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Research Article

RELATIONSHIP OF ABO AND Rh BLOOD GROUPS WITH DIABETES MELLITUS

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A B S T R A C T

A person's genetic disposition and unhealthy lifetsyle habits are some of the common factors that increase the risk of diabetes. Blood groups differ in their susceptibility for certain diseases. In the present study, ABO and Rh blood groups are tested to get more information about these in relation to diabetes. It is observed that there is preponderance of blood group B (35.5%) followed by group O (33.1%), A (22.5%) and AB (8.9%) in the total population. In borderline subjects, blood group O (35.7%) is more prevalent followed by B (32.8%), A (24.5%) and AB (7.05%). In diabetic subjects O blood group is more prevalent than the B, A and AB blood groups. In the total population, frequency of gene 'r' (0.58) is more than the frequency of q (0.25) and p (0.17). Same series of frequencies has been found in other categories i.e. normal, borderline, newly detected, known and total diabetic subjects. Frequency of D gene is more than the d gene in total population and in all other categories i.e. normal, borderline, newly detected, known and hypoglycemic subjects.

INTRODUCTION

The term diabetes refers either to a deficiency of insulin or to the body's decreased ability to use insulin. Diabetes mellitus effects on all other organ systems of the body. Heredity plays an important role in the aetiology of diabetes. Blood groups are inherited character. It is a known fact that all blood groups are not alike. Every blood group contains specific antigen that generates a specific immune response when foreign substances attack the body. An additional variable, called Rhesus (Rh) factor, also differentiates blood types. A person's blood type is known to impart certain characterictics, but in this study its association with the risk of diabetes has been explored. It is worthwhile to study the relationship of diabetes with particular type of blood group. Many surveys had been undertaken to find out the relationship of ABO and Rh blood group systems and diseases. Blood groups differ in their susceptibility for certain diseases. In the present study, ABO and Rh blood groups are tested to get more information about these in relation to diabetes.

MATERIALS AND METHODS

The present epidemiological and biochemical study was undertaken in the district Sangrur, Punjab, India. The random sample survey was undertaken and 1000 subjects were selected randomly for questioning regarding different aspects of epidemiology. They were questioned personally, using a questionnaire which is designed for collection of data and general information regarding various epidemiological factors. Fasting and random blood sugar levels were measured. The blood grouping was done by the technique of haemagglutination reaction. Red blood cells are agglutinated as they possess the antigen which reacts with the corresponding antibody that is present in the serum. The results were interpreted on the basis of presence or absence of agglutination.

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Gene Frequencies

ABO allele frequencies were calculated by following the methods of Yoshida (1984). The sample was checked for Hardy-Weinberg proportions.

Calculations for gene frequencies for ABO blood group

For calculating the gene frequencies from the observed values, Yoshida (1984) gave the following formulae.

	P =	½ AB+A+O-$\sqrt{O (A+B)}$ / T
	Q =	½ AB+A+O-$\sqrt{O (A+B)}$ / T
	r =	1-P-Q
Where	P =	the frequency of gene A
	Q =	the frequency of gene B
	r =	the frequency of gene O
	T =	Total of A+B+AB+O

Expected frequency of A = N (2 Pr + P2), Expected frequency of B = N (2Qr + Q2)

Expected frequency of AB = N 2 PQ, Expected frequency of O = N (r) 2

Where N denotes total number of subjects in that blood group.

Rh blood groups

For Rh factor the genes are D and d and the gene frequency is calculated by the following formula

$d = \sqrt{dd}$

D = 1-D

D and d stand for Rh (D), positive and negative gene frequencies respectively.

RESULTS

It is observed that there is preponderance of blood group B (35.5%) followed by group O (33.1%), A (22.5%) and AB (8.9%) in the total population (Table- 1).

Table 1 Prevalence of blood groups in total population (N=1000)

Blood Group	Number	Percentage
A	225	22.5
B	335	35.5
AB	89	8.9
O	331	33.1

X2: 351.31; DF: 3; p: <0.0001, Highly significant

In borderline subjects, blood group O (35.7%) is more prevalent followed by B (32.8%), A (24.5%) and AB (7.05%). In diabetic subjects O blood group is more prevalent than the B, A and AB blood groups (Table-2).

Table 2 Prevalence of ABO blood groups in total population and in different status of subjects (Normal, Borderline, Newly detected, Known diabetic, Hypoglycemic and Total diabetic) N = 1000

Status of subjects	A	B	AB	O
Normal Subjects(653)	147(22.5%)	228(34.9%)	73(11.2%)	205(31.4%)
Borderline Subjects (241)	59(24.5%)	79(32.8%)	17(7.05%)	86((35.7%)
Newly Detected(55) Subjects	11(20%)	16(29.1%)	11(20%)	17(30.9%)
Known Diabetic(38) Subjects	8(21.0%)	13(34.2%)	4(10.5%)	13(34.2%)
Hypoglycaemic(13)	5(38.5%)	3(23.1%)	2(15.4%)	3(23.1%)
Total Diabetic (93)	19(20.4%)	29(31.2%)	15(16.1%)	30(32.2%)

The Chi square test is applied and significant values for total ($p<0.01$), normal (<0.0001) and borderline ($p<0.001$) have been obtained (Table-2A).

Table 3A Distribution of ABO blood groups and gene frequencies in total pouplation. (N = 1000)

	Phenotypes				Gene Frequencies			
	A	**B**	**AB**	**O**	***p***	***q***	***r***	***X2***
Observed	225	355	89	331	*0.172*	*0.25*	*0.58*	
Expected	228.52	352.5	86	336.4				
								0.25
X2	0.054	0.018	0.105	0.09				p<0.05

Genotypic Frequencies: AA (p2) 0.029 AO (2pr) 0.199 BB (q2) 0.0625 BO (2qr) 0.29 OO (r^2) 0.336 AB (2pq) 0.086

Table-3A-3G give the gene and genotypic frequencies of total, normal, borderline, newly detected, known diabetic, hypoglycemic and total diabetic subjects.

Table 3B Distribution of ABO blood groups and gene frequencies in normal subjects. (N = 653)

	Phenotypes				Gene Frequencies			
	A	**B**	**AB**	**O**	***p***	***q***	***r***	***X2***
Observed	147	228	73	205	*0.183*	*0.263*	*0.554*	
Expected	153.95	235.19	62.86	200.42				
								2.273
X2	0.314	0.219	1.635	0.105				p<0.05

Genotypic Frequencies: AA (p2) 0.033 AO (2pr) 0.20 BB (q2) 0.069 BO (2qr) 0.291 OO (r^2) 0.307 AB (2pq) 0.096

Table 3 C-Distribution of ABO blood groups and gene frequencies in borderline subjects. (N = 241)

	Phenotypes				Gene Frequencies			
	A	**B**	**AB**	**O**	***p***	***q***	***r***	***X2***
Observed	59	79	17	86	*0.173*	*0.225*	*0.602*	
Expected	57.2	77.3	18.8	87.3				
								0.287
X2		0.056	0.04	0.172	0.019			p<0.05

Genotypic Frequencies: AA (p2) 0.0299 AO (2pr) 0.208 BB (q2) 0.05 BO (2qr) 0.2700.362 OO (r^2) 0.078 AB (2pq)

Table 3D Distribution of ABO blood groups and gene frequencies in newly detected diabetic subjects. (N = 55)

	Phenotypes				Gene Frequencies			
	A	**B**	**AB**	**O**	***p***	***q***	***r***	***X2***
Observed	11	16	11	17	*0.21*	*0.26*	*0.53*	
Expected	14.6	18.8	6.01	15.4				
								5.59
X2	0.88	0.41	4.14	0.16				p<0.05

Genotypic Frequencies: AA (p2) 0.044 AO (2pr) 0.222 BB (q2) 0.067 BO (2qr) 0.275 OO (r^2) 0.280 AB (2pq) 0.109

Table 3 E-Distribution of ABO blood groups and gene frequencies in known diabetic subjects. (N = 38)

	Phenotypes				Gene Frequencies			
	A	**B**	**AB**	**O**	***p***	***q***	***r***	***X2***
Observed	8	13	5	13	*0.18*	*0.26*	*0.56*	
Expected	10.2	13.6	3.6	11.9				
								1.137
X2	0.47	0.026	0.54	0.101				p<0.05

Genotypic Frequencies: AA (p2) 0.032 AO (2pr) 0.201 BB (q2) 0.067 BO (2qr) 0.291 OO (r^2) AB (2pq)

Table 3F Distribution of ABO blood groups and gene frequencies in hypoglycemia subjects. (N = 13)

	Phenotypes				Gene Frequencies			
	A	**B**	**AB**	**O**	***p***	***q***	***r***	***X2***
Observed	5	3	2	3	*0.32*	*0.21*	*0.47*	
Expected	5.2	3.13	1.74	2.8				
								0.062
X2	0.007	0.005	0.04	0.01				p<0.05

Genotypic Frequencies: AA (p2) 0.102 AO (2pr) 0.300 BB (q2) 0.044 BO (2qr) 0.197 OO (r^2) AB (2pq)

Table 3G Distribution of ABO blood groups and gene frequencies in total diabetic subjects. (N = 93)

	Phenotypes				Gene Frequencies			
	A	**B**	**AB**	**O**	***p***	***q***	***r***	***X2***
Observed	19	29	15	30	*0.19*	*0.26*	*0.55*	
Expected	32.9	9.2	28.13	22.8				
								59.16
X2	5.87	42.6	6.12	4.5				p>0.01

Genotypic Frequencies: AA (p2) 0.036 AO (2pr) 0.209 BB (q2) 0.067 BO (2qr) OO (r^2) 0.286

p : Gene frequency of blood group A
q : Gene frequency of blood group B
r : Gene frequency of blood group O

Table-4 and Table-5 show the distribution of Rh factor in total population and in different status of subjects respectively.

After applying the Chi square test highly significant values have been obtained for all categories. The gene frequencies of Rh positive and Rh negative factor are given in Table-6A-6G. Frequency of D gene is more than the d gene in total population and in all other categories i.e. normal, borderline, newly detected, known and hypoglycemic subjects.

Table 4 Prevalence of Rh blood groups in total population of district Sangrur, Punjab (India)

Blood Groups	Number	Percentage
Rh Positive	897	89.7
Rh Negative	103	10.3

X2: 630.436; DF: 2 ; p: <0.0001, Highly Significant.

Table 5 Prevalence of Rh blood group in different status of subjects (N = 1000).

Status of subjects	Rh Positive (n = 897)	Rh Negative (n = 103)
Normal subjects	580(64.65)	73(70.87)
Borderline subjects	223(24.86)	18(17.47)
Newly detected diabetic subjects	49 (5.46)	695.82%)
Known diabetic subjects	33(3.67)	5(4.85)
Hypoglycemic subjects	12(1.33)	1(0.97)
Total diabetic subjects (93)	82(9.14)	11(10.67)

%age is calculated from the bold bracketed values.

Statistical Analysis

Status of subjects	X2	DF	p	HS/NS
Normal	393.64	1	<0.0001	HS
Borderline	33.618	1	<0.0001	HS
Newly Detected	20.631	1	<0.0001	HS
Known Diabetic	9.307	1	<0.001	HS

X2: Chi Square test, p: Probability, HS: Highly Significant, NS: Non significant, DF: Degree of Freedom,

Table 6A Distribution of Rh (D) blood group types in total population

Phenotypes	Number	Percentile
Rh (Anti-D) +	897	0.897
Rh (Anti-D)-	107	0.103
Total	1000	0.1

d = 0.321 D = 0.68

Table 6B Distribution of Rh (D) blood group types in normal subjects

Normal	Observation	Percentile
Rh (Anti-D) +	580	0.888
Rh (Anti-D) -	73	0.112
Total	653	0.1

d = 0.335 D = 0.665

Table 6C Distribution of Rh (D) blood group types in borderline subjects

Normal	Number	Percentile
Rh (Anti-D) +	223	0.925
Rh (Anti-D) -	18	0.075
Total	241	0.1

d = 0.274 D = 0.726

Table 6D Distribution of Rh (D) blood group types in newly detected diabetic subjects

Phenotypes	Number	Percentile
Rh (Anti-D) +	49	0.891
Rh (Anti-D) -	5	0.109
Total	55	0.1

d = 0.330 D = 0.669

Table 6 E Distribution of Rh (D) blood group types in known diabetic subjects

Normal	Observation	Percentile
Rh (Anti-D) +	33	0.868
Rh (Anti-D) -	5	0.132
Total	38	0.1

d = 0.363 D = 0.637

Table 6F Distribution of Rh (D) blood group types in hypoglycemic subjects

Normal	Observation	Percentile
Rh (Anti-D) +	12	0.923
Rh (Anti-D) -	1	0.077
Total	13	0.1

d = 0.277 D = 0.723

Table 6 G Distribution of Rh (D) blood group types in total diabetic subjects.

Normal	Observation	Percentile
Rh (Anti-D) +	82	0.882
Rh (Anti-D) -	11	0.112
Total	93	0.1

d = 0.343 D = 0.657

d : Gene frequency of Rh negative blood group
D : Gene frequency of Rh positive blood group

DISCUSSION

ABO blood groups differ in their susceptibility for certain diseases. Many reports have been published to show the relationship of ABO blood groups and diseases. Aird *et al*. (1954) initiated the thorough enquiry between blood groups and diseases. Aird *et al*. (1954) and Clarke (1955) were pioneers to find out the relationship between patients suffering from diabetes mellitus and ABO blood groups. In the present study, O blood group is more susceptible followed by the group B and AB blood group is more resistant one followed by group A. McConnel *et al*. (1956), Race and Sanger (1962), Bhonslee and Kulkarni(1977) found the higher incidence of diabetes in blood group A than the control group. Fequency of blood groups B and O is significantly higher and lower respectively in the patients (Coll, 2003).

These studies found the prevalence of diabetes in different blood groups like -

Worker (year) Blood group in diabetics

Roberts (1957)	B
Buckwalter (1966)	B
Sidhu *et al*. (1988)	B
Andersen and Luritzen (1960)	O
Jolly *et al*. (1969)	O
Chopra (1979)	AB
Malhotra (1981)	AB

Lamba *et al*. (1974) found relative incidence was found to be higher in O and B blood groups. Some of the workers found no association of diabetes with blood group ABO (Craig and wang ,1955; Machr ,1961; Berg *et al*.,1967 and Macafee ,1969, Okan *et al*,2008,Kamil *et al*,2010).

The results of the present study are in confirmation with the findings of Lamba *et al* (1974), Andersen and Luritzen (1960) and Jolly *et al*. (1969). In the total population, frequency of gene 'r' (0.58) is more than the frequency of q (0.25) and p (0.17). Same series of frequencies has been found in other categories i.e. normal, borderline, newly detected, known and total diabetic subjects. Genotypic Frequencies in the total

population for AA (p2), AO (2pr) , BB (q2) , BO (2qr), OO (r^2),AB (2pq) are 0.029 , 0.199 ,0.0625, 0.29, 0.336 and 0.086 respectively. Same series of frequencies has been found in other categories i.e. normal, borderline, newly detected, known and total diabetic subjects. Genotypic Frequencies of homogenous one i.e. r^2 is followed by qr, pr , pq,q^2 and p^2 ·Rh negative subjects shows the more susceptibility towards diabetes as 10.6% of subjects are Rh negative in total diabetic subjects as compared to 9.1% of Rh positive subjects. Sidhu *et al*. (1988) also found the higher frequency of Rh negative patients in diabetes but Simpson (1962), Bucwalter (1966) and Jolly *et al*. (1969) could not find any significant relationship between Rh blood group system and diseases. Frequency of D gene is more than the d gene in total population and in all other categories i.e. normal, borderline, newly detected, known and hypoglycemic subjects. Study of Fagherazzi shows for the first time in a large prospective cohort that specific ABO blood groups are associated with an increased type 2 diabetes risk." The authors say that the reasons behind the association are currently unknown, but could be related to a number of factors: it has been suggested that the human ABO locus might influence endothelial or inflammation markers. ABO grouping is also associated with various molecules known to be connected to type 2 diabetes, and a recent paper concluded that ABO grouping is a factor which determines the overall gut microbe composition, which in turn affects metabolism and thus could be related to type 2 diabetes (Fagherazzi *et al* ,2014).

The phenotypic "ABO" blood groups are inherited antigenic substances which are found on the surface of red blood cells in addition to other tissues. Certain hypothesis advocates that genetic predisposition like "ABO" blood group would be associated with occurrence of diseases including type 2 diabetes. This study aimed to investigate the potential association between "ABO" and "Rhesus" blood groups with type 2 diabetes. Subjects with blood group "B" are at high risk while individuals with blood group "O" are at low peril of evolving type 2 diabetes. It is suggested that subjects with blood group "B" should be closely monitored by physicians as these subjects have an increased risk of type 2 diabetes (Meo *et al*, 2016)**.**

CONCLUSION

Diabetes mellitus type 2 and blood groups are interrelated because of the broad genetic immunologic basis in both. It is concluded that the frequency of blood groups in O and B borderline is significantly higher and of AB and A is lower in the diabetics and borderline subjects.

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