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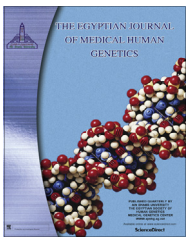

ORIGINAL ARTICLE

Comparative frequency and allelic distribution of ABO and Rh (D) blood groups of major tribal communities of southern Bangladesh with general population and their determinants

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KEYWORDS

Bangladesh;
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Abstract *Background:* Allelic distribution of major blood groups (ABO and rhesus) has not been defined in Bangladeshi population. Determinants of blood group frequency in this region have not been studied properly.

Aim: To determine ABO and rhesus blood group frequency and allelic distribution in a multiethnic area of Bangladesh and to explore possible genetic, racial and environmental factors influence as determinants of major blood groups.

Subjects and methods: Data collected retrospectively from blood group register of Rangamati General Hospital (2006–2011). Four tribal (Chakma, Marma, Tanchangya and Tripura) and general Bengali population were included in the study.

Results: Collectively all tribal had distinct ABO phenotypic frequency (B > A > O > AB) which is different from Bengali population (O > B > A > AB). Tripura's showed a unique pattern of A > B > AB > O. Overall tribal had higher frequency of B and AB group ($P < 0.0001$). Though differing in proportion; allelic frequency was O > B > A in all study groups except Tripura (A > O > B). Rhesus negative group was very uncommon in study groups. Data among tribal suggest their common origin as well as drift from original population due to possible founder effect among Tripura's. Despite being malaria endemic zone the protective group O was less ($P < 0.0001$) among native tribal (23%) and high among migrating Bengali (34%).

1. Introduction

Blood groups vary with ethnicity, geographical area, race, population migration, natural selection and genetic phenomenon such as genetic drift, founder effect. Environment also determines the ABO blood group selection in population.

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Need for survival has influenced blood group selection in human since antiquity. Prevalence of O group is high among African malaria endemic countries [1]. High frequency of B group in some parts of Bangladesh is protective against cholera [2–4]. This study is done in Rangamati; a malaria endemic district of Bangladesh. Four major tribal communities of Bangladesh with mongoloid background reside here. The majority has cultural and anthropological linkage with similar population living in India and Myanmar. The purpose of this study is not to merely describe frequency and variation of blood groups among tribal and non-tribal general population but it will attempt to assess the possible role of environment, natural selection and genetic determinants of blood groups in this area.

2. Subjects and methods

2.1. Populations

Rangamati district is placed in the south eastern part of Bangladesh and having borders with India and Myanmar (Fig. 1). It is a hilly area with forest, lakes and is one of the most malaria endemic zones of the country. Officially 11 tribal groups live in this area. The major four tribal groups of population according to census of 2005 were Chakma – 1,86,395, Marma – 44,727, Tanchangya – 18,607, Tripura – 6697 [5].

2.2. Data collection

This retrospective study was undertaken in Rangamati General Hospital. The register of blood groups was analyzed. Data were collected from the available registers from 2006 to 2011. Data were collected for persons belonging to four tribal groups (Chakma, Marma, Tripura and Tanchangya) and non-tribal Bengali population.

2.3. Statistical analysis

The frequency of each major ABO and rhesus blood group was recorded and compared among study groups. Statistical formula for genetic analysis was used to derive results. Bernestein's modified formula (1930) was used to determine allele frequency of ABO groups [6]. There are two Hardy–Weinberg formulas; one for allele frequency and the second one for genotype frequency determination [6]. Both were used to determine rhesus allele and genotype frequency. The test of significance for the different blood group frequencies of the two study groups (tribal vs Bengali) was made by chi-square test. P value < 0.05 at 95% confidence interval defines the level of significance. Data were processed in SPSS version 20.

3. Results

A total of 7498 people's blood group was registered during the studied period. Of them were non-tribal Bengali ($n = 3393$), Chakma ($n = 4105$), Marma ($n = 183$), Tanchangya ($n = 123$) and Tripura ($n = 109$). The frequency of different blood groups among the studied ethnic groups is presented in Table 1.

3.1. Phenotypic frequencies for A, B and O group

The overall observed ABO phenotypic frequencies were B > O > A > AB. Bengali population (O > B > A > AB) and all tribal groups together had different distributions (B > A > O > AB). Chakma and Tanchangya had similar distribution (B > A > O > AB). Marma had B > O > A > AB, while that of the Tripura ethnic group was unique (A > B > AB > O).

The B blood group was dominant in all ethnic groups but Tripura's. AB group was least observed in all except Tripura's. Group A and O usually maintained interchanging (O > A or A > O) intermediate position among tribal (except Tripura). Highest percentage of group A (38%) and AB (21%) was found among Tripura's. While Marma had the highest frequency of B group (45%) and Bengali had the highest frequency of O group (34%). The overall frequency of group A was equal among tribal population and Bengali (27%). The tribal population had a significantly higher frequency of B ($P < 0.0001$) and AB ($P < 0.0001$) group and a lower frequency of O group ($P < 0.0001$) in comparison with Bengali.

3.2. Allele frequencies for A, B and O group

The frequencies of ABO blood group alleles were determined using Bernestein's formula (Table 2). ABO allele frequency was O > B > A in all ethnic groups except Tripura's who had A > O > B.

3.3. Phenotypic and allelic frequencies for Rh group

Rhesus negative blood groups were very rare in this series. It was less frequent among tribal than Bengali. AB rhesus negative was the rarest group in this series. Therefore tribal rhesus positive homozygous (DD) phenotype was higher than Bengali (Table 3).

4. Discussion

No large scale data are available on the frequencies of ABO/Rh blood groups among Bangladeshi population which may be considered representative of the country; but some regional data exist (Table 4) [7–13]. The Bengali population in Rangamati has ABO phenotypic frequencies (O > B > A > AB) which are different from the pattern (B > O > A > AB) of those residing in the central (Dhaka division), south-west (Khulna region); and northern (Dinajpur) region of the country (O > A > B > AB) (Fig. 1) [7,9,12,13]. However, current pattern is similar to the south-east (Chittagong, Noakhali, Comilla) and western (Jessore) region of Bangladesh (Fig. 1) [10,11]. The B > A > O > AB frequency pattern calculated for Chakma and Tanchangya was observed for the first time in Bangladesh. The ABO blood group phenotypic frequencies of different tribal communities of Rangamati are also different from the other tribal communities (Garo, Khasia and Manipuri) from north-east region of Bangladesh (Mymesingh, Sylhet and Moulvibazar) (Table 4) (Fig. 1).

Seven different patterns of ABO phenotypic frequencies are so far observed in Bangladesh (Tables 1 and 4). The O > B > A > AB pattern of Bengali community of Rangamati was observed in Chittagong, Noakhali, Comilla (south-east) and Jessore (west) districts (Fig. 1, green bordered areas) [10,11]. Except for Jessore the mentioned areas are adjacent to Rangamati (Fig. 1). Therefore, there is a similar blood group frequency pattern ranging from Noakhali to Rangamati among Bengali population.

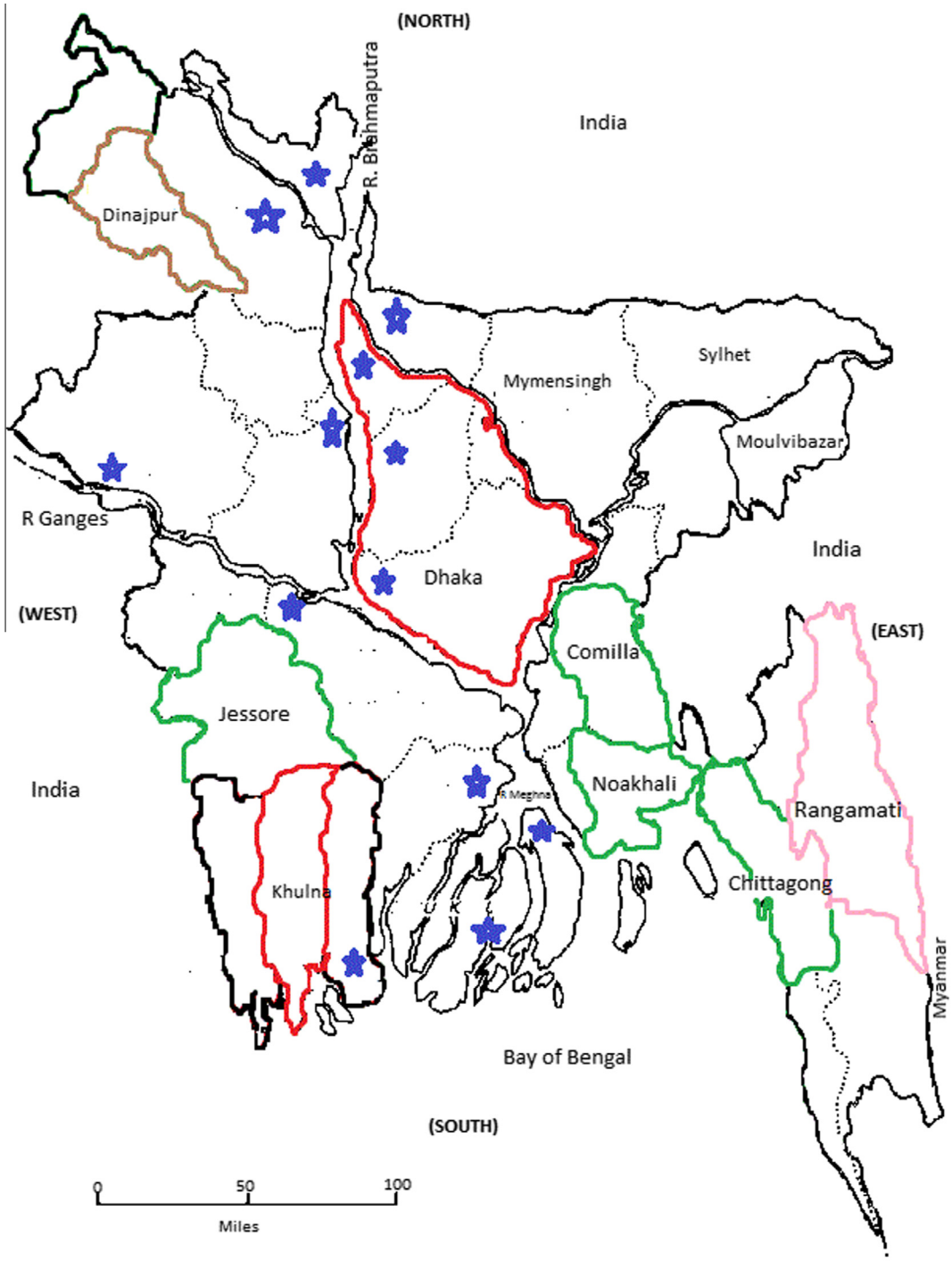

Figure 1 Area of blood group studies done in Bangladesh. Green areas (O > B > A > AB), Red and pink areas (B > O > A > AB), Brown area (O > A > B > AB). Cholera prone areas marked in blue.

The estimated frequencies of ABO blood groups in the world are O (40–45%), A (35–40%), B (4–11%) and AB (0–2%) [1]. The distribution pattern worldwide is O > A > B > AB. Blood group A is dominant in western Europe and its frequency diminishes as we move eastward [1].

The B group is dominant in central Asia. Modern day anthropologists consider B group as ''eastern blood group'' [1]. The distribution of B allele is highly concentrated in an area stretching from the Himalayas to the Ural region [1]. Therefore B group expected to have high frequency in Bangladesh. But there are regions in our country where O group is dominant [10,11,13]. Glass et al. in 1980 mentioned there is an increased risk of the individuals with group O to develop severe cholera infection and hence their observation also offers partial explanation to the dominance of B group in some parts of Bangladesh [3]. Harris et al. further confirmed that in Bangladesh group O increases the risk of severe infection with *Vibrio cholerae* serover O1 and O139 [4]. Most of the major cholera

Table 1 Frequency of ABO and Rh blood groups in Rangamati.

Study group	A (%)	B (%)	O (%)	AB (%)	Total	Phenotypic frequency	Rh +Ve (%)	Rh −Ve (%)
Overall	2029 (27%)	2579 (34%)	2096 (28%)	794 (10%)	7498	B > O > A > AB	7419 (99%)	79 (1%)
Bengali	916 (27%)	1066 (31%)	1149 (34%)	262 (7%)	3393	O > B > A > AB	3335 (97%)	58 (2%)
Tribal (All)	1113 (27%)	1513 (36%)	947 (23%)	532 (13%)	4105	B > A > O > AB	4084 (99%)	21 (0.5%)
Chakma	1003 (27%)	1359 (37%)	861 (23%)	467 (12%)	3690	B > A > O > AB	3673 (99%)	17 (0.4%)
Marma	36 (19%)	83 (45%)	44 (24%)	20 (11%)	183	B > O > A > AB	182 (99%)	1 (0.5%)
Tanchangya	35 (28%)	44 (36%)	29 (23%)	15 (12%)	123	B > A > O > AB	120 (97%)	3 (2%)
Tripura	42 (38%)	31 (28%)	13 (12%)	23 (21%)	109	A > B > AB > O	109 (100%)	–

Table 2 Allele frequency of ABO and Rh group.

	Overall	Tribal	Chakma	Marma	Tanchangya	Tripura	Bengali
A	0.2105	0.2260	0.2246	0.1672	0.2303	0.3646	0.1926
B	0.2585	0.2919	0.2897	0.3394	0.2794	0.2896	0.2204
O	0.5308	0.4820	0.4855	0.4932	0.4901	0.3456	0.5868
Frequency	O > B > A	O > B > A	O > B > A	O > B > A	O > B > A	A > O > B	O > B > A
Rh +Ve	0.6776	0.9284	0.9321	0.9260	0.8438	1.00	0.8692
Rh −Ve	0.3223	0.0715	0.0678	0.0739	0.1561	–	0.1307

Table 3 Genotypic frequency of rhesus blood group allele in Rangamati.

Trait	Overall (%)	Tribal (%)	Chakma (%)	Marma (%)	Tanchangya (%)	Bengali (%)
DD	45.91	86.19	86.88	85.74	71.19	75.55
Dd	43.67	13.27	12.64	13.68	26.34	22.72
dd	10.38	0.51	0.46	0.54	2.43	1.70

Table 4 Percentage of ABO and Rh groups according to ethnicity in Bangladesh.

Ethnicity	A (%)	B (%)	O (%)	AB (%)	Phenotypic frequency	Rh +Ve (%)	Rh −Ve (%)
Garo [7]	36.9	31.1	23.6	8.4	A > B > O > AB	99.1	0.9
Khasia [8]	28.4	28.4	35.2	7.8	O > A = B > AB	100	–
Manipuri [8]	41.2	12.9	38.6	7.1	A > O > B > AB	97.1	2.9
Bengali							
Sultana et al.[7]	23.5	39.8	27.6	9.2	B > O > A > AB	97.4	2.6
Talukder et al. [13]	26.6	23.2	40.6	9.6	O > A > B > AB	96.8	3.2
Ahad et al. [12]	24.1	34.5	33.0	8.2	B > O > A > AB	97.1	2.8

epidemics in Bangladesh did occur along the Ganges–Brahmaputra–Meghna river basin which dissects the country diagonally and there is a low prevalence of O group gene and high prevalence of the B blood group gene in the region of Ganges delta (Fig. 1) [3,14]. The Ganges delta consists of Bangladesh and West Bengal state of India. Careful scrutiny of previous studies on ABO blood group frequencies shows that observation of Glass et al. holds true only in the center part of Bangladesh which is along the course of these rivers and in addition along coastal areas in south-west Bangladesh (Fig. 1, red bordered areas) [3,7,9,14]. As *Vibrio cholerae* is a halophilic bacterium, coastal areas are prone to cholera epidemic. This natural selection of group B for protection against cholera was described by Rowe et al. as "region specific selection pressure" [15]. Therefore, geographical and environmental influences along with natural selection perhaps are in part the reasons for either B > O (cholera prone area) or O > B (non-cholera prone area) propensity in Bangladesh on regional basis among Bengali population (Fig. 1).

Despite Rangamati district being far from the Ganges basin and a hilly area, there is overall group B dominance (Fig. 1). This is because B group is dominant among most tribal

communities and second in frequency among Bengali. The tribal communities had origin from the mongoloid race which acquired the group B gene in antiquity; it also explains the dominance of B group among all except Tripura community [1]. The Marma had the highest frequency of group B in Bangladesh (Table 3). Possibly racial determinants rather than environmental factors (e.g. cholera) determine the B group dominance in Rangamati.

There is dominance of O group among Bengali in current study (Table 1). It could be a protective mechanism from severe malaria or continuation of the O group dominance (O > B > A > AB pattern) observed in neighboring districts as discussed previously (Fig. 1). The blood group O is protective against severe malaria. The erythrocytes of a person with group O are not suitable for rosette formation by *Plasmodium falciparum* [15]. This finding can be explained with the "Malaria theory" put forward by Haldane [16]. His theory states that certain human genetic polymorphism does occur at higher frequencies in specific population as protective means against malaria infection. Majorities of such polymorphism are those involving the different aspects of erythrocytes. Examples are hemoglobin (thalassemia, hemoglobin S, hemoglobin E – protects against *falciparum* malaria) and surface antigen (Duffy blood group protect against *vivax* malaria), etc. It is malaria that is regarded as the chief environmental factor inducing mutation or change in ABO blood groups. In malaria prone countries of Africa group O is dominant with the distribution ranging from 40.0% to 80.0% [17]. However, in the Indian subcontinent group O is not always the dominant blood group among all the communities living in a malaria endemic area as observed in parts of Africa. In Sylhet and Moulvibazar – two malaria prone districts in the north-east of Bangladesh O group is dominant in Khasia and second in frequency in Manipuri tribal groups (Fig. 1) (Table 4) [8]. Adjacent to Sylhet and Moulvibazar is the Manipur state of India – a *falciparum* malaria prone area. There, dominance of O group was observed among Kabui (40.1%), Purum (Chothe) (47.7%) ethnic groups; and Muslim (49.5%) population [18,19]. However, in native Manipuri (31.1%) and Brahmin (35.5%) community group O was not dominant [18,19].

The malaria burden is much lower in Sylhet and Moulvibazar than Rangamati. In Rangamati O group is dominant among Bengali, but third among native tribal communities. Only Marma has this blood group in second position; it is third in Chakma's and Tanchangya's and last in Tripura's (Table 1). Perhaps O group has lesser role in protection against malaria among ethnic groups of Rangamati. Group O was dominant in the studies done in the north-west, south-east and west of Bangladesh most of which are free from malaria [10,11,13]. The frequency of O group among Bengali (34.0%) in Rangamati is within the values observed in the studies done in non-malaria endemic parts of country (27.6–40.6%) [7,12,13]. Therefore, as previously mentioned, dominance of group O among Bengali community of Rangamati may just be representative of the usual higher frequency of group O that is seen in non-cholera endemic areas.

The protective role of ABO groups from malaria is uncertain in the Indian subcontinent. Study results from various areas are conflicting; Thakur et al. and Joshi et al. found no association, while Deepa et al. and Gupte et al. observed group O and A respectively were more susceptible to malaria [20–23]. According to Rowe et al. even in the malaria endemic areas other co-existing balancing selection pressures influences frequency of protective O group [15]. Therefore, one may hypothesize that acquisition of blood group O may not be the chief natural protection against malaria in Rangamati. High prevalence of hemoglobin E (HbE) trait in south-east Asia is regarded as natural protection to malaria infection [17]. In Bangladesh higher frequency of HbE trait was reported among the tribal children of south Bangladesh (41.7%) in comparison with Bengali children (6.1%) [24]. Therefore, it is possible that higher rate of HbE mutation is playing the more dominant role as natural protection against malaria than O group selection among the tribal communities of Rangamati. High HbE mutation is perhaps the natural balancing factor here. Only future studies done on susceptibility of ABO blood groups and hemoglobin variants to malaria in this area can confirm relative importance of HbE mutation versus group O among the tribal population and Bengali as natural protection against malaria.

Tripura is the only community which has group A as the dominant blood group. Their ABO phenotypic frequency is different from the Tripura communities in India (B > O > A > AB) [25]. Despite being of mongoloid origin Tripura in Rangamati has group A dominance, but original Tripura population in India show expected group B dominance. This is the most likely manifestation of founder effect. In population genetics founder effect occurs when small numbers of population who are not representative of the original parent population group migrate and settle in a new area. Genetic variation occurs with time and as a result new population group becomes genotypically and phenotypically distinct from parent population. The only other tribal community where group A was dominant was the Manipuri in Sylhet and Garo in Mymensingh (Table 3) [7,8].

Tanchangya are regarded to be closely related to the Chakma and both communities have similar phenotypic frequencies (B > A > O > AB). The "clustering effect" (similarity of phenotype frequency) that is observed in these two groups supports the possibility of common origin. The Marma is the only tribal group to have ABO phenotypic frequency identical to the Bengali population of central and south-west Bangladesh.

AB is the most recent group in terms of evolution in the ABO system, originating from intermingling of caucasians (A) with mongoloid race (B) [1]. There was remarkably high percentage (13.0%) of AB group among the tribal groups particularly among the Tripura. The higher frequency among the Tripura may be due to continued endogamous mating. This trend is in accordance with the findings of Haque et al. who found higher percentage of AB group among six tribal groups of Sylhet, Rajshahi and Chittagong hill tracts (13.7%) [26]. Ethnic group wise AB frequency was Garo (8.4%), Khasia (7.8%) and Manipuri (7.1%) [7,8].

The overall frequency of rhesus negative blood is low as expected (1.0%). It is very low among tribal (0.5%) and that recorded among Bengali (2.0%) is also the lowest ever reported from Bangladesh in this community.

The allelic frequencies of the total population of the world is estimated to be O = 62.3%; A = 21.5% and B = 16.2% [27]. To the best of knowledge no study in Bangladesh had calculated allelic frequencies for ABO/Rh systems previously. Therefore, allelic frequencies from past studies are calculated and presented for comparison with current finding (Table 5). Allelic frequencies are the same for all ethnic groups

Table 5 ABO and rhesus allele frequency of different natives of Bangladesh.

Ethnicity	A	B	O	Allele frequency pattern	Rh +Ve	Rh −Ve
Garo [7]	0.2299	0.1881	0.5799	O > A > B	0.9057	0.0942
Khasia [8]	0.1769	0.1769	0.6450	O > A = B	1.0	–
Manipuri [8]	0.2581	0.0734	0.6682	O > A > B	0.8288	0.1711
Bengali						
Sultana et al. [7]	0.1802	0.2871	0.5326	O > B > A	0.8402	0.1597
Ahad et al. [12]	0.1782	0.2440	0.5776	O > B > A	0.8300	0.1699

(O > B > A) in Rangamati except the Tripura who showed A > O > B (Table 2). This frequency (O > B > A) is similar to the studies among Bengali population. But the Garo, Khasia and Manipuri tribal had different allelic frequencies (O > A > B). As Tribal groups had fewer rhesus negative blood group; homozygous (DD) rhesus positive allele was more than Bengali population.

Estimation of gene frequency provides information on genetic similarity of different populations and ancestral linkages. The Chakma and Tanchangya share closely matching allele frequency suggesting common ancestral origin. The Marma, Tripura and Bengali had different frequencies. Similarly Khasia, Manipuri and Garo may have separate origins.

5. Conclusion

The results show remarkable diversity in the ABO group and allele distribution in an area not more than 6116 square kilometer. The available data suggest in Rangamati genetic factors had more roles to play in determining blood group frequency rather than environmental influence or natural selection. In-depth future study may be able to answer some hypothesis put forward in the current study. The results should be of importance to build up a regional blood bank information system, for population genetics & population migration study and anthropological research. It may also reflect possible disease burden in relation to the blood group which will help define future health policies.

Conflict of interest

The author declares no conflict of interest and no fund received for the study.

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