ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 15, Issue, 11, pp.26482-26489, November, 2023
DOI: https://doi.org/10.24941/ijcr.46237.11.2023

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

ABO-BLOOD GROUPS INVOLVEMENT IN THE MALARIA INFECTION INTO PATIENTS IN SOUTHERN AREAS OF CÔTE D'IVOIRE

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ARTICLE INFO

Article History:
Received 20th August, 2023
Received in revised form
27th September, 2023
Accepted 15th October, 2023
Published online 28th November, 2023

Key words:
Malaria, ABO Blood groups, host susceptibility, Côte d'Ivoire.

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ABSTRACT

Background: Malaria, sometimes called the "King of Diseases" is one of the oldest and most frequently occurring infectious diseases in humans. Findings have shown that in malarious areas of the world, a higher proportion of the population has O-group than other groups. Thus,the ABO blood group systems are very important clinical tools that are usually used in blood transfusion but also their associations with various disease conditions have been widely reported. Here, this study investigated the distribution of these blood group systems and assessed the association of malaria infection with the ABO blood groups among patients in health centers of Jacqueville and Tiassalé, Côte d'Ivoire. **Methods:** Blood specimens from veinous of 132patients aged between 0-71 years were examined for malaria parasites using thick drop technical. ABO and Rhesus blood group antigens tests were also performed using standard tile protocols. Of all the children admitted into the study, 445 were sick while 285 were apparently healthy. After determinizing Hemoglobin concentration by automated (ALPHATEC SCIENTIFIC® 34) hematology analyzer, ABO bloodgroups and rhesus factor grouping were done by antigen-antibody agglutination test using slide method and commercially available anti-A, anti- B, anti-AB and anti-D monoclonal antibodies. **Results:** The prevalence of malaria was 52.27 % with 50.10 % and 50.70 % at Jacqueville and Tiassalé respectively. The O-group was be predominant group with 50.82 % at Jacqueville and 46.48 % at Tiassalé and AB-group weakly represented, 3.28 % at Jacqueville and 4.23 %at Tiassalé. Rhesus positive was hugely represented at Jacqueville like Tiassalé with 93.44 % and 94.37 % respectively. The malaria infection was not associated with gender (p = 0.63 at Jacqueville ;p = 0.71 at Tiassalé) but it was associated with ABO blood groups (p = 0.042 ; $_{95\%}$CI = [1.02-7.02] ; OR = 2.68) with as individuals of O-group appears the risk people who could be exposed over twice more than individuals of other groups. **Conclusion:** The results suggest that there is not association between malaria infection and gender while there is an association between this infection and ABO group systems and O-group individuals are more are more susceptible to malaria infection compared to other blood groups.

Citation: ***KASSI Bohoussou Georges, TOURE Mahama, SIMARO Siriki, AHOUTY Ahouty Bernardin et al.*** **2023.** "ABO-blood groups involvement in the malaria infection into patients in Southern areas of Côte d'Ivoire*". International Journal of Current Research*, 15, (10), xxxx-xxxxx.

INTRODUCTION

Malaria is one of the oldest and most frequently occurring infectious diseases in humans (Onanuga & Lamikanra, 2016). It is a kind of infectious disease mainly caused by protozoan parasites of the genus *Plasmodium* and sometimes called the "King of Diseases" (Tangpukdee *et al*., 2009). The most serious and sometimes fatal type of malaria is caused by *Plasmodium falciparum*. The other human malaria species, *P. vivax, P. ovale, P. malariae,* and sometimes *P. knowlesi* can cause acute, severe illness but mortality rates are low (Tangpukdee *et al*., 2009).

Transmitted by mosquitoes, malaria is widespread in tropical and subtropical regions of the world and it is the second leading infectious disease that causes death in Africa, after HIV/AIDS (Murray *et al*., 2014). It appears a life-threatening parasitic disease and is the most important infectious disease in tropical and subtropical regions(WHO, 2014). It continues to be a major global health problem, with over 40% of the world's population exposed to varying degrees of malaria risk in some 100 countries. About over 500 million people suffer from malaria infections yearly, resulting in about 1-2 million deaths, of whom 90% are children in sub Saharan Africa(WHO, 2014).In Côte d'Ivoire, malaria is the first cause of morbidity (40 %) and mortality (10 %) with the prevalence remains high (33%) and the transmission is continual during whole year (PNLP, 2008).

It is a major cause of anemia in endemic areas although caused by several factors with a significant proportion of deaths caused by malaria resulted directly or indirectly from anemia (Kenangalem *et al*., 2016; Moraleda *et al*., 2017). Indeed, all the deaths caused by malaria start when the plasmodial parasites invade erythrocytes, the very cells that express the ABO antigens on their surface which allow to determine the different blood groups. Thereby, malaria is a disease for which an association with ABO blood group distribution seems most plausible, and these ABO blood groups may have played an important role into this association (Athreya & Coriell, 1967). The outcome of the disease may depend on the genetic diversity of the host or the parasite(Ahouty *et al*., 2019)Indeed, it has been identified that red blood cell polymorphisms and genetic variants of the host are contributors of malaria infection(Greenwell, 1997).In addition, the ABO blood group is also possibly one of the genetic factors(Wahlgren *et al*., 2017). In fact, human ABO blood type antigens exhibit alternative phenotypes and genetically derived glycoconjugate structures that are located on the red cell surface which play an active role in the cells physiology and pathology(Aliyu, 2016).

In view of a heavy burden placed on human health due to malaria, some investigations have been conducted by several researchers to find out whether or not ABO blood groups are associated with susceptibility or resistance of malaria infection. Nonetheless, results were contradictory and unable to establish an unequivocal link between ABO blood groups and the malaria (Bayoumi *et al*., 1986; Montoya *et al*., 1994).In fact, a study conducted in Ghana was concluded that blood group A is more prone to severe malaria infection than blood group O (Afoakwah *et al*., 2016). Similarly, studies conducted in Ethiopia (Tekeste & Petros, 2010) and Cameroon (Kuete *et al*., 2017) on ABO blood group and malaria also found that people with blood groups A and B are at a higher risk of experiencing intense symptoms of malaria compared to those having blood group O type. Also, a study conducted in Southern Ethiopia showed that people with blood groups A, B and AB were more vulnerable to malaria infection compared to those with blood group O (Zerihun *et al*., 2011). In contrary, a study realized in Ghana showed that there was no significant relationship between malaria and blood group (Osisiogu *et al*., 2023).In Côte d'Ivoire where the majority of consultations in the hearth centers is caused by malaria and the malaria's transmission is continual during whole year(PNLP, 2008), it would be useful to know whether there is any relationship between blood groups and malaria infection. Therefore, the current study aims to search for the association between ABO blood groups and malaria into the patients for knowing which blood group/groups could be take care in first time in the hospitals in the malaria cases.

MATERIALS AND METHODS

Study area: Jacqueville and Tiassalé are located in South of Côte d'Ivoire with GPS coordinates 5° 12' 21.532" N 4° 25' 24.071"W and 5° 54' 0" N 4°49' 59.999" W respectively. The climate of the both is marked by wet and dry seasons, two types of each (one little and other large) while a mean monthly temperature varies between 21°C and 35°C throughout the year with a mean annual rainfall estimated about 696 mm at Jacqueville and 22°C to 34°C with 826.4 mm at Tiassalé. The study was conducted in those cities and the samples were collected in their health center.

Laboratory procedures

Blood sampling: Blood human samples were collected by specialists of health centers and according to the methods used of everyday. So, this study was conducted in accordance with ethical principles. A volume of 2.5 mL of venous blood sample was drawn into tubes containing the anticoagulant potassium ethylenediamine-tetra acetic acid (EDTA). The blood samples have been taken in the arm and, the mainly steps are the following:

Palpate the area for locate a vein of good size that is visible, straight and clear. Then, applied a tourniquet around the arm. After this step, alcohol (70%) used for clearing the area and wait about 30 seconds for the alcohol to dry following by insertion of blood collector contains tube contains EDTA as anticoagulant into the holder. Coming step consist to anchor the vein by holding the patient's arm and placing a thumb below the place where to place the needle and enter the vein swiftly, when blood starts to flow, and once sufficient blood has been collected (2.5 mL), release the tourniquet before withdrawing the needle. Finally, the blood collector tube is removed from holder and put into collection box.

Staining of thick drop and parasite detection: To make a thick drop, a drop blood was stirred in a circular motion with the corner of the slide, taking care not make the preparation too thick, and allowed to dry for 25 min. After drying, the drop is stained with Giemsa diluted 10-fold (Adu-Gyasi *et al*., 2012) for 20 min, and washed by sterilized water. The slide is allowed to air-dry for 25 min again. The thick drop was examined under a light microscope at a magnification 100X with oil immersion. About 50 fields were observed, if the *plasmodium*'s presenceis identified, the patienttested positive otherwise, he tested negative.

Hemoglobin (Hb) concentration determination: The whole blood sampled and collected in EDTA tube like indicated rather, was used in this step. This quantity blood allowed to determine the hemoglobin (Hb) concentration using automated (ALPHATEC SCIENTIFIC® 34) hematology analyzer and the results for all analyzed samples were printed. Based on the Hemoglobin level, there are either anemic patients or not anemic patients and the Hemoglobin threshold was 10 g/dL for children, 12 g/dL for female adults and 13 g/dL for male adults (Kiggundu *et al*., 2013; WHO, 2014).

Blood groups and rhesus factor determination: The ABO blood groupsand rhesus factor grouping were done by antigen-antibody agglutination test using slide method and commercially available anti-A, anti- B, anti-AB and anti-D (for rhesus factor) monoclonal antibodies. Following the preparation of suspension of test red blood cells from EDTA tube, 1 volume of anti-A, anti-B anti-AB and anti-D reagent and 1 volume of test red cell suspension were placed on a labeled glass slide. Then the reagent and the cells were mixed over anarea of about 20x40mm using a clean applicator stick. The slide was slowly tilted back and forth for about 30 seconds with occasional further mixing during the 2 minutes of period by maintaining the slide at room temperature. Finally, agglutination was read macroscopically after 2 minuteswith careful investigation to avoid mistakes due to fibrin strands and weak reactions.

Statistical analysis: The data obtained were registered using Microsoft Excel statistical package. The data were analyzed using R software (version 3.2.2, 2014). The chi-square or Fisher'sexact test was calculated to compare the categorical variables. Odds ratios (OR) and 95% confidence intervals (CI) were used to assess the risk between ABO blood groups and malaria. The value of Cramer (Cramer's V) was calculated. It measures the degree of association or it assesses the association intensity. Cramer's V varies from 0, where there is no association between the variables to 1 where there a complete association. Thus, when the result is statistically significant, for Cramer's V $\leq$ 0.2: the association is weak, for 0.2 < Cramer's V $\leq$ 0.6: there is a moderate association link and for Cramer's V > 0.6: there is a strong association link (Cramér, 1946).*P* value $\leq$ 0.05 was considered statistically significant for all analyses.

RESULTS

Basic characteristics of study population: In this study, 132 patients were enrolled with 61 at Jacqueville and 71 at Tiassalé representing 46.21 % and 53.79 % respectively (Table 1).

Table 1. Characteristics of studied population

Characters	Jacqueville (%)	Tiassalé (%)
Sex		
Male (M)	26 (42.62 %)	32 (45.07 %)
Female (F)	35 (57.38 %)	39 (54.93 %)
Total	61 (46.21 %)	71 (53.79 %)
Sex-ratio (M/F)	0.71	0.82
Age groups		
Children	34 (57.74 %)	29 (40.85 %)
Adults	27 (44.26 %)	42 (59.15 %)
Mean age (Range)	18 (1-71)	23 (0-62)
Age variance	19.5	17.3

At Jacqueville, with 18 years as mean age, patients' age varies from 1 to 71years and with 19.5 as age variance. 42.62 % of patients are males and 57.38 % female representing a sex-ratio (M/F) of 0.71. The children predominate weakly at Jacqueville with 57.74 % (Table1). At Tiassalé, with 23 years as mean age, the age ranged from 0 to 62 years and with 17.3 as age variance. 45.07 % of patients are males and 54.93 % female representing a sex-ratio (M/F) of 0.82. The adults predominate weakly at Tiassalé with 59.15 % (Table1).

Frequencies ofABO blood groups and rhesus factor in the population: As it was shown in Fig 1, The O-blood group predominates in the two cities: 50.82 % at Jacqueville and 46.48 % at Tiassalé followed by B-blood group with 28.87 % at Jacqueville and 32.39 % at Tiassalé, then the A-blood group with 18.03 % and 16.90 % at Jacqueville and Tiassalé respectively. At the last, the AB-blood group represented by weak frequencies of 3.28 % at Jacqueville and 4.23 % at Tiassalé. For the rhesus factor, almost all people were of positive rhesus with 93.44 % at Jacqueville and 94.37 % at Tiassalé, the negative rhesus was minority: 6.56 % at Jacqueville and 5.63 % at Tiassalé (Fig 2).

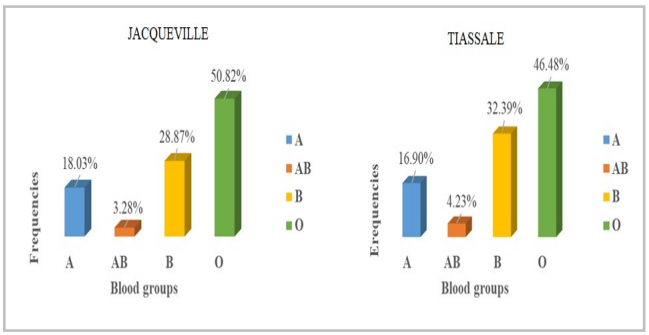

Figure 1. Distribution of ABO blood groups in the population

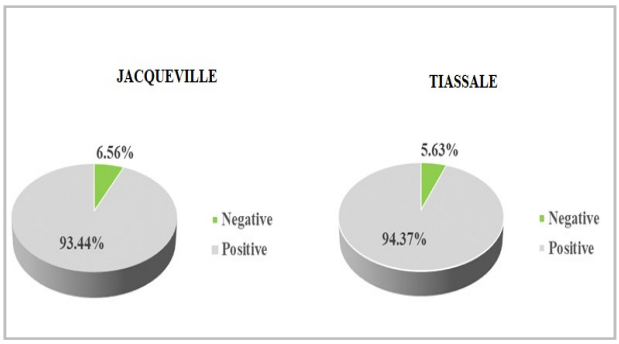

Figure 2. Distribution of rhesus factor in the population

Malaria and anemia prevalence: 33 of 61 of Jacqueville's patients were positive of the testof thick drop representing, 50.10 %while, 40 of the same 61 of Jacqueville's patients representing 65.57 % had a hemaglobinconcentration below the threshold whom were declared anemic patients (Table 2). And finally, 25 of Jacqueville's patients representing 49.98 % are infected by *palsmodium* while that they are anemics (the both, malaria and anemia) (Table 2).

Among the patients infected by *plasmodium*, 45.45 % was male and 54.56 % was femalewhile among anemics 'patients, 45 % was male and 55 % was female(Table 2). For those with the both (malaria and anemia), 52 % was male and 48 % was female (Table 2). Regarding age groups, among the patients infected by *plasmodium*, 63.64 % was children and 36.36 % was adults while among anemics 'patients, there equal percent (50 %)in the children as adults (Table 2). For those with the both (malaria and anemia), 56 % was children and 44 % was adults (Table 2).

36 of 71 of Tiassalé's patients were positive of the test of thick drop representing, 50.70 % while, 23 of the same 71 of Tiassalé's patients representing 32.39 % had a hemaglobinconcentration below the threshold whom were declared anemic patients (Table 2). And finally, 12 of Tiassalé's patients representing 16.90 % are infected by *palsmodium* while that they are anemics (the both, malaria and anemia) (Table 2). Among the patients infected by *plasmodium*, 47.22 % was male and 52.78 % was female while among anemics 'patients, 39.13 % was male and 60.87 % was female (Table 2). For those with the both (malaria and anemia), 41.67 % was male and 58.33 % was female (Table 2). Regarding age groups at Tiassalé, among the patients infected by *plasmodium*, 44.44 % was children and 54.56 % was adults while among anemics 'patients, 39.13 % was children and 60.87 % was adults (Table 2). For those with the both (malaria and anemia), 41.67 % was children and 58.33 % was adults (Table 2).

Association between studied factors and malaria infection or anemia in the different localities: At Jacqueville like at Tiassalé, the malaria infection did not differ significantly between male and female(p= 0.62at Jacquevilleand p = 0.71 at Tiassalé) (Table3). The same remark was be observed with children and adults with p = 0.27 at Jacqueville and p = 0.53 at Tiassalé (Table3). The distribution of anemic individuals and non-anemic individuals did not differ significantly between male and female at Jacqueville (p = 0.60) and at Tiassalé (p = 0.49) (Table4). Also, in the age groups, the proportion of anemic children did not differ significantly to the proportion of anemic adults at Jacqueville (p = 0.21) like at Tiassalé (p = 0.84) (Table 4). The table 5 shows that the distribution of malaria-anemic individuals did not statistically significance between male and female at Jacqueville (p = 0.22) and also at Tiassalé (p = 0.80) (Table 5). This observation was be identical with the age groups at Jacqueville (p = 0.37) and at Tiassalé (p = 0.95) (Table 5). At Jacqueville, the risk of malaria infection was not statistically different between blood group A and non-A (p = 0.17;$_{95\%}$CI=[0.63-11.23]), blood group B and non-B (p = 0.49;$_{95\%}$CI = [0.22-2.08]), blood group AB and non-AB (p = 0.91;$_{95\%}$CI = [0.05-14.14]) and blood group O and non-O (p = 0.69;$_{95\%}$CI = [0.30-2.24]). Also, the risk of malaria infection was not statistically different between rhesus factors (p = 0.23;$_{95\%}$CI = [0.38-39.19])(Table 6). At Tiassalé, the risk of malaria infection was not statistically different between blood group A and non-A (p = 0.96;$_{95\%}$CI = [0.28-3.35]), blood group B and non-B (p = 0.006;$_{95\%}$CI = [0.14-1.07]), blood group AB and non-AB (p = 0.54;$_{95\%}$CI = [0.04-5.45]) whilst it wasstatistically different between blood group O and non-O (p = 0.042;$_{95\%}$CI = [1.02-7.02]) with OR = 2.68 and 0.241 like Cramer Value (Cramer'sV). According to rhesus factors, the risk of malaria infection was not also statistically different (p = 0.32;$_{95\%}$CI = [0.03-3.27]) (Table 6).

DISCUSSION

The malaria's prevalence about 50 % in the both localities shows that Côted'Ivoire belongs malaria endemic countries. This high prevalence is beyond the malaria's national prevalence whom is about 23 %(PNLP, 2020). Indeed, those cities are located at southern of country where it rains almost the year, thus stagnant water and rainfall could be favor the breeding of malaria vectors as well as parasite development within them (Kimbi, 2012). Levels of *Plasmodium* infection prevalence observed in the current study were near of those found in a study conducted in Taabo, located at 150 km north-west of Abidjan with prevalence of *Plasmodium* infection of 46.0 % in 2010 and 56.6 % in 2011 (Bassa *et al*., 2016).

Table 2. Malaria and anemia prevalence according to the gender and age groups in each locality

Jacqueville					**Tiassalé**			
Prevalence					Prevalence			
Characters	Exanimated people	Malaria subjects (%)	Anemia subjects (%)	Malaria & anemia subjects (%)	Exanimated people	Malaria subjects (%)	Anemia subjects (%)	Malaria & anemia subjects (%)
Sex								
Male	26	15 (45.45 %)	18 (45 %)	13 (52 %)	32	17 (47.22 %)	09 (39.13 %)	05 (41.67 %)
Female	35	18 (54.55 %)	22 (55 %)	12 (48 %)	39	19 (52.78 %)	14 (60.87 %)	07 (58.33 %)
Total	61	33 (50.10 %)	40 (65.57 %)	25 (49.98 %)	71	36 (50.70 %)	23 (32.39 %)	12 (16.90 %)
Age groups								
Children	34	21 (63.64 %)	20 (50 %)	14 (56 %)	29	16 (44.44 %)	09 (39.13 %)	05 (41.67 %)
Adults	27	12 (36.36 %)	20 (50 %)	11 (44 %)	42	20 (55.56 %)	14 (60.87 %)	07 (58.33 %)
Total	61	33 (50.10 %)	40 (65.57 %)	25 (49.98 %)	71	36 (50.70 %)	23 (32.39 %)	12 (16.90 %)

Table 3. Comparison of frequency of patients among malaria-infected individuals with that of non-malaria-infected individuals at gender and age groups

Localities	Jacqueville					Tiasalé				
Characters	Total	Malaria subjects (%)	OR (95% CI)	*P.value*	Cramer'sV	Total	Malaria subjects (%)	OR (95% CI)	*P.value*	Cramer'sV
Sex										
Male	26	15 (57.69 %)	1.29 (0.46-3.58)	0.63	0.062	32	17 (53.13 %)	1.19 (0.47-3.04)	0.71	0.044
Female	35	18 (51.43 %)				39	19 (48.72 %)			
Total	61	33 (54.10 %)				71	36 (50.70 %)			
Age groups										
Children	33	20 (60.61 %)	1.78 (0.64-4.92)	0.27	0.142	29	13 (44.83 %)	1.35 (0.52-3.50)	0.53	0.074
Adults	28	13 (46.43 %)				42	20 (47.62 %)			
Total	61	33 (54.10 %)				71	36 (50.70 %)			

Table 4. Comparison of frequency of patients among anemic individuals with that of non-anemic individuals at gender and age groups

Localities	Jacqueville					Tiasalé				
Characters	Total	Anemia subjects (%)	OR (95% CI)	*P.value*	Cramer'sV	Total	Anemia subjects (%)	OR (95% CI)	*P.value*	Cramer'sV
Sex										
Male	26	18 (69.23 %)	1.33 (0.45-3.91)	0.60	0.066	32	09 (28.13 %)	0.70 (0.25-1.92)	0.49	0.083
Female	35	22 (62.86 %)				39	14 (35.90 %)			
Total	61	40 (65.57 %)				71	23 (32.39 %)			
Age groups										
Children	34	20 (58.82 %)	0.50 (0.17-1.50)	0.21	0.159	29	9 (31.03 %)	0.90 (0.33-2.48)	0.84	0.024
Adults	27	20 (74.07 %)				42	14 (33.33 %)			
Total	61	40 (65.57 %)				71	23 (32.39 %)			

Table 5. Comparison of frequency of patients among malaria-anemic individuals with that of non-malaria-anemic individuals at gender and age groups

Localities	Jacqueville					Tiasalé				
Characters	Total	Malaria & anemia subjects (%)	OR (95% CI)	*P.value*	Cramer'sV	Total	Malaria & anemia subjects (%)	OR (95% CI)	*P.value*	Cramer'sV
Sex										
Male	26	13 (50 %)	1.92 (0.68-5.41)	0.22	0.158	32	05 (15.63 %)	0.85 (0.24-2.97)	0.80	0.031
Female	35	12 (34.29 %)				39	07 (17.95 %)			
Total	61	25 (40.98 %)				71	12 (16.90 %)			
Age groups										
Children	31	11 (35.48 %)	0.63 (0.22-1.76)	0.37	0.114	29	05 (17.24 %)	1.04 (0.30-3.67)	0.95	0.008
Adults	30	14 (46.67 %)				42	07 (16.67 %)			
Total	61	25 (40.98 %)				71	12 (16.90 %)			

Table 6. Distribution of ABO blood groups and rhesus factors in malaria patients and no-malaria patients

Localities	Jacqueville					Tiasalé				
Blood groups	Total	Malaria subjects (%)	OR (95% CI)	*P.value*	Cramer'sV	Total	Malaria subjects (%)	OR (95% CI)	*P.value*	Cramer'sV
A	11	08 (72.73 %)	2.67 (0.63-11.23)	0.17	0.175	12	06 (50 %)	0.97 (0.28-3.35)	0.96	0.006
B	17	08 (47.06 %)	0.68 (0.22-2.08)	0.49	0.088	23	08 (34.78 %)	0.38 (0.14-1.07)	0.06	0.22
AB	02	01 (50 %)	0.84 (0.05-14.14)	0.91	0.015	03	01 (33.33 %)	0.47 (0.04-5.45)	0.54	0.073
O	31	16 (51.61 %)	0.82 (0.30-2.24)	0.69	0.051	33	21 (63.64 %)	2.68 (1.02-7.02)	0.042*	0.241
Total	61	33 (54.10 %)				71	36 (50.70 %)			
Rhesus factors										
Positive	57	32 (56.14 %)	3.84 (0.38-39.19)	0.23	0.16	67	33 (49.25 %)	0.32 (0.03-3.27)	0.32	0.119
Negative	04	01 (25 %)				04	03 (75 %)			
Total	61	33 (54.10 %)				71	36 (50.70 %)			

* = Statistically significant (P ≤ 0.05)

Another study carry outin the health facilities of the Yopougon municipality,the largest and most recent municipality (117 sq. km) of Greater Abidjan, have shown ano trifling malaria infection rate of42.8% into one to five years-olds(Wang *et al*., 2006). The malaria infection was not be associated with gender (p = 0.63 at Jacqueville, p = 0.71 at Tiassalé) in this study. This observation shows that number of infected men could be noticeably identical to those of infected women. The explanation of the remarkable result is that mosquito vectors have not a clearcut preference for either sex(Reuben, 1993). A similar situation was observed in a study carry out in Abidjan, Côte d'Ivoire from January 2007 to February 2011(Goran-Kouacou *et al*., 2017). The anemic frequency found in thisstudy (65.57 % at Jacqueville and 32.39 % at Tiassalé) is consistent with data regarding to the third world countries which vary of 22 % et 78 % (Hercberg, 1988). A study carry out at south of Benin was observed the same remark (Koura *et al*., 2011).

The anemic frequency found in thisstudy (65.57 % at Jacqueville and 32.39 % at Tiassalé) is consistent with data regarding to the third world countries which vary of 22 % et 78 % (Hercberg, 1988). A study carry out at south of Benin was observed the same remark (Koura *et al*., 2011). Despite that malaria is not associated to anemia in the two cities (p = 0.60 at Jacqueville and p = 0.49 at Tiassalé), howeverthe percentage of anemic female is more than those of anemic male in the two cities respectively. This result could be due to the high needs in iron of the female during pregnancy or menstruation periods allowing the female more vulnerable than male (Ouzennou *et al*., 2018). In this study, high percentage of O blood group (50.82 % at Jacqueville and 46.48 % at Tiassalé) was observed among the study participants followed by B-group (28.87 % at Jacqueville and 32.39 % at Tiassalé), A-group (18.03 % at Jacqueville and 16.90 % at Tiassalé) and the low percentage attributed to AB-group (3.28 % at Jacqueville and 4.23 % at Tiassalé).

This result with predominance of O-group goes in line with some recent studies reporting high group O frequency in malaria rampant tropical regions as compared to other blood groups(Mandefro *et al*., 2014; Muntaka & Opoku-Okrah, 2013). In fact, this distribution is inhomogeneous in populations of different regions. Thus, the O allele has a higher frequency in sub-Saharan Africa, whist the B antigen is more common in Asians (Loscertales *et al*., 2007).The percentages obtained in the same order was observed in the study conducted at general hospitals in malaria endemic areas along the Thai-Myanmar at Thailand (Kuesap& Na-Bangchang, 2018). Another study realized at Dore Bafeno Health Center, Southern Ethiopia have showed O-group as predominant percentage and AB-group, low percentage(Zerihun *et al*., 2011). The results of this study on the relationship between malaria infection and ABO blood groups showed that there is an association (p = 0.042) with as individuals of O-group appears the risk people who could be exposed over twice more than individuals of other groups. The value of Cramer (Cramer'sV = 0.241) shows a moderate association link between O-group and malaria in this case. The result could be explained by preference feeding of moustiquoes. In fact, even if the parasitized red blood cells have a stronger tendency to form rosettes with uninfected erythrocytes of the A, B or AB blood groups than with those of blood group O(Rowe *et al*., 2007), the research are found that under laboratory conditions that vectors as *Anopheles gambiae* seems to recognize blood groups and to feed preferentially on O-group (Wood *et al*., 1972). This result is consistent with previous reportsat Navi Mumbai in India, which suggest that person having blood group O are more prone to malarial infection inendemic areas(Singh *et al*., 2015). However, many study have not shown a significant association between ABO blood groups between malaria infection (Bayoumi *et al*., 1986; Montoya *et al*., 1994; Singh *et al*., 1995; Zhang *et al*., 2017).

CONCLUSION

The current findings indicate that malaria infection was associated to ABO blood groups and that individuals of blood group O are more susceptible to malaria infection as compared with individuals of blood groups A, B and AB. Nevertheless, further in-depth studies are required to clearly establish the role that ABO blood group plays inmalaria infection

ACKNOWLEDGEMENTS

We thank all those who voluntarily participated in this study. We in particular, thank the parents and guardians who willingly consented on behalf of their children. Thanks also go to all the staff of Jacqueville and Tiassalé regional hospital and Jean Lorougnon Guédé University.

Conflicts of Interest: The author declares that he has no conflicts of interest.

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