

## Comparison of Allelic, Genotypic and Phenotypic Distributions of ABO and Rhesus (D) Blood Group Systems of the Tribal Ethnic Groups of South-East Bangladesh with the Bengali Population

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### Abstract

**Background:** Ethnic diversity in relation to ABO and rhesus blood systems are yet to be determined for multiethnic areas of Khagrachari, Bandarban and Cox's bazaar districts of Bangladesh. Therefore we aimed to characterize the genetic characteristics of ABO and rhesus blood systems from population of these districts.

**Materials and methods:** It was a retrospective descriptive study conducted in Khagrachari, Bandarban, and Cox's Bazaar district. From hospital blood bank register we obtained ABO and rhesus blood groups related information. They were segregated by ethnicity and allele, genotypic and phenotypic distributions were calculated using the Hardy-Weinberg formula.

**Results:** Six patterns of phenotypic frequency were observed. B > O > A > AB and O > B > A > AB were the most frequent phenotype pattern. Highest I<sup>A</sup> was in Chak (0.3300), I<sup>B</sup> in Tripura (0.4883) and I<sup>O</sup> in Khumi (0.7475). Among the Bengali highest I<sup>A</sup> was 0.1738 (Cox's Bazar), I<sup>B</sup> was 0.2644 (Khagrachari) and I<sup>O</sup> was 0.6292 (Cox's Bazar). Rhesus negative group were scarce (0.1 to 2.7%).

**Conclusion:** Remarkable ethnic variation exists in genetic pattern of ABO and rhesus blood systems among population from the studied areas.

**Key words:** ABO blood group systems; Allele frequency; Genotype; Phenotype; Rhesus blood group systems.

### Introduction

A common means to describe genetic variation among racially different populations is the determination of ABO blood group gene characteristics. Determination of allele frequency of three ABO system genes expressed as I<sup>A</sup>, I<sup>B</sup>, and I<sup>O</sup> allows interracial comparison.<sup>1</sup> Bangladesh comprises of multiethnic population. The majority

of ethnic communities live in the southeast part of the country. Rangamati, Khagrachari and Bandarban districts are home to the Chakma, Marma and Tripura - the largest three communities. A small number lives in the adjacent Cox's Bazar district. Previously genetic characteristics of the Rangamati district were determined.<sup>1</sup> However, Bawm, Chak, Khumi, and Murung ethnic groups reside mainly in the Bandarban district. Their genetic characteristics are yet to be explored.

The study aimed to describe ABO and Rhesus blood group frequency and their genetic characteristics among Bengali and ethnic minorities from Khagrachari, Bandarban, and Cox's Bazar districts. The genetic characteristics are allele frequency, phenotype, and genotype distribution.

### Materials and methods

We conducted a retrospective descriptive study in Khagrachari, Bandarban, and Cox's Bazar districts. We surveyed registers from the blood bank of the district hospitals. Donor blood group and ethnicity-related data were available from the registers. Available data were for the period 2002 to 2016 for Bandarban, 2014 to 2016 for Khagrachari, and 2014 to 2016 for Cox's Bazar.

Individual blood group frequency was expressed as a percentage. Genetic characteristics were derived from these percentage results.

To calculate allele frequency and genotype distribution, we used the Hardy-Weinberg formula for allele and genotype frequency calculation.<sup>2</sup> This is a standard formula of quantitative population genetics. Results were expressed according to the convention in decimal, where all allele frequencies add up to 1.00. The genotypic frequency of ABO and rhesus systems was also expressed similarly. Details of this formula have been described in detail by Agrawal et al.<sup>2</sup> Allele frequency of O, A and B group expressed as I<sup>O</sup>, I<sup>A</sup>, and I<sup>B</sup> respectively.

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For general calculation, we used SPSS software. Allele, genotype frequency calculated on hand using formula. Ethical clearance for this study has been obtained from the Institutional Review Committee (IRC).

## Results

The ethnic distribution of studied population is described in Table I. Bandarban had diverse ethnic contribution. Ethnic population accounted for only small part in Cox's Bazar.

**Table I** Distribution of the study population by ethnicity

Ethnic group	Khagrachari		Bandarban		Cox's Bazar	
	n	%	n	%	n	%
Bengali	545	41.19	2759	62.56	3603	98.65
Chakma	472	35.67	72	1.63	6	0.16
Marma	151	11.41	1007	22.83	35	0.95
Tripura	155	11.71	79	1.79	-	-
Tanchangya	-	-	101	2.29	2	0.05
Bawm	-	-	212	4.80	-	-
Murung	-	-	56	1.26	-	-
Khumi	-	-	34	0.70	-	-
Chak	-	-	71	1.60	6	0.16
Others*	-	-	19	0.43	-	-
	1,323		4410		3652	

Distribution of blood groups according to ABO and Rhesus (D) system is described in Table II. As ethnic minorities were very few in Cox's Bazar, they are not included in this list.

**Table II** ABO blood group frequencies by ethnicity

	A+ve		A-Ve		B+Ve		B-Ve		O+Ve		O-Ve		AB+Ve		AB-Ve	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Bengali																
Khagrachari	117	21.5	1	0.2	196	35.9	4	0.7	175	32.1	2	0.4	50	9.2	-	-
Bandarban	507	18.4	5	0.2	971	35.2	3	0.1	1041	37.7	15	0.5	217	7.9	-	-
Cox's-Bazar	868	24.1	29	0.8	1020	28.3	29	0.8	1395	38.7	32	0.9	224	6.2	6	0.2
Chakma																
Khagrachari	110	23.3	-	-	173	36.6	-	-	151	32.0	-	-	38	8.0	-	-
Bandarban	19	26.4	-	-	25	34.7	-	-	17	23.6	-	-	11	15.2	-	-
Marma																
Khagrachari	25	16.5	1	0.7	72	47.7	-	-	37	24.5	1	0.7	15	1.0	-	-
Bandarban	205	20.3	-	-	428	42.5	1	0.1	236	23.4	-	-	137	13.6	-	-
Tripura																
Khagrachari	42	27.1	1	0.6	64	41.3	-	-	33	21.3	-	-	15	1.0	-	-
Bandarban	7	8.9	-	-	48	60.7	-	-	20	25.3	-	-	4	5.0	-	-
Tanchangya	18	17.8	-	-	36	35.6	-	-	39	40.6	-	-	8	8.0	-	-
Bawm	47	22.1	-	-	66	31.1	-	-	84	39.6	-	-	15	7.1	-	-
Murung	18	32.1	-	-	18	32.1	-	-	14	25.0	-	-	6	10.7	-	-
Chak	27	38.0	-	-	21	29.5	-	-	12	16.9	-	-	11	15.4	-	-
Khumi	5	14.7	-	-	4	11.8	-	-	19	55.9	-	-	6	17.6	-	-

Rhesus negative blood group was reported only among the Bengali, Marma and Tripura (Table III).

**Table III** Ethnic distribution of Rhesus (D/d) blood group

Ethnic group	Rhesus +Ve		Rhesus -Ve	
	n	%	n	%
Bengali				
Khagrachari	538	98.6	7	1.3
Bandarban	2736	99.1	23	0.8
Coxs-bazar	3507	97.2	96	2.7
Chakma				
Khagrachari	472	100.0	-	-
Bandarban	72	100.0	-	-
Marma				
Khagrachari	149	98.5	2	1.4
Bandarban	1006	99.9	1	0.1
Tripura				
Khagrachari	154	99.3	1	0.6
Bandarban	79	100.0	-	-
Tanchangya	101	100.0	-	-
Bawm	212	100.0	-	-
Murung	56	100.0	-	-
Chak	71	100.0	-	-
Khumi	34	100.0	-	-

**Table IV** Allele frequencies of ABO and Rhesus systems

Ethnic group	ABO system			Rhesus system	
	I <sup>A</sup>	I <sup>B</sup>	I <sup>O</sup>	I <sup>d</sup>	ID
Bengali					
Khagrachari	0.1658	0.2644	0.5698	0.1140	0.8859
Bandarban	0.1351	0.2463	0.6186	0.0894	0.9106
Cox's Bazar	0.1738	0.1970	0.6292	0.1643	0.8356
Marma					
Khagrachari	0.1474	0.3576	0.4950	0.1183	0.8816
Bandarban	0.1776	0.3384	0.4840	0.0316	0.9683
Tanchangya	0.1270	0.2359	0.6371	-	-
Chakma					
Khagrachari	0.1780	0.2564	0.5656	-	-
Bandarban	0.2214	0.2929	0.4857	-	-
	0.3883	0.1260			
Bawm	0.1562	0.2146	0.6292	-	-
Tripura					
Khagrachari	0.2342	0.3043	0.4615	0.0774	0.9225
Bandarban	0.0147	0.4883	0.4970	-	-
Chak	0.3300	0.2589	0.4110	-	-
Murung	0.2559	0.2441	0.5000	-	-
Khumi	0.0926	0.1599	0.7475	-	-

Allele frequencies of both systems are presented in the Table-IV. I<sup>A</sup> ranged from 0.0147 (Tripura, Bandarban) to 0.3300 (Chak). I<sup>B</sup> from 0.1599 (Khumi) to 0.4883 (Tripura, Bandarban), I<sup>O</sup> from 0.4615 (Tripura, Khagrachari) to 0.7475 (Khumi). I<sup>d</sup> ranged from 0.0316 (Marma, Bandarban) to

0.1643 (Bengali, Cox's Bazar),  $I^D$  0.8356 (Bengali, Cox's Bazar) to 0.9683 (Marma, Bandarban).

Highest  $I^A$  was in Chak (0.3300),  $I^B$  in Tripura (0.4883) and  $I^O$  in Khumi (0.7475). Among the Bengali highest  $I^A$  was 0.1738 (Cox's Bazar),  $I^B$  was 0.2644 (Khagrachari) and  $I^O$  was 0.6292 (Cox's Bazar).

The difference in phenotypic and genotypic frequencies of ABO system shown in Table V.

**Table V** Phenotypic and genotypic distribution of the ABO system

Ethnic group	Phenotype frequency pattern	AA	AO	BB	BO	OO	AB
<b>Bengali</b>							
Khagrachari	B > O > A > AB	0.0274	0.1889	0.0699	0.3013	0.3246	0.0876
Bandarban	O > B > A > AB	0.0182	0.1671	0.0606	0.3047	0.3826	0.0665
Coxsazar	O > B > A > AB	0.0302	0.2187	0.0388	0.2479	0.3938	0.0684
<b>Chakma</b>							
Khagrachari	B > O > A > AB	0.0316	0.2013	0.0657	0.2900	0.3199	0.0912
Bandarban	B > A > O > AB	0.1507	0.3771	0.0158	0.1223	0.2359	0.0978
<b>Marma</b>							
Khagrachari	B > O > A > AB	0.0217	0.1459	0.1278	0.3540	0.2450	0.1054
Bandarban	B > O > A > AB	0.0315	0.1719	0.1145	0.3275	0.2342	0.1201
<b>Tripura</b>							
Khagrachari	B > A > O > AB	0.0548	0.2161	0.0925	0.2808	0.2129	0.1425
Bandarban	B > O > A > AB	0.0002	0.0146	0.2384	0.4853	0.2470	0.0145
<b>Tanchangya</b>	O > B > A > AB	0.0161	0.1618	0.0556	0.3005	0.4058	0.0599
<b>Bawm</b>	O > B > A > AB	0.0243	0.1965	0.0460	0.2700	0.3958	0.0670
<b>Murung</b>	A > B > O > AB	0.0654	0.2559	0.0595	0.2441	0.2500	0.1249
<b>Chak</b>	A > B > O > AB	0.1089	0.2712	0.0670	0.2128	0.1689	0.1708
<b>Khumi</b>	O > AB > A > B	0.0085	0.1384	0.0255	0.2390	0.5587	0.0296

## Discussion

We observed six patterns of ABO phenotypic frequency. Group B was the most common group among the Chakma, Marma, and Tripura. Group O was the most common among Tanchangya, Bawm, and Khumi. Chak and Murung had A as the dominant blood group. For Bengali, group B was the highest in Khagrachari, while the O group was frequent in Bandarban and Cox's Bazar. Except for the Khumi (B group), all the ethnic groups had AB as the least common group of the ABO system.

Phenotypic frequency of the Chakma is similar in the Rangamati and Bandarban (B > A > O > AB) districts but differed from Khagrachari (B > O > A > AB).<sup>1</sup> Marma phenotype frequency (B > O > A > AB) was similar with a prior study from

Rangamati.<sup>1</sup> Tanchangya had B > A > O > AB frequency in Rangamati that differed from the current observation in Bandarban (O > B > A > AB).<sup>1</sup> Previously observed A > B > AB > O frequency among Tripura of Rangamati was different from the current observation in Khagrachari and Bandarban.<sup>1</sup>

Studies on blood groups of Bangladeshi ethnic populations previously explored Rangamati, greater Sylhet, Mymensingh and North Bengal regions. Observed frequencies - from Rangamati Khayang (A > O > AB > B) and Pangkhua (B > O > A > AB), Garo (A > B > O > AB) in Mymensingh, in greater Sylhet Khasia (O = A > B > AB) and Manipuri (A > O > B > AB). In North Bengal, Santal (B > O > A > AB).<sup>3-5</sup>

Geographical location does influence blood group frequency. Blood group A is dominant in western Europe. As we move eastward, blood group B becomes dominant in Asia.<sup>6</sup> In population genetics B is regarded as the "eastern blood group".<sup>6</sup> The prior observation was that in the eastern part of Bangladesh O > B and, in central (Dhaka) and western (Khulna) parts, the B > O pattern exists.<sup>1</sup> Those are the areas mainly consisting of the Bengali population.

Observed O > B > A > AB frequency among Bengali from Bandarban and Cox's Bazar is similar to previous studies from Jessore, Sherpur, Cumilla, Noakhali, Feni, Chittagong, and Ragamati districts.<sup>7-12</sup> Except for Jessore and Sherpur districts, all the mentioned districts are geographically adjacent. This phenotypic frequency in Bandarban and Cox's Bazar is explainable as a continuation of the neighboring trend. However, the Phenotypic frequency for Khagrachari B > O > A > AB was similar to Dhaka and Khulna regions. In Dinajpur district, Bengali had an O > A > B > AB pattern.<sup>13</sup>

Environmental selection pressure is a well-known determinant of blood group frequency. Natural selection of a particular blood group as a protective measure against specific infection is well known. In Bangladesh, group B is protective against cholera. Cholera endemic areas of Bangladesh have B group dominance.<sup>14-15</sup> Blood group O is protective against severe malaria in Africa. The evidence for this is conflicting in the Indian subcontinent concerning protection against

malaria.<sup>1</sup> Despite the high falciparum malaria burden, blood group O was not dominant among the major ethnic groups of Rangamati, Khagrachari and Bandarban.<sup>1</sup>

A previous study postulated that in Bangladesh geographical and /or environmental influence and/or natural selection processes are responsible for either B > O (Cholera endemic areas) or O > B (Non-cholera endemic areas) distribution among the Bengali population.<sup>1</sup> Our findings in the three districts are in agreement with those observations. The authors observed Tanchangya, Khumi, and Bawm had O dominance in Bandarban. They are a small ethnic group. Possibly, a small population size, strict intraracial marriage, continued endogamous mating, or founder effect have played an influential role to establish O dominance in these three groups.

The Bengali population has a mixed origin, whereas the Chakma, Marma, Tripura, Tanchangya, Bawm, Murung, Chak, and Khumi - all have mongoloid origin. Blood group B is predominant among the Asian population of mongoloid origin.<sup>1</sup> Chakma, Marma and Tripura had B dominance, which may be due to their ancestral origin. However, the remaining mongoloid ethnic groups had either O or A as the dominant group. Possible explanation for O dominance has been offered earlier.

Rhesus (D) positive cases were most common while negatives were not recorded in smaller ethnic groups.

### Limitation

As it was a hospital based study representation from ethnic group comprising very low population like chak and khumi were very low.

### Conclusion □

The distribution of ABO and rhesus (D) blood groups show ethnic diversity in the Khagrachari, Bandarban, and Cox's Bazar region of Bangladesh. The observed ethnic differences may be due to geographical location, differing ancestry, founder effect, small population size, migration, and endogamous mating.

### Recommendation

A large scale comparative study can be conducted including all the tribal ethnic population of three hill districts, greater Sylhet and greater Mymensingh districts with their Bengali counterparts.

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### Contribution of authors

MNUC-Conception, acquisition of data, interpretation data, data analysis, drafting, critical revision & final approval.

GD-Design, acquisition of data, interpretation data, data analysis, critical revision & final approval.

### Disclosure

Both the authors declared no competing interest.

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