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Relationship between blood group, packed cell volume, knowledge and practices of adults to malaria prevalence in Lagos Island, Nigeria

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ABSTRACT

Objective: To determine malaria prevalence, knowledge, attitude and practices at residents of Lagos Island Local Government.
Methods: Two hundred blood samples were collected from adults attending the General Hospital, Marina while 100 questionnaires were administered to individuals still in the same hospital. Majority of the respondents were between the ages of 18 and 30 years (44%), while the age group 60 and above had the lowest population (9%).
Results: More than half of the respondents (68%) were employed and engaged in different occupations such as entrepreneur (32%), students (31%), trader (24%), and civil servant (10%). Stratification of the respondents by income revealed that 71% earned above the minimum wage, while 29% earned below. The prevalence of malaria by microscopy method was 10.5%. Malaria parasite had significant effect on the packed cell volume of infected individuals ($P < 0.05$). Preventive measures employed by the respondents were majorly insecticide (72.2%), while some others (5.6%) used mosquito net. Majority of the respondents (98%) believed that malaria was caused by mosquito.
Conclusions: Therefore, it is appropriate to put in place preventive measures against malaria to avoid high prevalence of the number one killer in tropical Africa.

1. Introduction

Malaria is an infectious disease of humans and other animals. It is caused by parasites of the genus *Plasmodium*[1]. The symptoms of malaria commences between 10 and 15 days after infection. This must be treated immediately to avoid recurrences of the disease months later. The disease is transmitted by an infected female *Anopheles* mosquito. The male mosquito can not transmit the disease. World Health Organization reports indicated that there were 198 million cases of malaria worldwide in 2013 and this resulted in 584 000–855 000 deaths. The majority of such cases (90%) are mainly from Africa[1]. Malaria can be diagnosed microscopically using blood films and rapid diagnostic tests[2]. The disease can be prevented by the use of insecticides treated nets, insect repellants and other preventive measures to reduce mosquito bites[2]. The disease is widespread in the tropical and subtropical regions where the mosquito vectors thrive such as sub-saharan Africa, Asia, and Latin America. PCR can also be used to detect the parasite's DNA. This has not been used widely due to high cost and the complexities of its use[3,4]. Malaria is commonly associated with poverty stricken populations with a negative effect on their economic development[5].

The thick blood film of an infected individual is usually stained with Giemsa and examined viewing the dark red chromatin bodies, pale purplish-blue cytoplasm, black pigments, and rings are usually located in marginal location. The ring form is the most common stage[6]. The disease remains one of the major killers of humans worldwide, threatening the lives of more than one third of the world's population[7]. Pyrethroids treated nets and indoor residual spraying are measures employed to control malaria in

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tropical Africa[8]. Through the use of insecticides treated net, there has been tremendous progress in vector control against malaria in tropical Africa[9]. This net protects the host by preventing the vectors from biting and sometimes kills them directly[10]. Bain[11] reported that deaths as a result of malaria are more frequent in children while Facer[12] reported that haematological abnormalities are to confirm high level of infection in patients linked to *Plasmodium falciparum* (*P. falciparum*). Jandl[13] reported the correlation of anaemia with severity of malaria infection. The life cycle of the parasites is of particular interest when after sporozoite invasion, the merozoites can repeat the pre-erythrocytic cycle in the liver cells, or they can enter the erythrocytic cycle[14,15]. Epidemiologically, heavy and torrential rainfall increases the abundance of *Anopheles gambiae* in tropical Africa.

The release of merozoites into the blood results in frequent paroxysms in the infected hosts. This is accompanied by chills and fever characteristics of the parasites depending on the species[15]. Malaria is established in a new host after the introduction of sporozoites by the bite of the mosquito vector. This is accompanied with the pathological consequences depending on the species[16].

Transmission is dependent on climatic conditions that may positively favour the abundance and survival of mosquitoes, such as rainfall patterns, temperature and humidity. In some geographical locations, transmission is seasonal, with its peak during and just after the rainy season. Malaria epidemics can occur when climate and other conditions suddenly favor transmission in areas where people have little or no immunity to malaria. They can also occur when people with low immunity move into areas with intense malaria transmission to find work, or as refugees.

2. Materials and methods

2.1. Study area

The study was carried out at the General Hospital, Marina, Lagos State, Nigeria under the Lagos Island Local Government, Lagos, Nigeria. The local government area had a population of 209 437 in an area of 8.7 km. The local government area is only restricted to the western half of Lagos Island while the eastern half is under the jurisdiction of the local government area of Eti-Osa. Historically, Lagos Island (Isale Eko) was home to the Brazilian Quarter of Lagos where the majority of the slave trade returnees from Brazil settled. Many families lived on Broad Street in the Marina. The general hospital is situated in Odan, Lagos Island, between Broad Street and Marina. The hospital was primarily established for the military personnel for the treatment of the British armed forces during the colonial era. At the time of its establishment in 1893, it was the first general hospital in Nigeria. The pioneer staffs were nationalities of the British Commonwealth. On the 1st of October, 1960, the hospital was handed over to the Federal Government and on 7th May 1967, it was finally taken over by the Lagos State Government while the nursing school was established in 1952. The Nigerian Medical Association was established at the hospital. The hospital has served as a training center for doctors, pharmacists, nurses, radiographers and technologists across the country. The map of Lagos Island is shown in Figure 1.

Figure 1. Map of Lagos Island.

2.2. Questionnaire

The questionnaires were designed to show the knowledge, attitude and practices of adults to the prevalence of malaria infection. The effects on the level of education as well as the occupation of the adults were also observed in questionnaire administered to determine the sex, age, and other personal details, also the knowledge about prevention methods and control attempts of malaria.

2.3. Data collection

A total of 200 adults aged 20–85 years with history of fever or no fever participated in the study. Out of 200 adult samples collected, 122 (61%) were female and 78 (39%) were male. They were recruited from Lagos Island General Hospital, from April to June.

2.4. Collection of blood and blood smear

A volume of 2.0 mL of blood was collected from an antecubital vein of each adult. The blood samples were collected by the trained medical laboratory scientist of the Lagos Island General Hospital and were used for the study. Tourniquet was used on the right hand to make the veins conspicuous for bleeding and cleansed with cotton wool soaked in methylated spirit. Sterilized syringe was used to bleed and blood drawn was discharged into a labeled ethylenediaminetetraacetic acid bottle.

2.5. Staining and microscopy procedure

A minute quantity of blood was placed on a clean grease free slide that has been labelled. It was air dried and later stained. One drop of host blood was placed at the middle of a clean grease free microscope slide. A clean smooth edged spreader was used to spread the blood to make a thin film and then air dried. The dried

film was then fixed with 1–2 drops of moisture free methanol for about 2 min and then stained.

A 2 mL of Giemsa stain stock solution was added to 65 mL of distilled water in a staining jar. The Giemsa solution was prepared on a daily basis. The fixed thin films and unfixed thick films were stained with the Giemsa solution for 30 min in the staining jar. Stained films were rinsed with water, air dried and examined under the microscope with 100× oil immersion objective lens to identify the parasite.

2.6. Data analysis

Data were entered and verified for entry errors and analyzed using the Epi Info software package version 7.1.1.14. It was used for the questionnaire analysis and also SPSS was used to analyze results from the experiment carried out. The data were exported to Microsoft Excel 2013 for further analysis.

3. Results

A total of 100 questionnaires were distributed to randomly selected individuals at General Hospital, Marina. Majority (44%) of the distributed questionnaire population was between the age group 18 and 30 years, while the age group 60 and above had the smallest (9%). About 60% of the individuals of the distributed questionnaires were female, while 40% was male. And 32% of the distributed questionnaire was unemployed, while 68% was employed. The occupation of individuals included students (31%), trader (24%), civil servant (10%), entrepreneur (32%) and retired (3%). The income profile of the individuals showed that 71% earned above the minimum wage while 29% earned below the minimum wage (Tables 1–4).

Table 1
Socio-demographic factor showing the relationship between sex and age in malaria.

Sex	Age	Prevalence
Male	18–30	16.0 (40.0%)
	31–35	18.0 (45.0%)
	36–60	3.0 (7.5%)
	61 and above	3.0 (7.5%)
Female	18–30	28.0 (46.6%)
	31–35	16.0 (26.8%)
	36–60	10.0 (16.6%)
	61 and above	6.0 (10.0%)

Table 2
Socio-demographic factor showing the relationship between sex and marital status in malaria.

Sex	Marital status	Prevalence
Male	Married	23.0 (57.5%)
	Single	16.0 (40.0%)
	Divorced	1.0 (2.5%)
Total		40.0 (100.0%)
Female	Married	28.0 (46.6%)
	Single	31.0 (51.0%)
	Divorced	1.0 (1.6%)
Total		60.0 (100.0%)

Table 3
Socio-demographic factor showing the relationship between sex and income per month in malaria.

Sex	Income per month	Prevalence
Male	None	9.0 (22.5%)
	18–50 thousand Naira	15.0 (37.5%)
	50–100 thousand Naira	8.0 (20.0%)
	100 thousand Naira and above	8.0 (20.0%)
Total		40.0 (100.0%)
Female	None	20.0 (33.3%)
	18–50 thousand Naira	17.0 (28.3%)
	50–100 thousand Naira	11.0 (18.3%)
	100 thousand Naira and above	12.0 (20.0%)
Total		60.0 (100.0%)

Table 4
Socio-demographic factor showing the relationship between sex and employment in malaria.

Sex	Employment	Prevalence
Male	Unemployed	12.0 (30.0%)
	Self employed	6.0 (15.0%)
	Employed	22.0 (55.0%)
Total		40.0 (100.0%)
Female	Unemployed	20.0 (33.3%)
	Self employed	20.0 (33.3%)
	Employed	20.0 (33.3%)
Total		60.0 (100.0%)

3.1. Risk factors associated with malaria

Risk factors that are associated with malaria in this study are shown in Table 5. Various variables were found to be associated with malaria. Presence of potholes and stagnant water, how often insecticide treated net is been used, how malaria is been treated, how malaria is been controlled and how often people sleep under insecticides treated net were responded during the administration of the questionnaire. Delay in the treatment of the disease which may be as a result of poverty ravaging tropical Africa and availability of potholes around homes to support the life cycle of the parasites dominated respondents' answers in the questionnaire administrations. Factors of epidemiological importance in relation to malaria in this study were prevalent which accounted for high incidence of the disease in tropical Africa.

3.2. Respondent knowledge of cases of malaria in Marina

A large portion believed malaria was caused by mosquito (98%) while 2% mentioned it was caused by exposure to sunlight. Individuals that had potholes and stagnant water present in their environment (86%) were more infected with malaria, while individuals that did not have potholes and stagnant water in their environment (14%) rarely got infected with malaria. Table 6 shows respondent knowledge on malaria in the distributed questionnaires while Table 7 shows the demographic background of the sampled population with the minimum age group of 18 and maximum age of 61 years.

3.3. Signs and symptoms

Based on the results of the questionnaire, the signs and

symptoms of malaria included headache, fever, weakness, high temperature, backache and body pain. The bar chart below shows the level of symptoms of malaria in the individuals. The overall signs and symptoms observed among respondents are shown in Figure 2.

Table 5
Response of people to risk factor of malaria infection, infected and non-infected adults.

Risk factor	Responses	Infected (18%)	Non-infected (82%)
Do you have potholes, stagnant water around your house	Yes	14 (77.78%)	72 (87.80%)
	No	4 (22.22%)	10 (12.19%)
How often do you use insecticide treated net	Rarely	12 (66.67%)	39 (47.56%)
	Daily	4 (22.22%)	36 (43.90%)
	Monthly	2 (11.11%)	4 (4.87%)
	Yearly	0 (0.00%)	1 (1.21%)
	Never	0 (0.00%)	2 (2.43%)
How do you treat the disease	Drug	17 (94.44%)	78 (95.12%)
	Herbal medicine	1 (5.56%)	4 (4.87%)
How do you control the disease	Insecticide	13 (72.22%)	58 (70.73%)
	Mosquito coil	4 (22.22%)	6 (7.31%)
	Mosquito net	1 (5.56%)	18 (21.95%)
How often do you sleep under insecticide treated net	Rarely	9 (50.00%)	41 (50.00%)
	Daily	3 (16.67%)	11 (13.41%)
	Monthly	1 (5.56%)	1 (1.12%)
	Yearly	0 (0.00%)	1 (1.21%)
	Never	5 (27.78%)	28 (34.14%)

Table 6
Respondent knowledge on malaria disease (n = 100). n (%).

Knowledge	Response (%)	Male	Female
Does mosquito cause malaria	Yes	39 (97.50)	59 (98.33)
	No	1 (2.50)	1 (1.67)
Total		40 (100.00)	60 (100.00)
How do you treat the disease	Drug	39 (97.50)	56 (93.33)
	Herbal medicine	1 (2.50)	4 (6.67)
Total		40 (100.00)	60 (100.00)
How do you control the disease	Insecticide	25 (62.50)	46 (76.66)
	Mosquito coil	4 (10.00)	6 (10.00)
	Mosquito net	11 (27.50)	7 (13.33)
Total		40 (100.00)	60 (100.00)
Do you go to the hospital when you have these symptoms	Yes	23 (57.50)	38 (63.33)
	No	17 (42.50)	22 (36.67)
Total		40 (100.00)	60 (100.00)
How often are you infected with malaria	Once a year	1 (2.50)	1 (1.66)
	Others	36 (90.00)	50 (83.33)
	Thrice	3 (7.50)	6 (10.00)
	Twice	0 (0.00)	3 (5.00)
Total		40 (100.00)	60 (100.00)
Do you have potholes, stagnant water around your house	Yes	38 (95.00)	48 (80.00)
	No	2 (5.00)	12 (20.00)
Total		40 (100.00)	60 (100.00)
What kind of hospital do you attend	Private	12 (30.00)	17 (28.33)
	Government	28 (70.00)	43 (71.67)
Total		40 (100.00)	60 (71.67)
How often do you sleep under insecticide treated net	Rarely	21 (52.50)	29 (48.33)
	Dialy	5 (12.50)	9 (15.00)
	Monthly	2 (5.00)	0 (0.00)
	Yearly	1 (2.50)	0 (0.00)
	Never	11 (27.50)	22 (36.67)
Total		40 (100.00)	60 (100.00)

3.4. Parasitological diagnosis of malaria parasite

Table 8 shows parasitological diagnosis of malaria parasites which revealed that 21 (10.5%) were positive to malaria while 179 (89.5%) were negative to the microscopy test. All the positive samples showed *P. falciparum* species. Out of the 179 negative samples, 107 (59.77%) females were negative while 72 (40.22%) males were negative.

Table 7
Socio-demographic background of the sampled population in General Hospital Marina, Lagos.

Variable		Frequency	Percentage
Age	18–30	49	24.4
	31–45	64	32.0
Sex	46–60	47	23.5
	61 and above	40	20.0
	Female	122	61.0
	Male	78	39.0

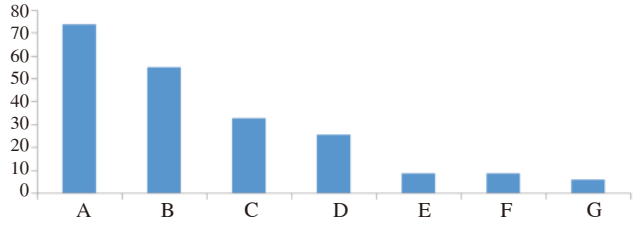

Figure 2. Signs and symptoms observed in individuals with malaria in Marina.
A: Headache; B: Fever; C: Weakness; D: High temperature; E: Catarrh; F: Backache; G: Stomach pain.

Table 8
Positive and negative malaria samples in Marina.

Group	Sex	Age	Prevalence
Positive	Female	18–30	3 (20.0%)
		31–35	2 (13.3%)
		36–60	7 (46.6%)
		61 and above	3 (20.0%)
Total			15 (100.0%)
	Male	18–30	2 (33.3%)
		31–35	0 (00.0%)
		36–60	3 (50.0%)
		61 and above	1 (16.6%)
Total			6 (100.0%)
Negative	Female	18–30	24 (22.4%)
		31–35	16 (14.9%)
		36–60	42 (39.2%)
		61 and above	25 (23.3%)
Total			107 (100.0%)
	Male	18–30	18 (25.0%)
		31–35	10 (13.8%)
		36–60	35 (48.6%)
		61 and above	9 (12.5%)
Total			72 (100.0%)

Table 9 shows the relationship between packed cell volume of each sample and the population in marina which was meant to reveal malaria infections. It has been showed using SPSS that the value was significant, which meaned packed cell volume had effect on positive malaria samples. Table 10 also reveals the blood group of the sampled individuals in Marina General Hospital, Lagos. Blood group of each sample was taken and results showed that A+ had the highest number (113), while O- had the lowest number (1), others were O+ (45), AB (33) and B+ (7). This is shown in Table 11.

Table 9
Relationship between the sample population's packed cell volume and malaria parasites in Marina.

Result		*n*	Mean	*P* value
Negative	Female	107	30.06	0.000
	Male	72	27.05	
Positive	Female	15	24.02	
	Male	6	18.87	
Total		200	100.00	

P value is significant at 0.05.

Table 10
Blood groups of the sampled population in Marina, Lagos State.

Blood groups	Frequency	Percentage	Cumulative percent
A+	113	56.8	56.8
O-	1	0.5	0.5
O+	45	22.6	22.6
AB	34	16.6	16.6
B+	7	3.5	3.5
Total	200	100.0	100.0

Table 11
Relationship between the sample blood group and malaria parasites in Marina.

Result	Blood groups					Total	*P* value
	A+	O-	O+	AB	B+		
Negative	94	1	44	32	7	179	0.027
Positive	19	0	1	1	0	21	
Total	113	1	45	33	7	200	

P value is significant at 0.05.

4. Discussion

Based on the World Health Organization reports of 2013 which indicated majority of death due to malaria to Africa[1], this research focused on the prevalence of malaria in Marina, Lagos and also studied the effects of socioeconomic and epidemiological factors on malaria prevalence in Marina.

Malaria prevention among adults in Marina was chiefly through the use of chemotherapy such as Amalar, chloroquine, artesunate, coartem, mefloquine, and lonart. However, the use of chemotherapy dominates the treatment of the disease by the infected persons. The antimalarial used has varying degrees of efficacies, which might result in its inactiveness in some patients. This may also depend on the immunocompetences of the hosts. Resistance to these drugs has been reported by World Health Organization[17].

On the use of mosquito treated net and insecticides, it was observed that most of the infected people control malaria through the use of insecticide. Few people realized the necessity and importance of mosquito treated nets. It was revealed that 18% of the respondents believed that they will be protected with its use. This is supported by high level of illiteracy and poverty in tropical Africa. Other studies have shown that bed nets are capable of reducing mortality from malaria when properly used[18]. However, these nets have to be treated with insecticide to make it more effective. Mosquito nets whether impregnated or not and in good condition are capable of preventing mosquito bites and thus reduce the incidence of malaria[18].

Malaria occurs in the tropical areas of Asia, Central and South America, where it affects millions of people[19]. Malaria disease records 9%–10% of Africa's disease burden with severe economic consequences[1,20]. Any country with a high incidence of malaria is bound to record a 1.3% annual loss of economic growth. A World Health Organization study suggests that sub-Saharan Africa's gross domestic product would have recorded tremendous growth if malaria has been eliminated[21]. It is reported by World Health Organization[22] that the number of malaria cases from 34 countries decreased by 85% from 1.5 million to 232 000 cases. The cases were attributed to *P. falciparum*.

In this study, it shows that the prevalence of malaria within the months of June, July and August results in 21 (10.6%) been positive, out of which 71.42% of infected persons are female, while the remaining 28.57% are male.

According to Hong *et al.*[23], *P. falciparum* infection prevalence is higher in the wet season than in the dry season. It is universally accepted that the rainy season presents favorable environment conditions that enhance mosquito breeding and survival, through the proliferation of larval habitat and improved humidity respectively[23]. Although higher prevalence rate was observed at the ending of this study due to the fact that it was conducted during the raining season, the lower prevalence might be due to the usage of anti-malarial drugs being used by individual whose sample was examined prior to the days of peripheral blood sample collection.

Presence of stagnant water and potholes is contributed greatly to the infection of malaria. It was recorded in this study that 77.78% of the positive patients have the presence of stagnant water or potholes in their area of residents[23].

P. falciparum established a successful infection in human host by interacting with a variety of human proteins on the surface of different cells types as well as with protein inside the host cells. Patients suffering from malaria also developed hematological complications and alterations of biochemical parameters[24].

Higher prevalence rate was observed in patients with low packed cell volume because the malaria parasite invades the red blood cells thereby destroying the cells, which in turn leads to low count in the red blood cells.

All the manifestations of malaria illness are caused by the infection of red blood cells by asexual forms of the malaria parasite and involvement of the red cells makes malaria a potentially multi-system disease, as every organ of the body is reached by the blood[25].

There have been studies of ABO blood group and malaria for some years and there are numerous studies on the blood group effects on various forms of malaria from multiple countries while many are yet to come to a reasonable conclusion[26].

Until recently, there has been no clear answer to the crucial and obvious questions whether ABO blood groups favour susceptibility to life-threatening malaria. Preliminary evidence however, suggested that blood group A might be detrimental and group O would be projective[27]. However, other studies of epidemiological importance are not taken into account the potential malaria risk factors such as haemoglobin variants, potholes, stagnant water and other factors that favour the breeding of the mosquito vectors. It has now been resolved that blood group O confers resistance to severe malaria[28].

ABO blood group in the present study shows that the various blood groups results obtained have an effect on the prevalence of

malaria. Blood group A+ has 19 positive samples out of 21 positive samples generally which implies that A+ blood groups are more susceptible to malaria infections. Lagos State Waste Management Authority should rise to this challenge of waste management in order to ensure a drastic reduction in malaria prevalence in Lagos Island.

This research considered environmental factors that affect malaria vector breeding in Lagos Island. The findings of the study proved that human induced environmental factors such as blocked drains, potholes, empty water sachets, receptacles that can hold water after rain and many more are breeding sites of mosquito in Lagos Island. Among these, empty water sachets/receptacles that can hold water after rain contribute more to mosquito breeding in the study area. The research also proved that rainfall and human-induced environmental factors work hand in hand to affect malaria vector breeding in Lagos Island (Marina).

Conflict of interest statement

We declare that we have no conflict of interest.

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