Distribution Of ABO And Rhesus D Blood Antigens In Morocco

A Benahadi, R Alami, S Boulahdid, B Adouani, A Laouina, A Mokhtari, A Soulaymani, H Khdija, M Benajiba

Citation

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Abstract

To determine phenotypic and allelic frequencies of ABO Rhesus D blood groups in a Moroccans blood population, a sample 219 287 blood donors was collected from 15 different regions across the country. The overall ABO antigens frequency was 32.86%, 15.80%, 4.53% and 46.80% for blood groups A, B, AB and O, respectively. In addition, the Rhesus D positive frequency was 91.00%. The allelic frequencies found were 0.2089, 0.1078 and 0.6838 for A, B and O alleles, respectively, and 0.2999 for d allele. The regional distribution of the ABO blood antigens showed slight differences between the studied regions. However, statistical analysis of the regional allelic distribution of the D antigen was found highly significant (P> 0.001). A close analysis using a z- score test showed that Ouarzazate from the South East of the country clears apart from all other regions. These findings are concordant with the geographical and historical data of Morocco. Finally, the found distribution would be of a great help in mapping the country's distribution of the ABO Rhesus D blood groups and blood donors' population.

INTRODUCTION

The erythrocytic group systems have special significance in ethnical anthropology.1, 2, 3, 4 ABO and Rhesus blood group systems are the first human polymorphisms recognized at the molecular level.5 These polymorphisms have been widely used as genetic markers to study the characteristics of the populations.

The distribution of these two blood groups has been repeatedly investigated in various populations all over the world during the last several decades and their frequencies exhibited considerable variation in different geographic locations, reflecting the underlying genetic and ethnic diversity of human populations.6, 7, 8, 9, 10, 11 Beside, many variations were observed in the distribution of blood type within human sub populations.12, 13, 14, 15

Among the western Europeans, 42% belongs to A blood group, 9% to B blood group, 3% to AB blood group, and the rest, 46% to O blood group. However, some of the western Europeans show higher proportion (up to 40%) of the blood group B. On the other hand, pure American Indians belong almost exclusively to group O. Among white Americans, the frequency of group A is 41%, B is 10%, AB is 4%, and O blood group is 45%.16As it is noticed, the O blood type is very common around the world. About 63% of humans share it. Its highest frequency was found among the indigenous populations of central and South America where it approaches 100%. The lowest frequency, on the contrary, was recorded in Eastern Europe and central Asia, where B is common.12, 11

The Rhesus system, on the other hand, is the most complex of all blood group systems with about 50 well established known antigens. Moreover, this system was heavily studied in the human population distribution. One of the major antigens of this system is the Rhesus D (Rh D). Its frequency varies from population to another. For example, about 85% of Caucasians and 95% of African-Americans are Rh D positive; whereas indigenous Africans are virtually all Rh D positive.17, 18

Population genetics has made extensive use of this genetic marker (ABO blood groups). It seems that adjacent populations differ only slightly in the frequencies of particular genes and that these differences tend to increase with the distances separating populations.19Therefore, it is important to have information on the distribution of these blood groups in any population group.

Morocco is a North African country. It has a population of more than 31 million and an area of 710,850 km² (Annuaire

Statistique du MAROC 2010), it spreads between Mauritania at the South and the Mediterranean sea in the North. The present gene pool of the Moroccan populations came from various origins as Berbers, Phoenicians, Sephardic Jews, Bedouin Arabs and sub-Saharan Africans.20, 21

Only few uncompleted studies have been conducted in Morocco, especially the Rhesus D distribution. Beside, no study so far had approached the eventual impact that could have the distribution of the ABO Rhesus D in the country for a better management of the regional and national availability of the blood supply.22, 23, 24

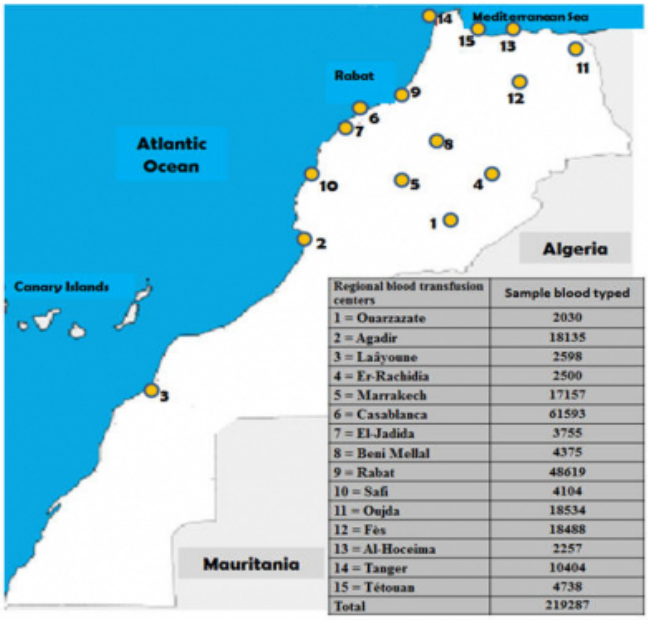
In order to get completed information on the distribution of the ABO Rh D blood groups around the country, the national and regional phenotypic and allelic frequencies of ABO and Rhesus D were calculated. In addition, we are expecting to use the found ABO RhD distribution around the country for a better management of blood units and blood donors to balance the country's supply for all blood groups.

MATERIALS AND METHODS

A sample of 219 287 blood donors was screened for the determination of ABO and Rhesus D antigens. The distribution and the origins of the samples are summarized in Figure 1.

Figure 1

Morocco map. The numbers refer to the CRTSs locations. The table on the right shows the sample studied from each region.



Regional blood transfusion centers	Sample blood typed
1 = Ouarzazate	2030
2 = Agadir	18135
3 = Laâyoune	2598
4 = Er-Rachidia	2500
5 = Marrakech	17157
6 = Casablanca	61593
7 = El-Jadida	3755
8 = Beni Mellal	4375
9 = Rabat	48619
10 = Safi	4104
11 = Oujda	18534
12 = Fès	18488
13 = Al-Hoceima	2257
14 = Tanger	10404
15 = Tétouan	4738
Total	219287

Blood group antigens were determined after double determination using at least two batches of reagents supplied by Diagast, (France) and Biotest, (Germany). The determination RH D was realized by two batches of polyclonal reagents. Samples negative for Rh D were confirmed by antiglobulin technique ('Du test').

The expected numbers of the various phenotypes were compared with the observed numbers by a Chi square test.25, 26, 27

The p, q and r allelic frequencies were calculated according to Hardy-Weinberg equilibrium (p2; 2pr; q2; 2qr; 2pq; r2): 28

Formulas and Calculations

Calculations

Phenotypes	AB	A	B	O	Total
Frequency	2pq	p^2+2pr	q^2+2qr	r^2	1

The Rh D –(d) allelic frequency is equal to the square root of the frequency of the individuals Rh D – and the allele frequency D + is obtained by difference to 1.We used Z-score test to compare observed Rhesus D frequencies in all CRTSs taken 2 x 2.[29,30]

$$\varepsilon_{obs} = \frac{|p_1 - p_2|}{\sqrt{p_{th}(1-p_{th})\left[\frac{1}{N_1}+\frac{1}{N_2}\right]}} \qquad p_{théorique} = \frac{N_1 p_1 + N_2 p_2}{N_1 + N_2}$$

P1 and P2: frequencies which we want to compare

N1 and N2: the size of the 2 samples to be compared

Statistical analysis:

All analysis were done on Excel spread sheet and Principal analysis component were performed using the software PAST.31

RESULTS

During 2010, 219 287 blood donors were collected and typed for ABO Rhesus D antigens across the country. The overall phenotypic frequencies of antigens ABO all regions included were 0.3286 for blood type A; 0.1580 for B; 0.0453 for AB and 0.4680 for O blood group. The overall frequencies of phenotypes Rhesus D positive and negative are 0.91 and 0.09, respectively. Table 1 illustrates the phenotypic frequencies in the different regions of the country.

Table 1

ABO and Rhesus D phenotypes frequencies in the studied regions

Region	N	A	frequency	B	frequency	AB	Frequency	O	frequency	D+	frequency	D-	frequency
Ouarzazate	2030	593	**(0,2921)**	316	(0,1557)	90	(0,0443)	1031	**(0,5079)**	1936	(0,9537)	94	**(0,0463)**
Agadir	18135	6258	(0,3451)	2415	(0,1332)	634	(0,035)	8828	(0,4868)	16643	(0,9177)	1492	(0,0823)
Laâyoune	2598	809	(0,3114)	433	(0,1667)	99	(0,03811)	1257	(0,4838)	2377	(0,9149)	221	(0,0851
Er-Rachidia	2500	749	(0,2996)	467	(0,1868)	106	(0,0424)	1178	(0,4712)	2282	(0,9128)	218	(0,0872)
Marrakech	17157	5546	(0,3232)	2709	(0,1579)	795	(0,0463)	8107	(0,4725)	15630	(0,911)	1527	(0,089)
Casablanca	61593	19396	(0,3149)	9822	(0,1595)	2735	(0,0444)	29640	(0,4812)	56075	(0,9104)	5518	(0,0896)
El-Jadida	3755	1134	(0,302)	637	(0,1696)	160	(0,0426)	1824	(0,4858)	3483	(0,9276)	272	(0,0724)
BeniMellal	4375	1482	(0,3387)	629	(0,1438)	194	(0,0443)	2070	(0,4731)	3954	(0,9038)	421	(0,0962)
Rabat	48619	15896	(0,327)	7936	(0,1632)	2218	(0,0456)	22569	(0,4642)	44497	(0,9152)	4122	(0,0848)
Safi	4104	1299	(0,3165)	764	(0,1862)	185	(0,0451)	1856	(0,4522)	3653	(0,8901)	451	(0,1099)
Oujda	18534	6275	(0,3386)	2951	(0,1592)	947	(0,0511)	8361	(0,4511)	16490	(0,8897)	2044	**(0,1103)**
Fès	18488	6217	(0,3363)	3097	(0,1675)	859	(0,0465)	8315	(0,4498)	16644	(0,9003)	1844	(0,0997)
Al-Hoceima	2257	836	(0,3704)	316	(0,14)	112	(0,0496)	993	(0,4400)	2019	(0,8946)	238	(0,1054)
Tanger	10404	3779	(0,3632)	1498	(0,144)	576	(0,0554)	4551	(0,4374)	9601	(0,9228)	803	(0,0772)
Tétouan	4738	1794	**(0,3786)**	663	(0,1399)	223	(0,0471)	2058	**(0,4344)**	4275	(0,9023)	463	(0,0977)
Total	219287	72063	(0,3286)	34653	(0,1580)	9933	(0,0453)	102638	(0,4680)	199539	(0,9100)	19507	(0,0900)

A, B and O allelic frequencies were 0.2089; 0.1078 and 0.6838, respectively (table 2). Results showed that the distribution between regions was statistically significant (Chi-square (2 = 44.188, ddl =28, with P> 0.05). The Rhesus D and d allelic frequencies were found 0.7000 and 0.2999, respectively. Statistical analysis of the regional allelic distribution of the D antigen was found highly significant (P> 0.001; =259.6; 14 ddl). Following this result we used Z-score test to compare observed Rhesus D frequencies in all regional centres taken 2 by 2. Table 4 Analysis showed that there is different degree of significance between the studied regions.

Table 2

ABO and Rhesus D blood allele frequencies in the studied regions

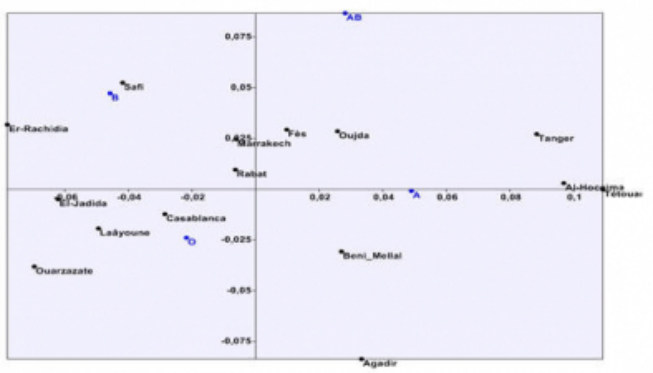
Region	Allele							
	A	*B*	*O*	Chi-square	*D*	Chi-square	*d*	Chi-square
Ouarzazate	0,183416	0,100373	0,712658	4,496	0,784826	4,068174182	0,215174	43,09781333
Agadir	0,212624	0,08793	0,697706	6,98	0,71312	1,187241229	0,28688	12,10317756
Laâyoune	0,193463	0,10824	0,695581	1,386	0,70834	0,06834577	0,29166	0,69304072
Er-Rachidia	0,188828	0,122048	0,68644	1,192	0,704704	0,021827041	0,295296	0,221381074
Marrakech	0,20862	0,112567	0,683566	2,143	0,698304	0,019649972	0,301496	0,198850162
Casablanca	0,199369	0,107739	0,693703	4,986	0,700667	0,012797463	0,299333	0,129422023
El-Jadida	0,190437	0,112447	0,696939	0,542	0,730928	1,252028592	0,269072	12,90042825
Beni Mellal	0,214561	0,096953	0,687854	0,575	0,689839	0,186414218	0,310161	1,871474966
Rabat	0,207895	0,110533	0,681323	0,337	0,708796	1,459382295	0,291204	14,83679733
Safi	0,201	0,123009	0,672489	2,724	0,668488	1,820330462	0,331512	17,99860883
Oujda	0,218759	0,111358	0,671652	3,763	0,667886	8,551252708	0,332114	84,51399804
Fès	0,214338	0,11342	0,670635	4,842	0,684247	1,939176274	0,315753	19,39229484
Al-Hoceima	0,23844	0,099796	0,663298	0,346	0,675346	0,600443219	0,324654	5,96654727
Tanger	0,237497	0,105208	0,661383	9,823	0,722151	1,859061531	0,277849	19,05707826
Tétouan	0,242179	0,096304	0,65906	0,033	0,68743	0,311140567	0,31257	3,118488041
Total				44.188				258.695

DISCUSSION

This research was carried out on 219 287 blood donors' samples. The overall phenotypic frequencies to ABO blood groups antigens in the Moroccan population was 0.32; 0.15; 0.46 and 0.04 for A, B, O and AB, respectively. The allelic frequencies, on the other hand, were 0.20, 0.10 and 0.68 for A, B and O, respectively.

Regional repartition of these antigens showed that blood group A is more common in the North of the country. In addition, the blood group O prevalence was found higher in the South compared to the North. Statistical analysis, demonstrated indeed that the variation between the regions were statistically significant. The detailed analysis of the distribution by principal component analysis (figure2) has shown that the north provinces, Tangier (#14, in the map firgure1), Tetouan (#15), Al Hoceima (#13), cluster together close to the blood group A. In the contrary, Laayoune (#3) and Ouarzazate (#1) which belong to the south region, cluster together with the O blood group. These findings confirm results described elsewhere 32

Figure 2



The slight increase of the prevalence of the O blood group appears to follow a more global gene flow from the sub-Saharan populations, where the O blood group is at a higher frequency compared to the A blood group.33, 34, 35

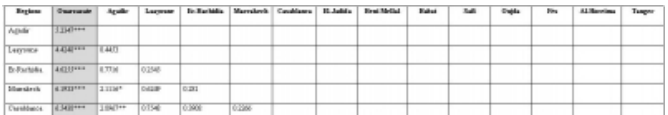
In addition, when we compare our results with those of other populations of Africa, Europe, Asia and America, table 3, we observed that our population is closer genetically to the Maghreb Arab populations, 36, 37 the Sudan38 and Egypt.39The A allelic frequency was lower in the Moroccan population compared to Europe, white populations of America, and Asia. However, the O allele frequency is higher than what was observed in Europe and Asia. The B allele frequency, on the other hand, was found to be closer to the Italian population.37, 40, 41, 42

Table 3

Country	Allele		
	A	B	O
Morocco	**0.208**	**0.107**	**0.683**
Algeria[36]	0.209	0.123	0.667
Tunisia [37]	0.195	0.120	0.684
Sudan [38]	0.191	0.140	0.668
Egypt. (Aswan) [39]	0.180	0.140	0.660
Senegal [35]	0.120	0.148	0.707
Nigeria [34]	0.149	0.144	0.706
Spain [37]	0.305	0.076	0.618
France [37]	0.270	0.070	0.660
Italy[37]	0.257	0.105	0.642
Syria [40]	0.286	0.130	0.582
Jordanian[41]	0.260	0.134	0.605
India (Phayengs/Khurkhuls) [42]	0.262/0.334	0.212/0.206	0.526
African American[37]	0.169	0.128	0.702
White American[37]	0.251	0.078	0.670

This study is the first to describe the distribution of the RhD allelic frequency in Morocco. It showed variations from one region to another, with a maximum recorded in Ouarzazate 0.95 and minimum observed in Oujda 0.89. Statistical analysis showed a highly significant variation (= 258.7). A two by two comparison of all the 15 regions using, a z-score test, showed that there is different degree of significance between the regions studied. The presence of the D antigen in the Ouarzazate region seemed to be different from all other regions in the country (Table 4).

Table 4



Beside the epidemiological and anthropological significance of the distribution of prevalence of the blood groups across the country, the low frequency of the Rhesus D and specially the O negative is of great importance from a blood banker point of view. Indeed, the Rhesus D negative blood has a strategic meaning in the management of blood units' supply. O negative blood units are the best choice for transfusion of red cell in an emergency. Besides, it is well documented that blood services worldwide have encountered recurrent shortfalls of O Rh D negative red cells (personal communication RA). In addition, one of the recommendations would be that blood centres and hospital user's work together to reduce the risk of group O Rh D negative red cell shortages through the management of both supply and demand. Our study showed that highly significant differences exist from region to another; especially, between Ouarzazate and Oujda, where the O negative is at the lowest (3%) and highest (5.4%) prevalence, respectively.

CONCLUSION

This is the first completed study about the ABO Rhesus D blood group distribution across the country. Results showed a clear evidence of a North to South gradient for the A blood group and an opposite figure for the O blood group. The frequency of Rhesus D antigen, on the other hand, showed a statistically difference between most studied regions. Our finding shows that Ouarzazate region clears apart from all other regions. These findings are concordant with the specificity of the Moroccan geographic and population history.

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Author Information

A Benahadi
Centre National de Transfusion Sanguine, Laboratoire de G
Rabat, Morocco

Raouf Alami
Centre National de Transfusion Sanguine
Rabat, Morocco
raoufalami@yahoo.com

Safia Boulahdid
Centre National de Transfusion Sanguine, Laboratoire de G
Rabat, Morocco

Bendaoud Adouani
Centre National de Transfusion Sanguine, Laboratoire de G
Rabat, Morocco

Abderrahim Laouina
Centre National de Transfusion Sanguine, Laboratoire de G
Rabat, Morocco

Abderhani Mokhtari
Laboratoire de G
Kenitra, Morocco

Abdelmajid Soulaymani
Laboratoire de G

Hajjout Khdija
Centre National de Transfusion Sanguine
Rabat, Morocco

Mohammed Benajiba
Centre National de Transfusion Sanguine
Rabat, Morocco