could be attributed to the sanitary situation of the university environment taking into account the drainage channels, availability of refuse bins etc. reducing malaria breeding sites (Greenwood, 1989). The study again found no significant associations between the age group (p = 0.593), sex

($p = 0.092$), ethnicity ($p = 0.799$), sickling status ($p = 0.249$) and Rh 'D' status ($p = 0.999$) and the occurrence of malaria among students. Males were slightly more than females, and among them, 66.7% of them were infected compared to females (43.2%) of their respective total number. The reasons for the observed gender differences are complex and warrant further investigation. Conducting additional studies on other populations in different regions of Ghana would be essential to provide a more comprehensive understanding and potential explanations. The practical application of these findings is that both males and females with ABO blood groups; A, B, AB, and O are equally at risk in any given situation. Again, the highest malaria cases were observed in participants with blood group "O" (50.0%), a finding which is in concordance with those of (Otajevwo, 2013). Despite the findings, significantly bigger sample sizes should be used to come to a more definite conclusion. Blood B and AB recorded the least (11.7%) malaria cases (Figure 3). In contrast, some studies by Migot-Nabias et al. (2000) have reported blood group "O" to provide a certain degree of protection against severe courses of certain diseases including malaria. While further validation through a study with a larger sample size would be necessary, it appears that malaria parasitemia is relatively evenly distributed among all blood groups in this study. Fischer and Boone made a similar assertion, reporting that malaria can affect individuals of any blood group, and no specific blood group excludes the risk of severe malaria.

5. Conclusion

The objective of the study was to determine the prevalence of malaria at the University of Energy and Natural Resources and to investigate its potential association with the ABO blood groups (A, B, O and AB) among the students. The outcome of the study found blood group "O" as the dominant group and "AB" as the least prevalent. There was however a low prevalence of malaria among participants (15.6%). The blood group "AB" recorded the highest percentage of malaria cases (21.9%) and the least (10.0%) was blood group "B". The study asserts that there is no clinically significant association between an individual's blood group and his or her incidence of contracting malaria infections, however, there is still the need for particular attention to be given to the control of malaria transmission in the Fiapre area in Sunyani where the university is situated as over 15% asymptomatic cases of malaria are recorded in the study.

6. Acknowledgement

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7. Authors' contribution

DNO, AA and RMT conceived and designed the study. GA, SA, and AWS collected and transferred all data from the field and did the laboratory work. GA and GOA drafted the manuscript. DNO, AA, GAB, AA and CO reviewed the study design and methods used in the study and accordingly, reviewed the manuscript critically.

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