

Prevalence of Malaria Parasitaemia in relation to ABO and Rhesus blood groups among selected students of a tertiary institution South-West Nigeria.

James A. Ndako

ndako.james@adelekeuniversity.edu.ng

Department of Medical Laboratory Science, Adeleke University Ede-Nigeria <https://orcid.org/0000-0002-2576-8230>

Faroun O. Boluwatife

Department of Medical Laboratory Science, Adeleke University Ede-Nigeria

Daniel A. Afariogun

Department of Medical Laboratory Science, Adeleke University Ede-Nigeria

Blessing N. Eze

Department of Medical Laboratory Science, Thomas Adewumi University, Oko-Nigeria

<https://orcid.org/0009-0005-8228-0804>

Christy J. Ndako

Department of Nursing Science, Adeleke University, Ede-Nigeria <https://orcid.org/0009-0006-2866-3385>

Tola O. Onaiwu

Department of Medical Laboratory Science, Redeemers University, Ede-Nigeria <https://orcid.org/0000-0003-0230-158X>

Isaiah A. Adeleke

Department of Medical Laboratory Science, Adeleke University Ede-Nigeria

Short Report

Keywords: Prevalence, Malaria, Parasitaemia, ABO, Rhesus, Blood groups, Students, Tertiary institution

Posted Date: June 29th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10142623/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: The authors declare no competing interests.

Abstract

The human ABO blood and Rhesus is an important determining factor in the distribution and co-infection of human malaria parasite infection, since, Blood-group antigens are increasingly recognized as key modulators of malaria susceptibility. Malaria is an important cause of ill-health primarily transmitted by Female Anopheles mosquito and is responsible for severe morbidity and mortality especially in Sub-Saharan Africa and globally. This study investigated the susceptibility to malaria infection when the ABO blood types and Rhesus is considered a predisposing factor. Two-three millimetres (2-3ml) of venous blood was obtained by venipuncture from asymptomatic subjects into ethylene-diamine-tetra-acetic-acid (EDTA) anticoagulated blood containers, properly mixed and labelled appropriately. One-hundredb & eighty-three (183) respondents comprising of 69 males and 114 females recruited for the study, were subjected to ABO blood typing using monoclonal Antisera A, B, AB, D and microscopic analysis for plasmodium parasites screening using thick and thin smear assay technique. All data was analyzed using SPSS 25.0 software package. The descriptive data was presented as means $\pm$ standard deviation (SD) was used for analytic assessment. Findings show that Prevalence of malaria was 50.1% among the screened population. However, there was no statistical significant association between malaria infection and gender ($p = 0.359$), also with age (0.484). Blood group O phenotype was the dominant ABO group (45.6%) recorded, followed by B (26.7%), A (22.2%) and AB (5.6%) in malaria parasitaemia (+), while in malaria parasitaemia (++) blood group B was the dominant ABO group (66.7%), followed by AB (33.3%), and A & B (0.0%). Subjects with Rhesus D (Rh D) positive were (90.0%) with malaria parasitaemia of (+), while Rh D negative recorded (10.0%) with a record of malaria parasitaemia of (+), while a parasitemic record of (++) was observed among individuals with Rh D positive at (100%) in contrast to individuals with Rh D negative recording (0.0%). However, there was no statistical significant association between malaria and Rh D phenotypes ($p = 0.264$). It was observed that ABO phenotypes respondents recorded a statistical significant association with malaria parasitaemia ($p = 0.54$). In conclusion prevalence of malaria among the participants was high, while blood group O phenotype respondents were the dominant group followed by B, A and AB. Rh D phenotype was not associated with malaria while ABO phenotype were associated with malaria. These findings call for thorough investigations of key haematological parameters among malaria patients to enhance accurate diagnosis and therapy.

BACKGROUND OF STUDY

Malaria infection has assumed a global concern particularly in LMICs, as an estimated 282 million malaria cases and 610 000 malaria deaths in have been reported in 80 countries, while the African Region carries a disproportionately high share of the global malaria burden, furthermore Children under 5 accounted for about 75% of all malaria deaths in the Region, (WHO, 2024). This burden of morbidity and mortality seem to be on the increase despite global efforts and research aimed at improving the prevention, diagnosis, and treatment of malaria (WHO, 2022). Malaria mortality rate globally ranges from 0.3–2.2%, and in cases of severe forms of malaria in regions with tropical climate from 11–30% (Talapko et al., 2019b). Malaria can bear the tag of an infection as well as a disease. It occurs as a result of the excessive destruction of erythrocytes (red blood cells) by parasites of the genus Plasmodium. Over the

years, malaria has proven to be a major selective force on the human population, especially in populations of many tropical and sub-tropical areas (Bawo et al., 2020), as thousands of deaths are continuously being recorded annually as a result of malaria. Knowing fully well that the human malaria vector (female *Anopheles* mosquitoes) and human malaria parasite *Plasmodium* spp. feeds on erythrocytes (RBCs) to obtain nutrients required to under-go their life cycle, in the process causing malaria disease.

There appears to be a definite relationship between the human blood and malaria parasite. Such relationship is parasitic, where the host has nothing to gain from the relationship, however, humans can either be susceptible or exhibit some levels of resistance to malaria disease through their blood. However, resistance to malaria has also been frequently reported among AA'genotype individuals. Considering this fact, the explanation of the sickled haemoglobin due to the presence of the sickle cell (S) allele as the factor that confers resistance to humans against malaria will not always be correct because AA'genotype individuals do not carry sickle cell (S) allele. The ABO blood group became an aspect to look out for to find answers to resistivity and susceptibility of the human blood to malaria disease, since it is directly involved in the interaction with malaria parasites and also because, generally, human blood is classified using the ABO blood grouping system. Findings were made and there actually exists a school of thought which says ABO blood groups have varying susceptible and resistance relationship with human malaria parasite. Susceptible in that some blood groups are more easily affected by malaria infections and resistance in that one or two has mechanisms that are capable of keeping malaria at a bay. If this is true, then it would be correct to say that malaria and its parasites contributes to varying global distributions of ABO blood groups in human populations (Bawo et al., 2020), especially in populations where malaria is prevalent.

This study provides insights into malarial pathogenesis in relation to ABO blood groups of respective subjects studied, putting into consideration factors that could confer resistance to malaria infection and possible measures in a bid to reduce the prevalence of malaria in malaria endemic region such as Africa and particularly, Nigeria and our study location. The human ABO blood and Rhesus could be an important determining factor in the distribution of human malaria parasite. Malaria infection presents clinical manifestation such as fever, headache, shivering, nausea, vomiting, arthralgia, anaemia, hepatomegaly, convulsion, death and retinal whitening (Bittaye et al., 2022). Malaria is the most important parasitic disease of man (White, 2018) which is believed to be a major obstruction to social and economic development in Africa because it causes enormous misery and suffering through the pain of fevers and the anguish of bereavement. Malaria is caused by parasites of the genus *Plasmodium* and transmitted by Female *Anopheles* mosquitoes. Malaria is a significant public health problem in sub-Saharan Africa. Of the estimated 228 million global malaria cases in 2018, 93% were from sub-Saharan Africa (WHO 2019). Notwithstanding, 94% of the overall 405,000 malaria deaths in the same year were from sub-Saharan Africa (WHO 2019). Malaria is a major public health concern in Nigeria, with an estimated 68 million cases and 194,000 deaths due to the disease in 2021. Nigeria has the highest burden of malaria globally, accounting for nearly 27% of the global malaria burden (WHO 2021). This magnitude of occurrence in this part of the world correlates with poverty, ignorance and social

deprivation in the community. There are five species of Plasmodium that infects human: *P. falciparum*, *P. vivax*, *P. vivo*, *P. malariae* and *P. knowlesi* (Sato, 2021). Several studies show that *P. falciparum* is the deadliest form of malaria especially in sub-Saharan Africa where it accounts for about 98% of the total malaria cases in Nigeria (Chijioke-Nwauche et al., 2015)

The blood grouping system consists of the A, B and H carbohydrate antigens, which can regulate protein activities during infection, and antibodies against these antigens. ABO blood grouping is based on the presence or absence of A and B blood group antigens on the surface of red blood cells (RBC) derived from inherited gene (Simon-Oke et al., 2016). The distribution of the four ABO blood types, A, B, AB, and O, varies in populations throughout the world and is determined by the frequency of the three alleles of the ABO gene.

With malaria being a life threatening disease and having a disproportionately high burden accrued to the African region (Alegana et al., 2020), it is therefore thought worthy to assess the distribution of malaria in relation to ABO blood group and Rhesus among Adeleke University student, Nigeria. This will create an invaluable window for enlightenment for prevention, proper diagnosis and treatment of malaria in relation their ABO blood group and Rhesus in order to prevent upsurge of emergency malaria cases.

Transmission

Malaria can be transmitted through the bite of an infected female Anopheles mosquito. When a malaria infected mosquito bites its host, the malaria parasites (plasmodium species) are transmitted into the bloodstream. Sporozoites travel to the liver and infect hepatocytes, where they mature and reproduce, this liver stage does not cause noticeable symptoms. Infected hepatocytes release merozoites, a form of the parasite into the bloodstream. Merozoites invade red blood cells, initiating the blood stage of infection, during these stage malaria symptoms such as fever, chills and anemia manifest. Some parasites develop into sexual forms called gametocytes which circulate in the bloodstream. When a mosquito bites an infected person, it ingests gametocytes along with blood. In the mosquito's stomach, gametocytes mature into male and female gametes, fertilization occurs leading to the formation of a zygotes. The zygote undergoes sporogony, producing sporozoites. Sporozoites travel to the mosquito's salivary glands, completing the cycle. (WHO, 2019)

This study aims to investigate the potential correlation between ABO blood group, Rhesus factor and the distribution of malaria. Understanding any association could provide valuable insights into the susceptibility or resistance of individuals with specific blood types to malaria infection. This knowledge may contribute to targeted preventive measures, improved patient care and the development of strategies for malaria control.

The current lack of comprehensive research on the association between ABO blood group, Rhesus factor and the distribution of malaria creates a gap in understanding potential predispositions or resistances in different populations. This statement of the problem addresses this gap which is crucial for informing

targeted interventions, personalized healthcare strategies, and advancing our overall understanding of the complex interactions between blood types and malaria susceptibility.

Objectives of this study includes:

1. To assess the prevalence of ABO blood groups among individuals diagnosed with malaria in the study site.
2. To determine the distribution of Rhesus factors among malaria-infected population in the study site.
3. To determine the Packed Cell Volume of the study population
4. To investigate potential association between specific ABO blood groups and an increased or decreased risk of contracting malaria.

MATERIALS AND METHODS

Study design

This is an analytic cross-sectional study that was conducted at Adeleke University, Osun state, Ede.

Study population and sampling

Selected Volunteer Student population of Adeleke University, Ede-Osun State, during the study period were recruited for the study. Combination of systematic and simple random sampling was used to select the participants. Volunteer students participants were registered and basic bio-data obtained. This information was used to construct a sampling interval. Using the registration serial numbers, simple random was employed using lottery approach to select the first and subsequent participants. This process was repeated daily until the required sample size was reached.

ETHICAL CONSIDERATION AND INFORMED CONSENT

The ethical approval for this study was obtained from the Ethical & Research committee of Adeleke University, Ede, Osun state, Nigeria. Approval from the AU- ethical committee was obtained for the study. Written consent was also obtained from the selected study Participants before the commencement of the study.

Statistical Analysis

Data analysis was performed using SPSS version 25.0 software package. The descriptive data are presented herein as means $\pm$ standard deviation (SD). Pearson's Chi-square test and one-way analysis of variance (ANOVA) was used to determine and classify the prevalence of malaria parasite in relation to ABO blood groups and Rhesus factors. Chi-square tests and descriptive statistics was used to describe the differences in socio-demographic characteristics. P value ≤ 0.05 will be considered significant. Point estimation of prevalence of malaria was calculated based on the blood sample results. The comparison

of prevalence of *P. falciparum* in relation to ABO blood group and Rhesus factor of students attending Adeleke University was performed using chi-square test. Odds ratios with a 95% confidence interval were computed to compare the strength of association.

Sample size

The sample size was calculated using standard statistical formula of Leslie Fischer

$$n = \frac{Z^2 \times pq}{d^2}$$

n= number of samples

P= Prevalence of malaria (Mukhtar, ahmat and salisu, 2020) = 26%

q = 1-p

z= statistics for 95% confidence limit (1.96)

d= allowed error in research (5%)

$$n = \frac{1.96^2 \times 0.26 \times 0.816}{0.05^2}$$
$$n = \frac{3.8416 \times 0.26 \times 0.816}{0.0025}$$
$$n = 326$$

Sample collection

Two millimeters (2-3ml) of blood was collected from the subjects by venipuncture using sterile needle and syringes. Blood collected were dispensed into ethylene-diamine-tetra-acetic acid (EDTA) anticoagulated blood containers, properly mixed and labeled appropriately. Proper aseptic techniques were followed to prevent contamination. Students attending Adeleke University who met the inclusion criteria and obtained their consent for participation in the study were selected for this study employing a simple random sampling method.

Sampling Assay

Microscopy

The collected blood samples were analyzed within 1 to 2 hours after collection. Thick and thin films (TnS/TkS) were prepared according to the standard technique. A drop of blood sample was placed on the center of grease-free slides. Thereafter, the reverse side of the slides was carefully cleaned with cotton wool, the slides were allowed to air-dry and stained with Giemsa stain for between 45min-1 hour.

The slides were then gently washed off with clean water. The prepared slides were examined under a microscope using oil immersion at 100× magnification to observe for *Plasmodium* parasite. The presence of ring forms or Trophozoites of *Plasmodium* indicated positive results. In contrast, the absence of either Trophozoites or ring form after 10 minutes of a thorough examination by a qualified microscopist indicates a negative result.

Principle of ABO and Rhesus blood group

The ABO and Rh blood group of each subject was determined using cell grouping Antisera (Agappe Diagnostic Ltd, India), using a tile method according to method described by Cheesebrough.

Determination of ABO and Rhesus factor

The ABO blood group of each subject was determined using cell grouping Antisera (A, B, AB and D). Four drops of each subject's blood were placed on separate points on a sterile white tile divided into four (4) cells. A drop of antisera A, B, AB and D were placed beside the blood and thoroughly mixed to obtain a homogenous mixture with the aid of a sterile rod and the tile was rocked gently to ensure uniform mixing. The mixture was carefully observed to determine the Rhesus factor. Finally, the blood samples of respondents were grouped based on these observation and confirmation into blood group A+, A-, B+, B-, AB+, AB-, O+, and O- (Simon-oke et al., 2016)

Determination of Packed Cell Volume (PCV)

A capillary tube was inserted vertically inside an EDTA bottle containing anticoagulated blood sample, the capillary tube was filled to 1/3 and was removed. The body of the capillary tube was cleaned with cotton wool and one end of the capillary tube was sealed with plasticine which is a sealant. It was then placed in a microhaematocrit centrifuge and spun for 5mins at 12000 rpm. After which the result is read using a microhematocrit reader.

RESULTS

All data was analyzed using SPSS 25.0 software package. The descriptive data was presented as means $\pm$ standard deviation (SD) was used for analytic assessment. The quantitative and qualitative findings of the study were jointly displayed in clear terms. The result was appropriately presented in Tables and Figures.

A total of two hundred subjects were recruited and their blood samples were collected and analyzed. During the study period, a total of 90 individuals were positive for malaria parasitaemia, given a prevalence of 50.1%.

TABLE 3.1: Distribution of Malaria Parasitaemia among male and female subjects screened.

			Malaria Parasitaemia			Total
			Positive (+)	Positive (++)	Negative	
Gender	Male	Freq	37	1	31	69
		% MP	41.1	33.3	34.4	37.7
	Female	Freq	53	2	59	114
		% MP	58.9	66.7	65.6	62.3
Total		Freq	90	3	90	183
		%MP	100.0	100.0	100.0	100.0

P>0.005

Table 3.1 shows that the total number of individuals screened were 183. The total number of individual that tested positive (+) for Malaria parasitaemia were 90, of this number, 37 (41.1%) were Males and 53 (58.9%) Females. The total number of individuals that tested positive (++) for Malaria parasitaemia were 3, of which 1 (33.3%) was a Male and 2 (66.7%) Females. The prevalence rate was higher among the Female gender. The total number of individuals that tested Negative for Malaria parasitaemia were 90, of which 31 (34.4%) are Males and 59 (65.6%) are Females.

TABLE 3.2: Distribution of ABO blood group and Malaria parasitaemia among study respondents

			Malaria Parasitaemia			Total	
			Positive (+)	Positive (++)	Negative		
Blood Group	A	Freq	20	0	16	36	
		% MP	22.2	0.0	17.8	19.7	
	B	Freq	24	2	26	52	
		% MP	26.7	66.7	28.9	28.4	
	AB	Freq	5	1	3	9	
		% MP	5.6	33.3	3.3	4.9	
	O	Freq	41	0	45	86	
		% MP	45.6	0.0	50.0	47.0	
	Total		Freq	90	3	90	183
			% MP	100.0	100.0	100.0	100.0

P<0.05

Table 3.2 The total numbers of individuals that tested positive (+) for Malaria parasitaemia were 90, analysis showed that; 20 (22.2) are blood group A, 24 (26.7%) are blood group B, 5 (5.6%) are blood group AB and 41 (45.6%) are blood group O. The highest prevalence rate of individuals that tested positive (+) for Malaria parasitaemia is blood group O. The total number of individuals that tested positive (++) for Malaria parasitaemia are 3, of which 0 (0.0%) are blood group A, 2 (66.7%) are blood group B, 1 (33.3%) are blood group AB and 0 (0.0%) are blood group O. The highest prevalence rate of individuals that tested positive (++) for Malaria parasitaemia is blood group A. The total number of individuals that tested Negative for Malaria parasitaemia are 90, of which 16 (17.8%) are blood group A, 26 (28.9%) are blood group B, 3 (3.3%) are blood group AB and 45 (50.0%) are blood group O.

TABLE 3. Distribution of Rhesus factor and Malaria parasitaemia in in study respondents.

			Malaria Parasitaemia			Total
			Positive (+)	Positive (++)	Negative	
Rhesus	Positive	Freq	81	3	85	169
		% MP	90.0	100.0	94.4	92.3
	Negative	Freq	9	0	5	14
		% MP	10.0	0.0	5.6	7.7
Total		Freq	90	3	90	183
		% MP	100.0	100.0	100.0	100.0

P>0.05

Table 3.3 shows that out of the total number of individuals that tested positive (+) for Malaria parasitaemia which are 90, 81 (90.0%) are Rhesus positive (+), while 9 (10.0%) are Rhesus Negative. Individuals that tested positive (++) for Malaria parasitaemia are 3, of which 3 (100.0%) are Rhesus positive, while 0 (0.0%) are Rhesus negative. Individuals that tested Negative for Malaria parasitaemia are 90, of which 85 (94.4%) are Rhesus positive, while 5 (5.6%) are Rhesus Negative.

TABLE 3.4: Comparison of PCV and Malaria parasitaemia in study respondents

PCV	23 -35	Freq	29	0	37	66
		% MP	43.9	0.0	56.1	100.0
	36 – 45	Freq	55	2	50	107
		% MP	51.4	1.9	46.7	100.0
	≥45	Freq	6	1	3	10
		% MP	4.7	10.0	2.8	100.0
Total		Freq	90	3	90	183
		% MP	100.0	100.0	100.0	100.0

P>0.05

Table 3.4 shows that of the total numbers of individuals screened and found positive with varying levels of MP, recorded a PCV ranging from 23%-35% were 66 out of which 29 (43.9) individuals tested Positive (+) for Malaria parasitaemia, 0 (0.0%) individual tested Positive (++) for Malaria parasitaemia and 37 (56.1%) individuals tested Negative for Malaria parasitaemia. The total numbers of individuals within the PCV ranging from 36%-45% recorded a total of 107 screened respondents, out of which 55 (51.4%) individuals tested Positive (+) for Malaria parasitaemia, 2 (1.9%) individuals tested Positive (++) for Malaria parasitaemia and 50 (46.7%) individuals tested Negative for Malaria parasitaemia. Finally the total number of individuals within the PCV ranging ≥ 45 were 10 respondents, out of which 6 (60.0%) individuals tested Positive (+) for Malaria parasitaemia, 1 (10.0%) individuals tested Positive (++) for Malaria parasitaemia and 3 (30.0%) tested Negative for Malaria parasitaemia.

DISCUSSION

Determination of the various ABO/Rh blood group distributions and their association with malaria infection has paramount significance in the context of transfusion medicine and malaria control (Ohiengbomwan et al., 2019). The participants recruited in this study were undergraduate students of Adeleke University with representation from different ethnic and geographical locations of Nigeria. Their composition therefore, may be more representative of Nigeria than south-western Nigeria and hence the ABO blood group phenotype frequencies similar to that of Nigeria.

Overall findings, showed a 50.1% prevalence of malaria parasitaemia among study participants which is slightly on a high side which implies an increased risk of malaria parasite transmission within the population. The rate obtained in this study is much higher than that obtained in Kano (Mukhtar, Ahmat and Salisu, 2020) and in another study carried out in a tertiary hospitals in Nigeria (Bo et al., 2024),

where prevalence rates of 26% and 21.1% were reported respectively. This may be due to differences in environmental factors, level of endemicity and prevention modalities for malaria.

The prevalence of malaria was higher in females (58.9%) compared to males (41.1) with regards to malaria parasitaemia (+) however, in malaria parasitaemia with (++), female subjects had the highest prevalence of (66.7%) compared to males (33.3%). This finding is in line with two studies by Antwi et al., (2019), where female had a higher malaria parasite infection rate than males but contrasts with the report by Bo et al., (2024) that reported a higher infection rate in males than females. The low rate of infection among male students in this study may be because of the low number of male participants.

The study gathered that 41 participants positive for Malaria infection, with the blood group O dominated the table out of 90 malaria positive subjects, while blood group AB (6) recorded the least prevalence among the sampled population for ABO grouping (Tables 4.1); where 90.0% rhesus positive and only 10.0% were observed to be rhesus negative in the study population., The predominance of blood group O was consistent with findings from similar studies conducted across sub-Saharan Africa, where the blood group O is most prevalent. In a research conducted by Akogu *et al.*, (2021) among some patients in North Central Nigeria, revealed a blood group O prevalence which is similar to the result obtained in this study. The Malaria infectious rate at our study location may be attributed to genetical predisposition, geographical locations and possibly tribal affiliations in the frequency of ABO blood group genes discovered.

In this study, a high prevalence of malaria parasitaemia (+) of the blood group O phenotype (45.6%) was observed among study participants followed by B (26.7%), A (22.2%) and AB (5.6%), while a high prevalence of malaria parasitaemia (++) was observed in blood group B (66.7%), followed by AB (33.3%) and both blood group O and A with (0.0%). These results are consistent with the reports from a research conducted in South-western Nigeria (Ohiengbomwam et al., 2019).

Blood group O phenotype was the dominant group in this study; this was followed by groups B, A and AB in that order. Similarly, Rh D positive was the dominant Rh D phenotype. This is similar to what was reported from different parts of Nigeria in a systematic review by (Mukhtar et al., 2018; Mukhtar and Aisha, 2019), it however contrasts the report from North-west Nigeria where blood group A frequency is higher than that of B (Anifowoshe et al., 2017). Rh D phenotype was not significantly associated with malaria in this study with $P > 0.05$. This is similar to what was reported by Bamou and Sevidzem (2016), that found no association with malaria and RhD phenotype among undergraduate students in a university in Cameroon (Mukhtar, ahmat and Salisu, 2020).

Malaria infection showed significant association with blood group with $P < 0.05$ with the highest malaria (+) prevalence (45.6%) recorded among individuals with blood group O. Blood group AB had the least malaria (+) prevalence of (5.6%). This agrees with the findings of (Mukhtar et al., 2018; Mukhtar and Aisha, 2019) who recorded highest prevalence in O blood type but the study is not in credence with the findings from the studies of Inyang-Etoh and Etefia (2021) in a work titled 'Prevalence of haemoparasites

among blood donors in calabar, Nigeria' where the most infected with malaria were those of blood group A.

Prevalence was relatively higher among female subjects with a record of (58.9%) compared to males (41.1%), although there was no significant difference in malaria parasitaemia in relation to gender ($p = 0.359$). The prevalence was higher in female students compared to male students (Fig. 4.1). Chi-square analysis showed no significant difference in gender-related prevalence ($p = 0.359$). This finding agrees with the observation of (Lemy et al., 2022). He did not find significant difference between males and females.

With regards to PCV, subjects in this category showed no association between PCV and malaria parasitaemia ($p = 0.304$). The prevalence was highest among subjects with PCV ranging from 36–45 (51.4%), followed by 23–35 (43.9%) and the least among > 45 (4.7%). Analysis using the > 45 PCV as reference range showed no association of PCV with prevalence of malaria parasite among subjects screened ($p = 0.304$) (Lemy et al., 2022).

Previous studies have tried to establish the reason for high level of infection among the blood group O. Antigens of blood groups A and B have been suggested to play important roles in cytoadherence (Afoakwah et al., 2016; Abegaz, 2021). Due to the absence of A and B antigens on the surface of blood group O erythrocytes and cytoadherence, hence rosetting and sequestration is reduced in individuals with blood group O. Several mechanisms relate to these associations, including affinity for Anopheles species, shared ABO antigens with *P. falciparum*, impairment of merozoite penetration of RBCs as well as cytoadherence, endothelial activation and resetting (Obisike and Thoman 2020).

The presence of several glycosylated adhesion molecules such as intracellular adhesion molecule, complement receptor, heparin sulfate-like glycosaminoglycan, platelet glycoprotein CD36, low arginine and nitrate levels, presence of cellular micro-particles and the nature of sugar molecules (trisaccharides) in blood group 'A' cells promote a high chance of binding with the rosette forming surface molecules of the *P. falciparum* such as Duffy binding like domain 1 alpha of *P. falciparum* erythrocytes membrane protein-1 (Afoakwah et al., 2016). Conversely, blood group O cells shows deficiency of most of the above adhesive molecules and contain disaccharides sugar molecules which reduce the rate, size and stability of rosette formed during *P. falciparum* infections. (Afoakwah et al., 2016). The destruction of both parasitized and non-parasitized erythrocytes as well as resetting and sequestration of parasitized erythrocytes has been cited to be the major cause of severe anaemia in complicated malaria (Afoakwah et al., 2016, Abegaz, 2021).

This study also infers that the distribution of ABO blood group may be impacted upon by the prevalent tribe among the study population or geographical location hence exhibiting racial patterns in distribution. It was also discovered that the participants in this study were apparently healthy and of relatively higher educational status compared to the community dwellers. They are therefore more likely to use malaria control and prevention techniques and to seek medical intervention early when faced with malaria-like illnesses.

CONCLUSION

Malaria infection appears to be endemic (50.1%) in the study population. This calls for promptness in proper diagnosis and treatment of malaria among students, to prevent upsurge in emergency cases. Most especially, the asymptomatic malaria whose potential of causing critical febrility crisis and morbidity should be checked in order to curb malaria casualties among university students and also to reduce the risk of passing on the parasite to recipients during blood transfusion if need arises.

The high prevalence of malaria parasite encountered, further established that socio-economic factors such as appalling unsanitary condition, low standard of living, inadequate use of treated mosquito nets are still very much in play as a predisposing factor to malaria infection in the study area. It is also evident that anaemia and malaria infection cannot be separated in most of the cases in the study; anaemia at various severities was an indicator of the presence of malaria parasite.

The relationship between ABO blood group and malarial infection was also revealed from the study, subjects with blood group O were the most susceptible to malaria parasite with the highest prevalence when compared with the other blood groups. Blood group AB exhibited low malaria prevalence when compared to other blood group.

References

1. Abegaz S, Birhanu, Human ABO Blood Groups and Their Associations with Different Diseases (2021) BioMed Research International, 6629060, 9 pages, 2021 <https://doi.org/10.1155/2021/6629060>
2. Afoakwah R, Aubyn E, Prah J, Nwaefuna EK, Boampong (2016) J. N. Relative Susceptibilities of ABO Blood Groups to Plasmodium falciparum Malaria in Ghana Advances in Hematology (2016) :5368793
3. Alegana VA, Okiro EA, Snow RW (2020) Routine data for malaria morbidity estimation in Africa: challenges and prospects. BMC Med 18(1). <https://doi.org/10.1186/s12916-020-01593-y>
4. Akogu SPO, Olumorin OI, Akor SE (2021) Distribution of ABO, Rhe-sus Factor Blood Phenotype and Haemoglobin Genotype among Antenatal Clinic Attendees in Anyigba, North Central Nigeria. Eur J Med Health Sci 3(6):11–13. 10.24018/ejmed.2021.3.6.954
5. Anifowoshe AT, Owolodun OA, Akinseye KM, Iyiola OA, Oyeyemi BF (2017) Gene frequencies of ABO and Rh blood group in Nigeria: a review. The Egyptian Journal of Medical Human Genetics, 18 (2017):205–210
6. Antwi-Baffour S, Kyeremeh R, Amoako AP, Annison L, Tetteh JO, Seidu MA (2019) The incidence of malaria parasites in screened donor blood for transfusion. *Malaria Research and Treatment*, 2019, 1–6. <https://doi.org/10.1155/2019/1457406>
7. Ashley EA, Phyo AP, Woodrow CJ (2018) Malaria. *Lancet (British Edition)*, 391(10130), 1608–1621. [https://doi.org/10.1016/s0140-6736\(18\)30324-6](https://doi.org/10.1016/s0140-6736(18)30324-6)

8. Bamou R, Sevidzem SL (2016) ABO/Rhesus blood group systems and malaria prevalence among students of the University of Dschang, Cameroon. *Malar world J* 7(4):1–4
9. Bawo DS, Pouna IE (2020) Relationship between ABO blood groups and malaria infection in endemic regions of Nigeria *Eksu j Sci Technol*, 5 (1) 49–61
10. Bianucci R, Fornaciari G, Montella A, Bandiera P *Origins of Malaria and leishmaniasis in Sardinia (2014) : First Results of a Paleoimmunological Study. Available online at (2021)*
<http://www.researchgate.net/publication/282658108>
11. Bittaye SO, Jagne A, Jaiteh LE, Nadjm B, Amambua-Ngwa A, Sesay AK, Singhateh Y, Effa E, Nyan O, Njie R (2022) Clinical manifestations and outcomes of severe malaria in adult patients admitted to a tertiary hospital in the Gambia. *Malar J (Online)* 21(1). <https://doi.org/10.1186/s12936-022-04294-4>
12. Bo O, Ak A, To OTL, Aa A, Od F (2024) Frequency of Blood Donation and Malaria Occurrence among Blood Donors in a Tertiary Hospital, Nigeria. *Ibom Med J* 17(1):103–107.
<https://doi.org/10.61386/imj.v17i1.385>
13. Branch DR (2015) Anti-A and anti-B: what are they and where do they come from? *Transfusion* 55(Suppl 2):S74–S79. <https://doi.org/10.1111/trf.13087>
14. Chijioke-Nwauche I, Nwauche C, Oguike MC (2016) The Interaction between Malaria Parasites and Blood Groups in Port Harcourt, Nigeria. *Int J Trop Disease Health* 14(2):1–7.
<https://doi.org/10.9734/ijtdh/2016/23211>
15. Chu CS, White NJ (2016) Management of relapsing *Plasmodium vivax* malaria. *Expert Rev anti-infective therapy* 14(10):885–900
- Cibulskis RE, Alonso P, Aponte J, Aregawi M, Barrette A, Bergeron L et al (2016) Malaria: Global progress 2000–2015 and future challenges. *Infect this Poverty* 5(1):61
16. Dawaki S, Al-Mekhlafi HM, Ithoi I, Jamaiah I, Atroosh WM, Abdulsalam AM, Sady H, Elyana FN, Adamu AU, Yelwa SI, Ahmed A, Al-Areeqi MA, Subramaniam LR, Nasr NA, Lau YL (2016) Is Nigeria winning the battle against malaria? Prevalence, risk factors and KAP assessment among Hausa communities in Kano State. *Malar J* 15(1). <https://doi.org/10.1186/s12936-016-1394-3>
17. Degarege A, Gebrezgi MT, Ibanez G, Wahlgren M, Madhivanan P (2019) Effect of the ABO blood group on susceptibility to severe malaria: a systematic review and meta-analysis. *Blood Rev* 33:53–62
18. Gelabert P, Olalde Í, De-Dios T, Civit S, Lalueza-Fox C (2017) Malaria was a weak selective force in ancient Europeans. *Sci Rep* 7(1). <https://doi.org/10.1038/s41598-017-01534-5>
19. Goel S, Palmkvist M, Moll K, Joannin N, Lara P, Akhouri R, Wahlgren R, M (2015) RIFINs are adhesins implicated in severe *Plasmodium falciparum* malaria. *Nat Med* 21(4):314–317
20. Gonçalves BP, Sagara I, Coulibaly M, Wu Y, Assadou MH, Guindo A, Ellis RD, Diakité M, Gabriel EE, Prevots DR, Doumbo OK, Duffy PE (2017) Hemoglobin variants shape the distribution of malaria parasites in human populations and their transmission potential. *Sci Rep (Nature Publishing Group)* 7(1). <https://doi.org/10.1038/s41598-017-14627-y>
21. Inyang-Etoh P, Etefia E, Chime C, Ejezie G (2021) Prevalence of Haemoparasites among Blood Donors in calabar, Nigeria. 15(6):17–22 <http://m1j.goums.ac.ir/article-1-1405-en.html>

22. Josling GA, Llinás M (2015) Sexual development in Plasmodium parasites: knowing when it's time to commit. *Nat Reviews Microbiol* (Print) 13(9):573–587. <https://doi.org/10.1038/nrmicro3519>
23. Jötten AM, Moll K, Wahlgren M, Wixforth A, Westerhausen C (2020) Blood group and size dependent stability of *P. falciparum* infected red blood cell aggregates in capillaries. *Biomicrofluidics*, 14 (2)
24. Juzénas S (2020) Genomewide association study of severe covid-19 with respiratory failure/Severe Covid-19 GWAS Group: David Ellinghaus, Frauke Degenhardt, Luis Bujanda, Maria Buti, Agustín Albillos, Pietro Invernizzi,[... Simonas Juzenas. *New England Journal of Medicine*. Boston: Massachusetts Medical Society, 2020, vol. 383, no. 16
25. Kourtis AP, Read JS, Jamieson DJ (2014) Pregnancy and infection. *N Engl J Med* 370(23):2211–2218
26. Kuadzi JT, Ankra-Badu G, Addae MM (2021) Plasmodium falciparum malaria in children at a tertiary teaching hospital: ABO blood group is a risk factor. *Pan Afr Med J* 10(2). <https://doi.org/10.11604/pamj.2011.10.2.84>
27. Lemy E, Edafemakor A, Egwunyenga A (2022) Socio-Demographic characteristics and blood parasites among blood donors in two communities in Delta State, Nigeria. *Sokoto J Med Lab Sci* 7(2):85–94. <https://doi.org/10.4314/sokjmls.v7i2.10>
28. Lindblade KA, Steinhardt L, Samuels A, Kachur SP, Slutsker L (2017) The silent threat: asymptomatic parasitaemia and malaria transmission. *Expert Rev anti-infective therapy* 11(6):623–639
29. Loscertales MP, Owens S, O'Donnell J, Bunn J, Bosch-Capblanch X, Brabin BJ (2007) ABO blood group phenotypes and Plasmodium falciparum malaria: unlocking a pivotal mechanism. *Adv Parasitol* 65:1–50
30. Maitland K (2015) Management of severe pediatric malaria in resource-limited settings. *BMC Med* 13:1–28
31. Marciniak S, Prowse T, Herring DA, Klunk J, Kuch M, Duggan AT, Bondioli L, Holmes EC, Poinar HN (2016) Plasmodium falciparum malaria in 1st – 2nd century CE southern Italy. *Curr Biol* 26(23):R1220–R1222. <https://doi.org/10.1016/j.cub.2016.10.016>
32. McQuaid F, Rowe JA (2020) Rosetting revisited: a critical look at the evidence for host erythrocyte receptors in Plasmodium falciparum rosetting. *Parasitology* 147(1):1–11
33. Medugu JT, Abjah U, Nasir IA, Adegoke S, Asuquo EE (2016) Distribution of ABO, Rh D blood groups and hemoglobin phenotypes among pregnant women attending a Tertiary Hospital in Yola, Nigeria. *J Med Tropics* 18(1):38–42. <https://doi.org/10.4103/2276-7096.177829>
34. Meibalan E, Marti M (2016) Biology of malaria transmission. *Cold Spring Harbor Perspect Med* 7(3):a025452. <https://doi.org/10.1101/cshperspect.a025452>
35. Moll K, Palmkvist M, Ch'ng J, Kiwuwa MS, Wahlgren M (2015) Evasion of Immunity to Plasmodium falciparum: Rosettes of Blood Group A Impair Recognition of PfEMP1. *PLoS ONE* 10(12):e0145120. <https://doi.org/10.1371/journal.pone.0145120>
36. Mukhtar IG, Rahmat S, Salisu AI, Nigeria (2020) <https://fjs.fudutsinma.edu.ng/index.php/fjs/article/view/29>

37. Mukhtar IG, Muhammad SM, Yakasai BW, Salisu AI (2018) ABO and Rh Blood Group Phenotypes of Nigerian Blood Donors at Murtala Muhammad Specialist Hospital Hospital, Kano – A One Year Retrospective study BJMLS. 3(1):48–53
38. Mukhtar IG, Abdulkadir AY (2019) Frequencies of ABO and Rhesus (D) blood group phenotypes among pregnant women attending antenatal clinic at Murtala Muhammad Specialist Hospital, Kano, Nigeria. J Med Tropics 21(1):31–36
39. Ndila CM, Uyoga S, Macharia AW, Nyutu G, Peshu N, Ojal J, Leffler E (2018) Human candidate gene polymorphisms and risk of severe malaria in children in Kilifi, Kenya: a case-control association study. Lancet Haematol 5(8):e333–e345
40. Niang M, Bei AK, Madnani KG, Pelly S, Dankwa S, Kanjee U, Preiser PR (2014) The variant STEVOR protein of Plasmodium falciparum is a red cell binding protein important for merozoite invasion and rosetting. Cell Host Microbe 16(1):81
41. Obisike VU, Thomas DM (2020) Association between ABO blood group and malaria infection and ownership and utilization of long lasting insecticide treated nets among school children in North Bank area of Makurdi, Nigeria. Biomedical J Sci Tech Res 3:1–2
42. Ohiengbomwan OT, Idemudia NL, Owoicho O, Adeyanju AA (2018) Gene Frequencies of Haemoglobin Genotype, ABO and Rhesus Blood Groups among Students Population of a Private University in Nigeria-Implications for Blood Banking. Int J Life-sciences Sci Research/SSR Inst Int J Life Sci 4(4):1851–1857. <https://doi.org/10.21276/ijlssr.2018.4.4.1>
43. Ohiengbomwan OT, Abechi P, Olumade T, Idemudia NL (2019) Haemoglobin Genotype, ABO/Rhesus Blood Groups and Malaria among Students Presenting to a Private University Health Centre in Nigeria. Am J Biomedical Sci 200–208. <https://doi.org/10.5099/aj190400200>
44. Opi DH, Ndila C, Uyoga S, Macharia A, Fennell C, Ochola L, Nyutu G, Siddondo B, Ojal J, Mohammed S, Awuondo KO, Mturi N, Peshu N, Tsofa B, Band G, Maitland K, Kwiatkowski DP, Rockett KA, Williams TN, Rowe JA (2023) Non-O ABO blood group genotypes differ in their associations with Plasmodium falciparum rosetting and severe malaria. PLoS Genet 19(9):e1010910. <https://doi.org/10.1371/journal.pgen.1010910>
45. Pagani L, Lawson DJ, Jagoda E, Mörseburg A, Eriksson A, Mitt M, Clemente F, Hudjashov G, DeGiorgio M, Saag L, Wall JD, Cardona A, Mägi R, Sayres MaW, Kaewert S, Inchley C, Scheib CL, Järve M, Karmin M, Metspalu M (2016) Genomic analyses inform on migration events during the peopling of Eurasia. Nature 538(7624):238–242. <https://doi.org/10.1038/nature19792>
46. Romanos-Sirakis EC, Desai D (2023) September 9). ABO Blood Group System. StatPearls - NCBI Bookshelf. <https://www.ncbi.nlm.nih.gov/books/NBK580518/>
47. Sharp PM, Plenderleith LJ, Hahn BH (2020) Ape Origins of human malaria. Annu Rev Microbiol 74(1):39–63. <https://doi.org/10.1146/annurev-micro-020518-115628>
48. Sato S (2021) Plasmodium—a brief introduction to the parasites causing human malaria and their basic biology. J Physiol Anthropol 40(1). <https://doi.org/10.1186/s40101-020-00251-9>

49. Simeon-Oke IA, Afolabi OJ, Itansanmi AI Prevalence of ABO blood groups and its relationship with malaria parasitaemia among students of Federal University of Technology Akure OS (2016) *Int J Trop Dis health* 17(1):1–8
50. Singh G, Urhekar AD, Singh R A study on correlation of malaria infection with A,B,O, RH blood group system (2015) *J Parasitol Vector Biology* 7:67–73
51. Talapko J, Škrlec I, Alebić T, Jukić M, Včev A (2019b) Malaria: the past and the present. *Microorganisms* 7(6):179. <https://doi.org/10.3390/microorganisms7060179>
52. Tekeste Z, Petros B (2017) The ABO blood group and Plasmodium falciparum malaria in Awash, Metehara and Ziway areas, Ethiopia. *Malar J* 9(1). <https://doi.org/10.1186/1475-2875-9-280>
53. Wahlgren M, Goel S, Akhouri RR (2017) Variant surface antigens of Plasmodium falciparum and their roles in severe malaria. *Nature Reviews Microbiology*, 15(8), 479–491
54. WHO (2016) Global Health Observatory (GHO) data 2016: causes of child mortality <http://> White NJ (2018) Anaemia and malaria. *Malar J* 17:371. <https://doi.org/10.1186/s12936-018->
55. WHO (2016) Global Health Observatory (GHO) data 2016: causes of child mortality <https://www.who.int/news-room/fact-sheets/detail/diarrheal-disease>
56. World Health Organization (2017) Diarrheal disease <https://> World Health Organization *World Malaria Report 2020:20 Years of Global Progress and Challenges*. Geneva: World Health Organization (2020) Available online at (2021) <https://www.who.int/publications/i/item/9789240015791>
57. World Health Organization (2022) World malaria report 2022. World Health Organization
58. Zakovic S, Levashina EA (2017) NF-κB-Like Signaling Pathway REL2 in Immune Defenses of the Malaria Vector Anopheles gambiae. *Front Cell Infect Microbiol*. [7https://doi.org/10.3389/fcimb.2017.00258](https://doi.org/10.3389/fcimb.2017.00258)

Figures

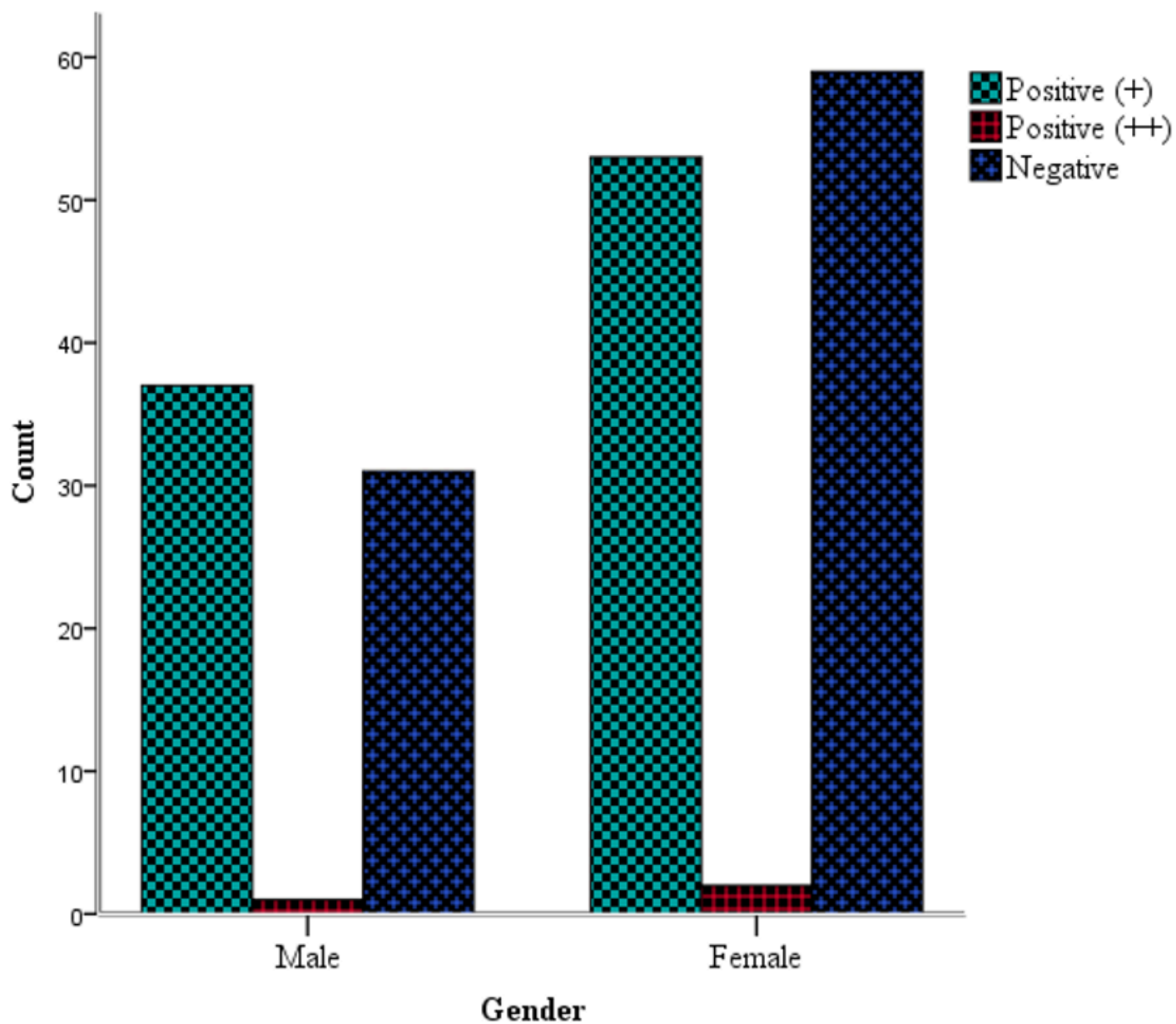


Figure 1

3.1: Distributions of malaria parasitaemia in male and female respondents

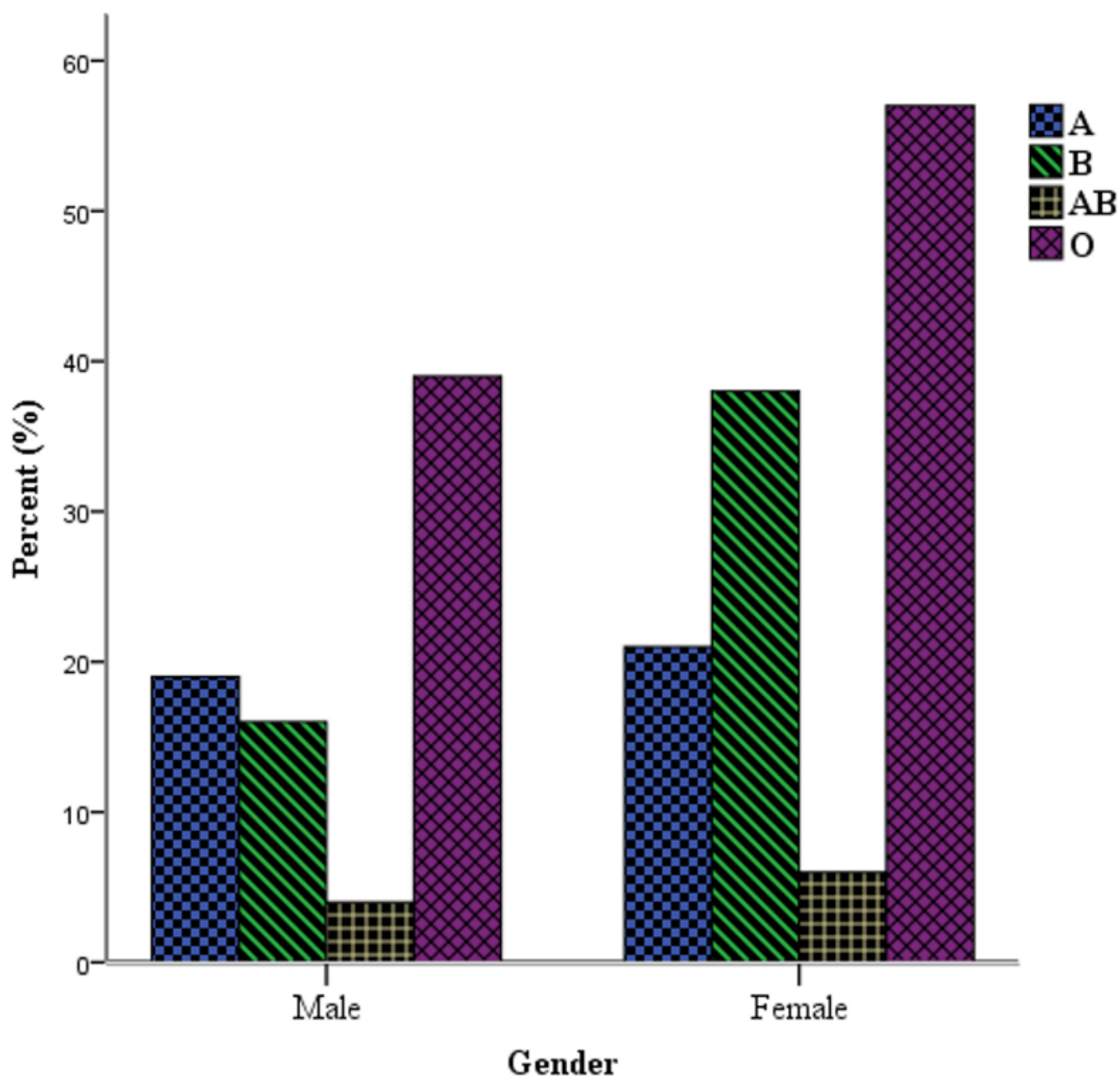


Figure 2

3.2: Distributions of blood group in male and female respondents

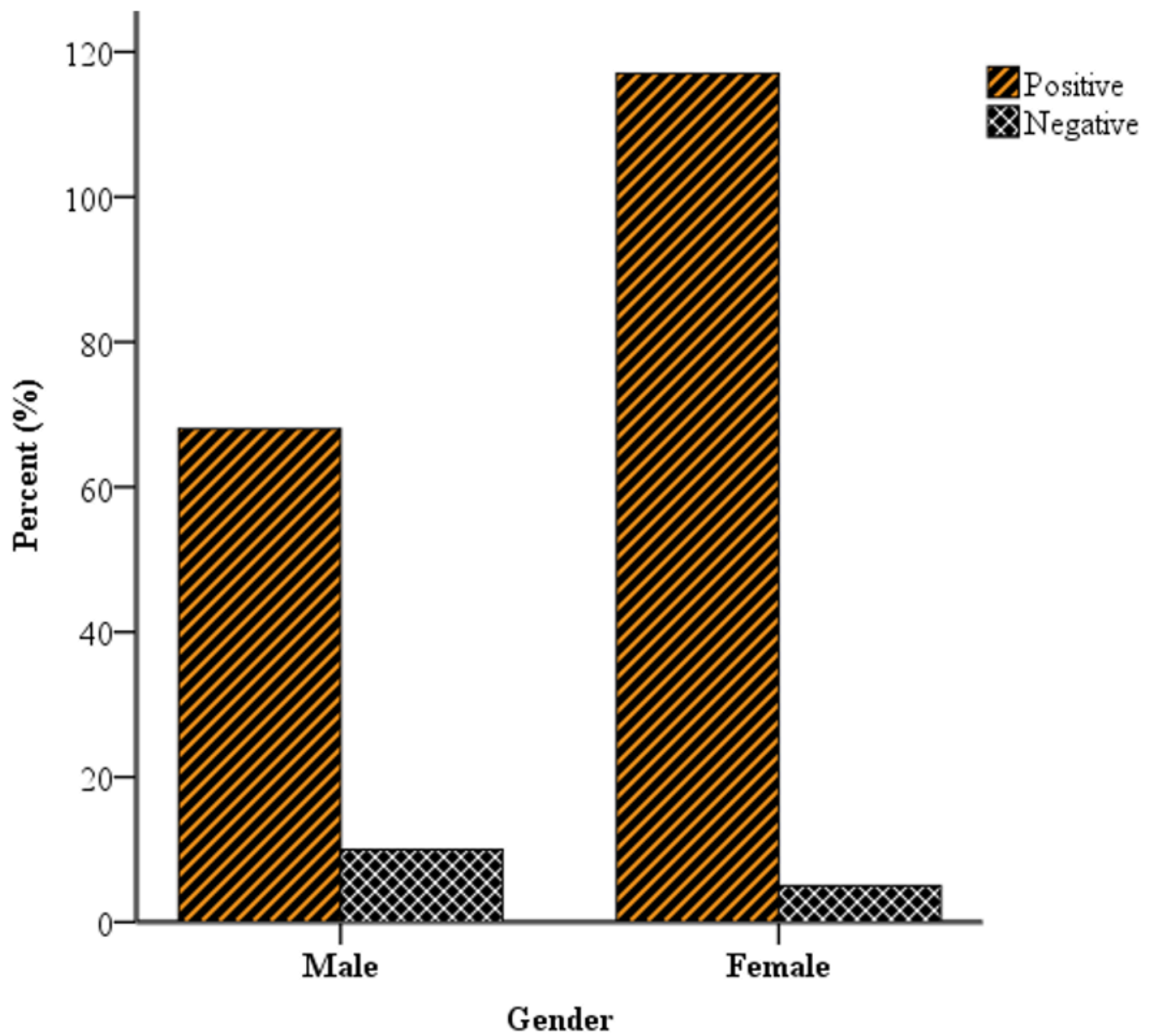


Figure 3

3.3: Distributions of Rhesus factor in male and female respondents