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Association of Abo Blood Group and Rh Factor with Malaria and Some Gastrointestinal Infectious Disease in a Population of Adet and Merawi, Ethiopia

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Abstract: ABO and Rhesus are the most important blood group systems in medicine and transplantation immunology which differ by the presence or absence of antigens on red blood cells (RBCs) and antibodies in the blood plasma. In this study, the frequency distribution of ABO and Rh blood groups in various phenotypes was assessed to seek for the possible relationships with diseases. A total of 100 volunteers donors were selected from West Gojjam (Merawi and Adet) towns and blood samples were collected from both inpatient and outpatient individuals. Then, blood grouping was done by the antigen-antibody agglutination test. The overall blood-group frequencies from this region was O (r=0.624), A (p=0.2299) and B (q=0.1456) and the genotypic frequencies were AA (p2=0.05285), AO (2pr=0.287), BB (q2=0.0212), BO (2qr=0.1818), AB (2pq=0.0669) and OO (r2=0.39).The ABO blood type frequency associated with Malaria diseases was highest in the A blood group than in others. Patients with gastric and intestinal diseases were the highest in O blood group individuals. Individuals with the blood type O had the least frequent malarial infection. Blood type B individuals were most affected followed by A, AB and O. Blood type A subjects were more prone to Ameobiosis than the other blood types whereas blood type O individuals were more affected with gastric and intestinal parasites. Overall these results show correlations of human blood types with various gastric diseases and malaria infection which may inform better regional resource allocations.

Key words: ABO AndRh Blood Groups · Allelic Frequencies · Disease · Genotype · Phenotype

INTRODUCTION

A series of glycoprotein and glycolipids on red blood cell surface constitute blood group antigens in ABO blood group and Rh in rhesus blood group systems. This antigen is genetically controlled [1]. All human populations share the same blood group systems inherited from common ancestor but they differ by their frequencies [2]. Genotypic and phenotypic frequencies depend on the frequency of the alleles and the mating system of a population [3, 4] and vary among different races, which furnish interesting questions in population studies, anthropology and human genetic diseases [5]. A/B antigen expression exhibits dynamic changes during development and pathogenesis [6]. Since the discovery of blood groups, there have been enormous efforts to elucidate a possible association between ABO and Rh blood groups and different regionally-enriched diseases. The data obtained from studies on patients with different types of cancer and tumors [7-10], thyroid disorders [11], heart disease [12, 13] parasitic and viral infections [14] and Diabetes Mellitus [15] have shown associations of Rh (D) and ABO blood groups with diseases. One of the central challenges in modern human genetics is to unravel the genetic basis of human diseases and the differences in genetic susceptibility. At the present time, little is known about the determinants of complex diseases. For a given disease, an individual's risk probably depends on various unknown functions of genetic, environmental/lifestyle and stochastic factors. For some complex diseases, there are also closely related monogenic forms e.g. MODY genes for diabetes [16].

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The significance of human blood groups can be seen more clearly in the context of population movement and the constant battle between humans and infectious disease [17]. Since the interplay between malaria parasites and blood group antigens is a fascinating subject with potential to contribute to the development of new interventions to reduce the global burden of malaria, the association between plasmodium and blood group is of particular interest [18]. Scientific evidence gained can be used for looking in to a different aspect of malaria vaccine production and resource allocation. Available evidence suggests surviving malaria is the most significant selective force affecting the expression of blood groups. Red cells lacking or having altered forms of blood group-active molecules are commonly found in regions of the world in which malaria is endemic [17].Selective enzymatic digestion of blood group A antigen from the uninfected RBC surfaces totally abolished the preference of the parasite to form rosettes with these RBCs. A and B antigens serve as co-receptors in P. falciparum resetting [19]. Patients with blood group O, which is less prone to rosetting have a reduced chance of developing severe falciparum malaria as compared to patients with other blood groups [20]. Blood group 'O' is associated with reduced and 'B' blood group with increased risk of development of severe malaria. Meta-analysis also supports the protective nature of blood group 'O' from severe falciparum infection [21]. Non-O haplotypes inherited from mothers, but not fathers, are significantly associated with severe malaria [22]. Of all the genetic markers tested, only Blood group O and Rh D negative had significant and positive associations with P. falciparum infection [23].

Bacterial diseases also have shown association with ABO blood groups [14]. The vibriocidal antibody response may be a surrogate marker for other immune responses that develop following infection and that actually confer protection on subsequent exposure [24]. Findings suggest that different strains of pathogens may recognize different human blood group antigens on intestinal epithelial cells as receptors for infection [25]. Infection with some strains of pathogens exhibited histological changes and increased inflammatory cell infiltration [26]. Individuals with blood group O are more susceptible than other individuals to severe cholera, although the mechanism underlying this association is unknown [24]. A statistically significant association was found between ABO genotype and gastric cholera risk [27].

The study of IgE in serum provides information on IgE deficiency, which is common in immunodeficiency-related gut disorders. Although the pathogenic significance of the IgE deficit remains uncertain [28] it has some unclear association between Amoeba and Giardia infection and blood groups. Additional testing is needed to determine the extent of association of the blood groups with disease and malarial parasite infection [14]. Further definition of the specific mechanisms of immunity to these diseases may allow an improved understanding of the association between blood groups and the risk of these infectious diseases [24, 27].Studies in different centers and locals may be valuable for identifying the association between ABO or Rhesus (D) blood groups and infections [29]. Only a few studies have investigated the information on the association between malaria, intestinal infection and blood groups in Ethiopia, an area of high malarial burden. Therefore, this study was conducted to assess the relationship between blood group and Rh factor associations with Malaria and various gastrointestinal infections in the population of Adet and Merawi Towns of West Gojjam, Ethiopia.

MATERIALS AND METHODS

Description of the Study Site: The study sites are located in West Gojjam Amhara, Northern Ethiopia and two sites were randomly selected for this study. The altitude of Merawi is 2000m above sea level, the latitude is 11.40 and the longitude is 37.160. The altitude, latitude and longitude of Adet are 2179m, 11.280 and 37.490 respectively.

Blood Collection and Typing: This cross sectional study examined 100 subjects, inclusive of both gender. The subjects living in West Gojjam towns (Adet and Merawi) inpatient and outpatient individuals who were admitted to health centers from January 2012 to March 2012 and gave informed consent were included in the study. All subjects voluntarily agreed to participate and gave written informed consent. Ethical clearance was obtained from the Ethical Clearance Committee of Addis Ababa University, Ethiopia. Their blood samples were collected by qualified medical laboratory technicians, using the standard clinical procedure, with a sterile, disposable plastic syringe. The blood grouping and Rh factor examination was performed by the slide method [30]. The blood drops that showed agglutination were considered to be positive for a particular blood grouping reagent.

Diagnosis of the Diseases: Thin blood smears were prepared for malaria diagnosis by visual inspection using microscopy by experienced laboratory technicians, presence or absence of malaria parasite was recorded. For the diagnosis of Ameobiosis and Giardisis, stool samples were taken from study subjects and microscopic examination was made. The results were recorded accordingly. For the diagnosis of H. pylori, the colloidal gold kit was used H. pylori antigen rapid test strip (LINEAR CHEMICAL SSL).

Statistical Analysis: The degree of association between blood type and the diseases from the populations was subjected to Chi-square testes using the statistical package SPSS version 20. Significant differences were determined at $p < 0.05$.

RESULTS

The phenotypic and genotypic frequencies of ABO blood groups in the Adet and Merawi populations are presented in table (1). The ABO phenotypes were 39 %, 34 %, 21 % and 6% for each of O, A, B and AB blood groups respectively. Allele frequencies shows a high frequency of the allele I over IB and IA alleles in the order of (i> IA >IB) respectively. Rh factor records: 91%, 9% for Rh+ and Rh- respectively in the population, with frequency of 0.7 for allele D and 0.3 for d respectively. Among the samples that were collected from Merawi, 38% had the blood type A, 36% had the blood type O, 24% had the blood type B and 2% had the blood type AB. Regarding the Rh type the majority of the samples were Rh positive i.e. 92% and Rh negative the rare one accounts for only 8%. Of the blood types observed at Adet, blood type A with 30% was the highest followed by O (42%), B (18%) and AB (10%). The majority (90%) of the population was Rh positive and the rest (10%) of the population was Rh negative. When we see the cross total of the two sites, 39% of blood type O, 34% of blood type A, 21% of blood type B and 6% of blood type AB were recorded. The majority of the population in the two sites was Rh positive (91%) and only 9% of the population was Rh negative.

Table 1: Phenotypic and genotypic distribution of ABO and Rh blood groups for Merawi and Adet, West Gojjam

Sites	Gene (allele) Frequency		Genotypic Frequency		Phenotypic Frequency	Remark
Merawi	O	0.6	OO	0.36	O	36%
	A	0.26	AA	0.07	A	38%
	B	0.14	AO	0.31	A	
	-	-	BB	0.02	B	24%
			BO	0.17	B	
			AB	0.07	AB	2%
	D	0.72	DD	0.51	Rh(D)+VE	92%
	D	0.28	Dd	0.41	Rh(D)+VE	
			dd	0.08	Rh (d)-VE	8%
Adet	O	0.65	OO	0.42	O	42%
	A	0.2	AA	0.04	A	30%
	B	0.15	AO	0.26	A	
	-	-	BB	0.02	B	18%
			BO	0.2	B	
			AB	0.06	AB	10%
	D	0.68	DD	0.47	Rh(D)+VE	90%
	D	0.32	Dd	0.43	Rh(D)+VE	
	dd	0.1	Rh (d)-VE	10%		
Totals of the two sites	O	0.62	OO	0.39	O	39%
	A	0.23	AA	0.05	A	34%
	B	0.15	AO	0.29	A	
	-	-	BB	0.02	B	21%
			BO	0.18	B	
			AB	0.07	AB	6%
	D	0.7	DD	0.49	Rh(D)+VE	91%
	D	0.3	Dd	0.42	Rh(D)+VE	
			dd	0.09	Rh (d)-VE	9%

Table 2: Summary statistics of disease distribution in West Gojjam

Disease diagnosed	Gender			Rh Blood type					ABO Blood type								
				Rh +ve		Rh –ve			O		A		B		AB		
	M	F	p-value	M	F	M	F	p-value	M	F	M	F	M	F	M	F	p-value
Malaria	20	23	0.792	18	20	2	3	0.425	2	8	6	10	9	4	3	1	0.024
Amoebiasis	25	31	0.935	22	28	3	3	0.972	8	9	6	16	7	4	4	2	0.040
Giardiasis	17	30	0.095	15	27	2	3	0.240	7	11	3	15	5	4	2	-	0.780
G and ID	27	28	0.363	23	24	2	6	0.032	13	17	8	9	3	3	1	1	0.002

G and ID represent gastric and intestinal disease

The proportions of the Rh positive individuals affected with diseases were 88.37 % (malaria) 89.29%, (Amoeba) 89.36% (Giardia) and 85.45%, (gastric and intestinal infection) of the total 100 individuals of the study site for each category of the diseases. Among Rh negative individuals with disease infection, (11.63%) Malaria, (10.71%) Amoeba, (10.64) Giardia and (14.55%) gastric and intestinal infection were recorded. The ABO blood type infection with Malaria was A (37.2%), B (30.23%), AB (9.3%) and O (23.26%). The percentage of infected ABO blood type individuals with Amoeba were A (39.29%), B (19.64%), AB (10.71%) and O (30.36%). Infected ABO blood type individuals with Giardia were A (38.3%), B (19.15%), AB (4.25%) and O (38.3%). Individual ABO blood types infected with gastric and intestinal disease were A (30.9%), B (16.36%), AB (3.63%) and O (54.54%)(Table2).

DISCUSSION

In the present study, blood group O subjects have dominated the study population, followed by A, B and AB. Also the frequencies of the ABO and Rh blood types from the Ethiopian Red Cross and hospitals recorded in the order O >A > B > AB and Rh+ > Rh- in most of the areas [31, 32].

In the last 20 years, there has been increasing evidence that blood groups have a function and play a biological role in disease association, especially malaria [33]. Much of these reports relate to severe malaria with little or no reference to subclinical or asymptomatic infection. There was significant association between ABO blood group andmalaria in the present investigation (p=0.024) in contrast to previous results [34]. Evidence from the literature has established that parasitized erythrocytes form rosettes more readily with RBCs of either A, B or AB blood groups than with those belonging to blood group O. This may explain why severe malaria was relatively more frequent in individuals of non-O blood groups.

The overall prevalence of H. pylori infection in Adet and Merawi was 55% and in agreement with the previous studies performed in Ethiopia which was 49-70%. Results also showed a significant association between the ABO blood group and gastric and intestinal infection caused by H. pylori (P = 0.002). This is similar to results from other studies [35]. Blood group AB patients were less prone to H. pylori infection than other blood groups [35]. However, there are reports from different parts of the world with lower prevalence of H. pylori infection; e.g. 27% in Kuwait and 15-46% in Gambia [36, 37]. This report of low prevalence may be attributed to differences in the study area, subjects, sample size or elimination of H. pylori infection as a result of antibiotic treatment.

The present study assessed only the data of ameobiosis which was found in 56% of the total population. There was no significant association with gender and ameobiosis in the present data. Results of this study showed a significant association between the ABO blood group and infection caused by Entamoebahistolytica (p= 0.04). Blood group A is more susceptible than O, B and AB respectively. This may be related to the level of immunoglobulin in the serum of individuals.

The present study showed no significant relation between ABO blood group system and Giardiasis (p=0.780). Genetic factors can play a major role in the protection of the body against some protozoal infection. The role of genetic factors is especially obvious in blood parasites. This importance of genetic factor is not as distinct in intestinal protozoa. Also, there was no significant difference in the frequency of Rh factor between infected and non-infected population, 42 patients were typed as Rh positive (expected 43.7) and six subjects were Rh negative expected (4.3). These variations in results indicated that there is no correlation between ABO and Rhesus blood groups and Giardia lamblia infection [39].

In Conclusion, blood group O dominated the study population followed by A, B and AB respectively. Also the allele frequencies of A, B and O were (O>A>B). This finding suggests that the higher distribution of O blood type is selectively advantageous than the other blood types. Blood type B individuals were more susceptible for malaria followed by A, AB and O. Blood type A subjects were more prone to Ameobiosis than the other blood types whereas blood type O individuals were more prone to Gastric and intestinal disease.

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