Prevalence of ABO and Rh blood groups and their association with demographic and anthropometric factors in an Iranian population: Mashad study

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Abstract

Background: Blood groups appear to be markers for various human diseases and their distribution among different communities, ethnic groups and geographical boundaries varies over time.

Aims: We aimed to investigate the frequency of ABO and Rh blood groups and their relationship with demographic and anthropometric characteristics among Iranian residents in Mashad

Methods: ABO and Rh blood groups were determined among 7268 participants from the MASHAD cohort study and their relationships with demographic and anthropometric parameters were evaluated. This part of the study was done in January 2017. Student t-test, ANOVA, Bonferroni and Chi-squared were used for comparison of quantitative and qualitative variables.

Results: The most common blood group was O (33.8%); AB was the least common (8.3%). The prevalence of Rh-positive and Rh-negative was 88.2% and 11.8% respectively. There were statistically significant associations between ABO blood groups and demi-span (P = 0.03), even after correction for multiple comparisons.

Conclusion: Our findings showed there was no relationship between ABO blood groups and demographic characteristics although there was an association with anthropometric measurements such as demi-span.

Keywords: ABO blood group, Rh blood group, anthropometric parameters, Iran

Introduction

The ABO and Rhesus (Rh) blood group systems are the most important among the 36 identified systems (I,2). In the early 20th century, 3 types of blood groups A, B and C (later re-named O) were known and later the fourth group, AB, was discovered (3). The ABO blood group antigens (A, B, and H) are determined by carbohydrate molecules that are ordinarily considered as red blood cell antigens. They are also expressed on other human tissues such as vascular endothelium and epithelium, sensory neurons and platelets (4). The second most important blood group system is Rh, which was discovered in 1941 and includes only 2 phenotypes, Rh-positive and Rh-negative (5,6).

Many studies have investigated the prevalence of ABO and Rh blood groups in different populations and ethnic groups. These studies have been undertaken for several reasons: their importance in blood transfusion and organ transplantation, their application in genetic research, forensic pathology and anthropology and studying the ancestral relationships of human (6,7). Blood group prevalence studies are also important in the management of blood product resources in the community as well as the assessment of different disorders related to blood groups, such as the risk of venous thromboembolism syndrome, blood coagulation and coronary artery disease (8).

Although the ABO blood group antigens are constant throughout life, the distribution of blood groups among different communities, ethnic groups and geographical boundaries do vary over time (5,9), even within the same region (10). The ABO blood groups appear to be markers for various human diseases, including cardiovascular, neoplastic and infectious conditions (11). It has also been suggested that they are associated with certain personality characteristics (12,13).

Hence, knowing the distribution of ABO and Rh blood groups within communities is important and helpful for safe blood transfusion and health care programmes (14). Several studies have reported the frequency of blood groups among Iranian people but till now only one has
been carried out among people living in the north-eastern region of the Islamic Republic of Iran (15).

We aimed to determine the prevalence of blood groups and whether there was any relationship with demographic, socioeconomic and anthropometric characteristics among a representative sample population living in Mashhad, the capital of Khorasan-e Razavi province in the northeast of the country.

Methods

Participants

The study population comprised participants in the Mashad Cohort Study who were Iranian residents of Mashhad. This cohort was originally recruited in 2010 and will continue to be followed up until 2020 (16). Participants were selected using a stratified cluster random sampling technique. There were 3 strata from 3 regions in Mashhad including Mashhad health centres No. 1, 2 and 3. Each stratum was divided into 9 areas centred on Mashhad health care centre divisions (clusters). Families with members aged 35–65 years were identified. We excluded those with a history of stroke or peripheral and cardiovascular disease. Of the participants recruited into this cohort study, blood group was determined for 7268 of them.

All participants gave written informed consent prior to participation in this study, which was approved by the ethics committee of Mashhad University of Medical Sciences.

Data collection

This part of the study was carried out in January 2017. Demographic and lifestyle characteristics, including age, sex, number of family members residing at the same location, educational attainment, job status and smoking habit, were collected via a questionnaire. Anthropometric parameters such as body mass index (BMI), demi-span (half the distance between their hands outstretched to either side in cm), and waist and hip circumference were measured and recorded by a certified health care professional and a skilled nurse. Body weight was measured using a clinical scale to the nearest 0.5 kg. Height was also measured without shoes to the nearest cm and BMI was calculated as weight (kg)/height² (m).

Waist circumference was measured halfway between the lower border of the ribs and the iliac crest in a horizontal plane. Hip circumference was measured at the widest point over the buttocks with a flexible tape (17). Demi-span was also measured in triplicate, using a flexible tape. For quality control and reliability, we used preset tolerance limits, 0.2 kg for weight, and 0.5 cm for arm circumference.

Fasting blood samples were taken from the antecubital vein and transferred immediately to a tube containing EDTA (6).

Determination of blood group

The ABO and Rh blood groups were determined using the antigen-antibody agglutination test. The antisera were obtained from the plasma of each blood sample; 3 drops were taken, designated A, B and Rh, then the relevant antiserum (A, B and D) was added. The ABO blood groups were assessed based on agglutination using ABO monoclonal reagents (Lorne, UK) and for determination of Rh blood group Lo-Du1 and Lo-Du2 monoclonal reagents (Lorne, UK) (18).

Statistical analysis

All statistical analyses were performed using SPSS, version 16. Descriptive statistics were used to define baseline characteristics. Independent sample t-test, analysis of variance (ANOVA) and post hoc tests (Bonferroni) were used for comparison of quantitative variables in Rh and blood groups and the chi-squared test was used for comparing the distribution of qualitative variables in Rh and blood groups. A P-value of < 0.05 was considered statistically significant.

Results

This study included 2882 males (39.6%) and 4386 females (60.3%) with a mean age of 48.1 [standard deviation (SD) 8.2] years. Among the 7268 participants, the most common blood group was O (n = 2457, 33.7%) and the least common was AB (n = 599, 8.2%) (Table 1). The frequencies for Rh-positive and Rh-negative were 88.2% and 11.8% respectively.

A statistically significant difference was observed in the distribution of blood groups between the sexes (P = 0.02) (Table 2). There was no statistically significant relationship between ABO blood groups and number of family members (P = 0.59) or educational attainment among individuals with different blood groups (P = 0.07) (Table 2).

Among our participants, 64.8% were unemployed or retired, 35.0% were employed and 0.1% were students; there was no statistically significant association between ABO blood group and job status (P = 0.23) (Table 2). We also observed no significant association between ABO blood group and smoking habit (P = 0.52).

Table 1 Distribution of blood groups, Mashad, 2017

<table>
<thead>
<tr>
<th>Blood group</th>
<th>Males, n = 2882</th>
<th>Females, n = 4386</th>
<th>Total, n = 7268</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>A</td>
<td>869</td>
<td>30.2</td>
<td>1327</td>
</tr>
<tr>
<td>B</td>
<td>822</td>
<td>28.6</td>
<td>1194</td>
</tr>
<tr>
<td>AB</td>
<td>204</td>
<td>7.1</td>
<td>395</td>
</tr>
<tr>
<td>O</td>
<td>987</td>
<td>34.2</td>
<td>1470</td>
</tr>
<tr>
<td>Rh+</td>
<td>2543</td>
<td>88.2</td>
<td>3870</td>
</tr>
<tr>
<td>Rh−</td>
<td>339</td>
<td>11.8</td>
<td>516</td>
</tr>
</tbody>
</table>
Table 2 Association between ABO blood groups and demographic and socioeconomic characteristics, Mashad, 2017

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>A No. (%)</th>
<th>B No. (%)</th>
<th>AB No. (%)</th>
<th>O No. (%)</th>
<th>Total No. (%)</th>
<th>Rh+ No. (%)</th>
<th>Rh– No. (%)</th>
<th>P-value&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P-value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>869 (39.6)</td>
<td>822 (40.8)</td>
<td>204 (34.1)</td>
<td>987 (40.2)</td>
<td>2882 (39.7)</td>
<td>2543 (39.6)</td>
<td>339 (39.6)</td>
<td>0.02</td>
<td>0.99</td>
</tr>
<tr>
<td>Female</td>
<td>1327 (60.4)</td>
<td>1194 (59.2)</td>
<td>395 (65.9)</td>
<td>1470 (59.8)</td>
<td>4386 (60.3)</td>
<td>3870 (60.4)</td>
<td>516 (60.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>326 (14.9)</td>
<td>280 (13.9)</td>
<td>81 (13.7)</td>
<td>326 (13.3)</td>
<td>1013 (14.0)</td>
<td>897 (14.0)</td>
<td>116 (13.7)</td>
<td>0.07</td>
<td>0.73</td>
</tr>
<tr>
<td>Elementary</td>
<td>910 (41.7)</td>
<td>796 (39.6)</td>
<td>250 (42.2)</td>
<td>1043 (42.6)</td>
<td>2999 (41.5)</td>
<td>2667 (41.8)</td>
<td>333 (39.3)</td>
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<td></td>
</tr>
<tr>
<td>Diploma</td>
<td>738 (33.8)</td>
<td>703 (35.1)</td>
<td>204 (34.4)</td>
<td>790 (32.2)</td>
<td>2435 (33.7)</td>
<td>2128 (36.1)</td>
<td>306 (33.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor degree</td>
<td>184 (8.4)</td>
<td>205 (10.2)</td>
<td>53 (8.9)</td>
<td>254 (10.3)</td>
<td>696 (9.6)</td>
<td>373 (5.8)</td>
<td>53 (6.2)</td>
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<td></td>
</tr>
<tr>
<td>Masters/PhD</td>
<td>20 (0.9)</td>
<td>22 (1.1)</td>
<td>5 (0.9)</td>
<td>34 (1.3)</td>
<td>81 (1.1)</td>
<td>72 (1.1)</td>
<td>9 (1.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religious education</td>
<td>4 (0.2)</td>
<td>2 (0.1)</td>
<td>0 (0.0)</td>
<td>3 (0.1)</td>
<td>9 (0.1)</td>
<td>9 (0.1)</td>
<td>0 (0.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job status</td>
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<td></td>
</tr>
<tr>
<td>Student</td>
<td>4 (0.2)</td>
<td>2 (0.1)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>6 (0.1)</td>
<td>4 (0.1)</td>
<td>2 (0.2)</td>
<td>0.23</td>
<td>0.15</td>
</tr>
<tr>
<td>Employed</td>
<td>770 (35.1)</td>
<td>725 (36.0)</td>
<td>206 (34.4)</td>
<td>860 (35.1)</td>
<td>2561 (35.3)</td>
<td>2257 (35.2)</td>
<td>303 (35.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>1208 (55.1)</td>
<td>1072 (53.2)</td>
<td>344 (57.5)</td>
<td>1364 (55.6)</td>
<td>3988 (55.0)</td>
<td>3555 (55.2)</td>
<td>454 (53.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retired</td>
<td>210 (9.6)</td>
<td>215 (10.7)</td>
<td>48 (6.8)</td>
<td>228 (9.3)</td>
<td>702 (9.7)</td>
<td>607 (9.5)</td>
<td>95 (11.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Be current smoker</td>
<td>500 (22.8)</td>
<td>446 (22.1)</td>
<td>132 (22.1)</td>
<td>516 (21.0)</td>
<td>702 (9.7)</td>
<td>1409 (22.0)</td>
<td>186 (21.8)</td>
<td>0.52</td>
<td>0.87</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>4.5 (1.5)</td>
<td>4.4 (1.5)</td>
<td>4.5 (1.5)</td>
<td>4.5 (2.5)</td>
<td>4.5 (1.9)</td>
<td>4.5 (1.9)</td>
<td>4.4 (1.5)</td>
<td>0.59</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Independent samples t-test and ANOVA were used for comparing demographic characteristics between Rh groups and ABO blood groups, respectively. SD = standard deviation.

P-value<sup>a</sup>: difference in anthropometric parameters between ABO blood groups; P-value<sup>b</sup>: difference in anthropometric parameters between Rh groups.
The mean demi-span was significantly higher among participants with blood group B (mean 76.7, SD 5.6) compared with the other participants \( (P = 0.03) \). The difference was greatest between blood groups B and O \( (76.7, SD 5.6 \text{ vs } 76.3, SD 5.5, P = 0.014) \), followed by AB \( (P = 0.025) \) and A \( (P = 0.032) \). There was no statistically significant difference between ABO blood groups and BMI \( (P = 0.3) \), waist circumference \( (P = 0.3) \) or hip circumference \( (P = 0.4) \) (Table 3).

**Discussion**

The ABO system comprises 4 groups, A, B, AB and O, determined genetically by 3 allelic genes located on chromosome 9 \( (19) \). The distribution of blood groups varies regionally and ethnically and there have been a number of studies on the distribution of ABO and Rh blood groups in different geographical, ethnic and socioeconomic groups \( (18,20) \).

Our findings in a population sample from Mashhad showed that blood group O had the highest frequency (33.7%) and the frequency of A, B, and AB blood groups was 30.2%, 27.7%, and 8.2% respectively. In 2 studies carried out in Pakistan and India, the most common blood group was B, followed by O, A, and AB \( (6,18) \). In a study conducted in Saudi Arabia, the most prevalent blood group was O, followed by A, B, and AB \( (7) \), comparable with our findings. In a population-based study from China, the most prevalent blood group was A, followed by O, B, and AB, and the frequency of ABO and Rh blood groups was significantly different among the ethnic groups in that study \( (21) \). In contrast, O was the most frequent blood group among our population. Data from British and American populations indicate that blood group O is the most common, followed by A, B, and AB, which is in agreement with our study \( (22) \). Although these studies observed similar results to our own, other surveys carried out among the Iranian population from different regions and ethnicities showed some variations: the most common blood group was B in a study conducted in Yazd in 2007, and in a study conducted among the Azari population, the most common blood groups were A and O \( (1,23) \). These differences may reflect a difference in population genetics or migration at different times from different areas of the country.

In our study, the frequency of A and AB in females was greater than in males, while, the prevalence of B and O was higher in males, indicating a possible difference of ethnic mix in the surveyed population. It should be noted that all of our study population were Iranian as self-declared, and this may be considered a limitation of this study; the ethnicity of the population should be more precisely determined.

In a 2004 study conducted among the population of Mashhad, the frequencies of O, A, B and AB blood groups in 867 individuals were recorded as 34.7%, 33.1%, 23.3% and 8.9%, respectively, similar to our findings, however in that study there were no important differences in the frequency of ABO blood groups based on sex \( (15) \). The
smaller sample size (867 against 7268 in the current study) might have led to this difference.

The results of this and previous studies also showed that AB was the least prevalent blood group, indicating that the gene segregation for the ABO system follows a similar distribution pattern in various ethnic groups, with certain exceptions (10). In accordance with the different distribution of ABO blood groups, transfusion centres should consider different strategies for providing and storing blood products for the ongoing needs in the population. Moreover, different distributions of disorders which are associated with blood group would be expected in the community.

For the Rh system, the distribution pattern in different regions of the world and in the Islamic Republic of Iran is similar (20). In 1982, Porfathollah et al. reported that the Rh-positive and Rh-negative distribution was 89.62% and 10.38% respectively among the Iranian population (20). The frequency of Rh-positive in other parts of the world was also higher than the Rh-negative blood group as observed in the current study (6,7,20). The Rh blood system distribution has remained constant over time.

Our findings showed no significant associations between demographic and socioeconomic factors and blood group; we also observed no significant relationship between the ABO blood groups and anthropometric parameters such as BMI, waist circumference and hip circumference. An exception was the significant association between demi-span and blood group (p = 0.03): the prevalence was higher for group B in comparison with the other blood groups. Sirajuddin et al. observed a significant correlation between anthropometric factors and certain genetic factors such as ABO blood groups and the Rhesus antigen in an Indian population; however, they did not mention the anthropometric factors precisely (25). The results of a 2012 Iranian study showed that mean weight and BMI were significantly higher in those with blood group A compared with other blood groups, but mean height was not significantly different (26). In comparison, in our study, blood group AB individuals had slightly higher BMI values; a 1985 American study reported that B individuals were taller than non-B individuals (27).

Conclusion
In addition to the various distributions of the blood groups in different regions, blood group appears to be associated with anthropometric measures. Further longitudinal and multicentre studies are required to investigate the exact pattern and related factors of blood groups.

Acknowledgement
We are truly grateful to the 7268 community health volunteers for their major contribution to this study.

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Competing interests: None declared.

Prévalence des groupes sanguins ABO et Rh et leur association avec des facteurs démographiques et anthropométriques dans une tranche de la population iranienne : l'étude de MASHAD

Résumé
Contexte : Les groupes sanguins semblent être des marqueurs de diverses maladies humaines. Leur répartition entre les différents groupes ethniques, communautés et frontières géographiques varie avec le temps.

Objectifs : Notre objectif était d’étudier la fréquence des groupes sanguins ABO et Rh et leur relation avec les caractéristiques démographiques et anthropométriques chez les habitants iraniens de Mashad

Méthodes : Les groupes sanguins ABO et Rh ont été déterminés chez les 7268 participants de l'étude de cohorte de MASHAD et leurs relations avec les paramètres démographiques et anthropométriques ont été évaluées. Cette partie de l'étude a été réalisée en janvier 2017. Le t-test de Student, l’analyse de la variance, l’ajustement de Bonferroni et le Chi carré ont été utilisés pour comparer les variables quantitatives et qualitatives.

Résultats : Le groupe sanguin le plus répandu était O (33,8 %) ; AB était le moins répandu (8,3 %). La prévalence du rhésus positif et du rhésus négatif était de 88,2 % et 11,8 % respectivement. Il existe des associations statistiquement significatives entre les groupes sanguins ABO et la demi-envergure des bras (p = 0.03), même après correction pour les comparaisons multiples.

Conclusion : Les résultats de notre étude ont montré qu’il n’y avait pas de lien entre les groupes sanguins ABO et les caractéristiques démographiques; par contre, il existe une association avec des mesures anthropométriques telles que la demi-envergure des bras.
References


