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

Abstract
To determine phenotypic and allelic frequencies of ABO Rhesus D blood groups in a Moroccans blood population, a sample 219287 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%.16 As 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.19 Therefore, 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.

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):

Formulas and Calculations

Calculations

<table>
<thead>
<tr>
<th>Phenotypes</th>
<th>AB</th>
<th>A</th>
<th>B</th>
<th>O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>2pq</td>
<td>q2+2qr</td>
<td>p2+2pq</td>
<td>r2</td>
<td>1</td>
</tr>
</tbody>
</table>

The Rh D (D) allelic frequency is equal to the square root of the frequency of the individual’s Rh D – and the allele frequency of Rh D is obtained by difference to 1. We used Z score test to compare observed Rh D frequencies in all CRTSs taken x 2 x 10^6

\[
P_{HWE} = \frac{|N_1 - N_2|}{\sqrt{\frac{N_1^2}{N_1} + \frac{N_2^2}{N_2}}}
\]

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

<table>
<thead>
<tr>
<th>Region</th>
<th>A Frequency</th>
<th>B Frequency</th>
<th>AB Frequency</th>
<th>O Frequency</th>
<th>A Allelic Frequency</th>
<th>B Allelic Frequency</th>
<th>AB Allelic Frequency</th>
<th>O Allelic Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casablanca</td>
<td>0.3027</td>
<td>0.3077</td>
<td>0.2014</td>
<td>0.1862</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
</tr>
<tr>
<td>Marrakech</td>
<td>0.3027</td>
<td>0.3077</td>
<td>0.2014</td>
<td>0.1862</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
</tr>
<tr>
<td>Fez</td>
<td>0.3027</td>
<td>0.3077</td>
<td>0.2014</td>
<td>0.1862</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
</tr>
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<td>Casablanca</td>
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<td>0.227</td>
<td>0.227</td>
</tr>
</tbody>
</table>

A, B and O allele frequencies were 0.2089; 0.1078 and 0.6838, respectively (table 2). Results showed that the distribution between regions was statistically significant (Chi-square ($\chi^2 = 44.188$, ddl =28, with $P> 0.05$). The Rhesus D and d allele frequencies were found 0.7000 and 0.2999, respectively. Statistical analysis of the regional allelic distribution of the D antigen was found highly significant ($P> 0.001$; $\chi^2 =259.6; 14$ 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

<table>
<thead>
<tr>
<th>Region</th>
<th>A Allelic Frequency</th>
<th>B Allelic Frequency</th>
<th>AB Allelic Frequency</th>
<th>O Allelic Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casablanca</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
</tr>
<tr>
<td>Marrakech</td>
<td>0.227</td>
<td>0.227</td>
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<td>0.227</td>
</tr>
<tr>
<td>Fez</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
<td>0.227</td>
</tr>
</tbody>
</table>

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.39 The 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
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 ($\chi^2 = 258.7$). 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

<table>
<thead>
<tr>
<th>Region</th>
<th>B Positive</th>
<th>O Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ouarzazate</td>
<td>0.95</td>
<td>0.05</td>
</tr>
<tr>
<td>Oujda</td>
<td>0.89</td>
<td>0.11</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

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.

FUNDING

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ACKNOWLEDGMENTS

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