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Genetic Analysis on Frequency of Alleles for Rh and ABO Blood Group Systems in the Barak Valley Populations of Assam

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Abstract

The genetic study was carried out on a sample of 1400 individuals in the Barak Valley Zone of Assam in India to estimate the gene frequency and the expected genotype frequency for Rh and ABO blood group systems in Hindu and Muslim populations separately. The Rh +ve blood group outnumbered Rh –ve blood group in Hindus (97 and 3%) and Muslims (98 and 2%). The frequencies of *A* (Rh +ve) and *a* (Rh –ve) alleles were 0.83 and 0.17 in Hindus and 0.86 and 0.14 in Muslims. For both of the populations, 'O' blood group was the highest followed by B, A and AB. Both A and B blood groups occurred in almost equal proportions in these two populations. The frequencies of I^A, I^B and *i* alleles were almost same for Hindus (0.19, 0.21 and 0.60) and Muslims (0.18, 0.19 and 0.63). The estimates of chi-square tests for gene frequency and genotype frequency of Rh and ABO blood group systems showed non-significant differences between the two populations. This suggested that the Hindus and the Muslims might be genetically the same, despite cultural, religious and socio-economic differences. Similar magnitudes of existing gene and genotype frequencies of Rh and ABO blood group systems of Hindus and Muslims suggested that both the populations of Barak Valley might have diversified from the same common ancestors in the recent past augmented by socioeconomic, religious and cultural factors over time.

Keywords: ABO system, gene frequency, Hindu, Muslim, Rh system

Introduction

Human beings are naturally outbreeding organisms and reproduce sexually. The transmission of genes (DNA) from one generation to the next one takes place biologically through the gametes. The genotype frequencies for a particular gene(s) in a population depend on the gene frequency. The proportions of different alleles of a gene in a Mendelian (panmictic) population are known as gene frequency (Singh, 1990).

Human beings are classified into Rh +ve and Rh –ve blood groups, following blood test depending on the presence or absence of Rh antigen or D-antigen. The term Rh was derived from the Rhesus monkey (*Macacus rhesus*) on which the antigen was first detected. Rh+ cell produces D-antigen while Rh- cell can't produce it. Assuming the role of a single gene with two alleles (alternative forms of gene) in its inheritance (*A* for D-antigen production and *a* for absence of D-antigen and *A* is dominant over *a*), the Rh+ phenotype will be exhibited by the dominant homozygote (*AA*) and heterozygote (*Aa*) genotypes. Therefore the recessive homozygote (*aa*) genotype will exhibit the Rh- phenotype only. Similarly on the basis of presence or absence of certain antigens, the ABO blood system in human beings was established by Karl Landsteiner. There are two antigens *viz*. A and B which remain present on the red blood corpuscles (RBC) of people. Four blood groups namely A, B, AB and O in human are identified depending on the presence or absence of either or both antigens.

The genetics of ABO blood group system has revealed that three alleles namely I^A, I^B and *i* determine blood groups. I^A produces A antigen, I^B produces B antigen whereas *i* produces neither. I^A and I^B are mutant alleles and show codominance with each other but both are dominant over the wild type allele *i* (Gupta, 1999). The concept of wild type allele is based on the fact that the allele more frequent in a population is a wild type allele.

Blood group testing plays a key role in medical treatment prior to blood transfusion and child birth. The blood group of a person does not change within one's own life time and so it is considered as a unique genetic marker for research. The blood group is determined by the genetic make-up of the alleles of a system. The present study was undertaken to estimate the existing frequencies of alleles and the expected frequencies of genotypes of both the systems in the Hindu and the Muslim populations of Barak Valley Zone, located in Southern Assam within India, sharing international border with Bangladesh. Estimates of gene's frequency provide very valuable information on the genetic similarity of different populations and to some extent on their ancestral genetic linkage, despite the cultural and religious differences of the two populations.

Materials and methods

The present study comprised of a total sample of 1400 individuals (700 each for Hindus and Muslims) across diverse age group of 10 to 70 years. Their blood samples were collected by qualified medical laboratory technicians, us-

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ing the standard clinical procedure, with disposable plastic syringe. Blood group of each individual was determined by appropriate reagents on glass slides in Sonoline X-ray and Pathology Centre (N.S. Avenue, Silchar) and in Barak Blood Bank (N.S. Avenue, Silchar).

Data were collected for Rh and ABO blood grouping of each individual, along with socio-economic factors namely monthly income, family size, age and occupation. Gene frequency was estimated considering two alleles at the same locus for Rh system and three alleles at the same locus for ABO system using standard formulae of quantitative genetics (Dabholkar, 1999). Existing and expected genotype frequencies were calculated on the basis of gene's frequency. Chi-square tests were done to test the independence and the goodness of fit for gene and genotype frequencies (Gupta, 1991).

Results and discussion

Barak Valley is geographically located between 24°15′and 25°9′N latitude and between 92°16′and 93°15′E longitude with subtropical warm humid climate and a population of ca. 3.21 million. Other climatic features of the region are presented in Tab. 1. Nearly 80% of the total population depends on agriculture (Tab. 2).

Rh System

The present distribution of Rh +ve and Rh –ve groups were almost similar for both Hindu (97%; 3%) and Muslim (98%; 2%) populations of Barak Valley, with the predominance of Rh +ve group. These distributions are closely similar to those of Red Indians in Quebec (Canada), Chinese in Beijing and Bengalis in Kolkata (India) as reported by Mourant *et al*. (1976) (Tab. 3).

The existing frequencies of *A* and *a* alleles in the Rh system were estimated as 0.83 and 0.17 in Hindus and 0.86 and 0.14 in Muslims of Barak Valley, respectively (Tab. 4). The expected genotype frequencies in both the populations were showed similar trend. The estimates of Chi-square tests (Tab. 7) for independence between the gene frequencies (0.0033) of two populations as well as genotypic frequencies (0.0020) were not significant at p = 0.05 or 0.01 indicating the absence of genetic difference between two populations for Rh system. In other words, the similarity in gene and genotype frequencies for Rh system in both the populations suggested that the Hindus and Muslims could be genetically related. For convenience of analysis in the present study, the Rh system was assumed to be governed by a single locus with two alleles (*A, a*) showing complete dominance (*A*>*a*). Over 40 human Rh antigens are now known indicating the complex inheritance mechanism of Rh system, particularly in respect of the number of genes and the number of alleles in each gene governing the trait. The Wiener system postulates a single gene locus regulating the Rh system with at least ten (multiple) alleles. But the Fisher system assumes the existence of three closely linked loci, designated as *C, D* and *E* regulating the Rh system. Further study at molecular level would elucidate the number of genes and the alleles regu-

Tab. 1. Climatic features of the Barak Valley Zone of Assam

Geographical location		Climate	Temperature (°C)		Average Annual Rainfall (cm)	No. of Rainy Days/year	Bright Sunshine Hours	Soil P^H	Population (million)
Latitude (N)	Longitude (E)		Min.	Max.					
24°15′-25°9′	92°16′-93°15′	Subtropical, Warm and Humid (hot Summer and Cool winter)	12.2	36.2	318	146	3.8(July) to 8.4(Dec.) hrs.	4.6–5.7 (acidic)	3.21

Tab. 2. Socio-economic and other characteristics of the population in the present study

Hindu		Muslim		Total persons	Monthly Family Income (US dollars)	Average family size (persons)	Occupation	Effect of environmental pollution	Major Diseases in the populations
M	F	M	F						
333	367	330	370	1400	43 – 350	3 – 7	Agriculture(80%) Non-Agric.(20%)	No significant effect except traces of arsenic in underground water in some places	Cancer, Diabetes, Sinusitis, Gastroenteritis

Tab. 3. Rh +ve (%) and Rh –ve (%) individuals of Hindus and Muslims of Barak Valley vis-à-vis other Populations

Population / Area of study	Rh +ve(%)	Rh +ve (%)	Total (%)
Hindus / Barak Valley	97	3	100
Muslims / Barak Valley	98	2	100
(Other exotic population)			
Mexicans / Mexico City	82	18	100
Americans / California	85	15	100
Jews / Israel	89	11	100
Arabs / Lebanon	89	11	100
Bengali / Kolkata	95	5	100
Red Indians / Quebec	98	2	100
Chinese / Beijing	99	9	100
Eskimo / Western Alaska	100	NIL	100

Tab. 4. Existing allelic (*A, a*) and genotype frequency vis-à-vis expected genotype frequency of Rh system of Hindus and Muslims of Barak Valley

Population/Area	Existing Allelic Frequency			Existing Genotype Frequency of Rh system			Expected Genotype Frequency of Rh system			
	Rh +ve (*A* allele)	Rh -ve (*a* allele)	Total	Rh +ve (*AA* and *Aa*)	Rh -ve (*aa*)	Total	Rh +ve (*AA*)	(*Aa*)	Rh -ve (*aa*)	Total
Hindus/Barak Valley	0.83	0.17	1.00	0.97	0.03	1.00	0.69	0.28	0.03	1.00
Muslims/Barak	0.86	0.14	1.00	0.98	0.02	1.00	0.74	0.24	0.02	1.00

Tab. 5. Existing per cent distribution of four blood groups under ABO system in Hindus and Muslims of Barak Valley in comparison to Great Britain

Population / Area	Blood Group Distribution (%)				Total (%)
	AB	A	B	O	
Hindus/Barak Valley	8	27	29	36	100
Muslims/Barak Valley	7	25	28	40	100
Great Britain / Europe	3	42	8.5	46.5	100

blood group was the highest followed by B, A and AB. Moreover, A and B blood groups occurred in almost equal frequency in both Hindu and Muslim populations. This is unlike the population of Great Britain where the A blood group occurs more than fourfold the B blood group (Pearce, 1993). This reveals that I^A allele is more frequent than I^B allele in Great Britain for reasons yet to be discovered. But both I^A and I^B alleles are equally frequent in the Hindus and the Muslims of Barak Valley.

The existing frequencies of I^A, I^B *and i* alleles are almost

Tab. 6. Existing allelic (I^A, I^B, *i*) and genotype frequency *vis-à-vis* expected genotype frequency of ABO system in Hindus and Muslims of Barak Valley

Population/Area	Existing Allelic Frequency				Existing Genotype Frequency of ABO system					Expected Genotype Frequency of ABO system				
	I^A	I^B	*i*	Total	AB	A	B	O	Total	AB	A	B	O	Total
Hindus/ Barak Valley	0.19	0.21	0.60	1.00	0.080	0.270	0.290	0.360	1.000	0.080	0.264	0.296	0.360	1.000
Muslims/ Barak Valley	0.18	0.19	0.63	1.00	0.070	0.250	0.280	0.400	1.000	0.068	0.259	0.276	0.397	1.000

Tab. 7. Estimates of chi-square tests for gene and genotype frequency of Rh and ABO system in Hindus and Muslims

Genetic Characteristic	df	Estimated chi-square value for Independence between Hindus and Muslims	Estimated chi-square value for goodness of fit between existing and expected frequencies of communities	
Gene frequency			Hindus	Muslims
Rh system	1	0.0033	0.2440	0.4181
ABO system	2	0.0040	0.3000	0.3747
Genotype frequency				
Rh system	1	0.0020	0.00	0.00
ABO system	2	0.0074	0.0003	0.0004

Genotype frequency of Rh system tested with 1 df due to non-detection of dominant homozygotes (*AA*) and heterozygotes (*Aa*)

lating the Rh blood group system. Electrophoretic banding pattern of Rh antigens would be useful in such study.

ABO System

For the ABO blood group system, both the Hindu and the Muslim populations of Barak Valley showed similar pattern in the distribution of four blood groups namely AB, A, B and O (Tab. 5). In both the populations, the O

the same for the Hindus (0.19, 0.21, 0.60) and Muslims (0.18, 0.19, 0.63) of Barak Valley (Tab. 6). The existing genotype frequencies of ABO system differed numerically between Hindus and Muslims. Although the chi-square tests (Tab. 7) did not reveal any difference between Hindus and Muslims for gene and genotype frequencies of ABO system. This further indicated that both populations could be genetically similar.

High magnitude of closeness of the gene and the genotype frequencies of both Rh and ABO systems could be attributed to the following reasons, either singly or jointly:

Hindus and Muslims of Barak Valley are genetically the same despite different religious beliefs.

Both populations might have diversified from common ancestors in the very recent past on the basis of religion and culture only.

The first reason is also supported by historical records, showing that during the reign of Mughal emperors in India, for nearly 200 years a large section of socio-economically backward Hindus converted to Islam. Had both the populations been highly different for gene and genotype frequencies of Rh and ABO systems, the role of genes thought to be introgressed from the exotic populations of

Afghanistan and Iran in the genetic make-up of the Muslims of Barak Valley would not have been ruled out.

Conclusions

The Hindus and the Muslims of Barak Valley in Assam might have diverged from the common ancestors. Furthermore, socio-economic, cultural and religious factors might have played the key role in the differentiation of the people of Barak Valley into two distinct religious groups in the very recent past despite their genetic closeness. Further study at molecular level would definitely reveal the degree of genetic proximity of the two groups in quantitative terms.

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