



Department of Biomedical Sciences, College of Health Sciences, Qatar University, Doha, Qatar.

Contacts of Authors



* To whom correspondence should be addressed: Ibrahim Mustafa

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The distribution of the ABO and RH blood groups among different populations in the MENA region: A review

Roan Zaid and Ibrahim Mustafa*

Abstract

ABO and Rh (rhesus) blood grouping is one of the most widely available laboratory tests that could prevent possibly deadly mismatches following blood transfusion and organ transplantation. The distribution of the blood group antigens varies between different populations and ethnic groups. Our objective was to showcase these variations within the Middle East and North Africa (MENA) region and to outline the relationship between blood type and disease risk association to determine the current findings and outline possible future study areas. In healthy blood donors, blood group O was found to consistently be the most prevalent blood group and AB the least prevalent blood group except in Turkey where A is the most prevalent and, in the United Arab Emirates (UAE), where B is the least prevalent blood type.

Keywords: ABO blood groups, Rh blood groups, blood donors

Introduction

According to the International Society of Blood Transfusion (ISBT), there are 33 blood group systems that represent more than 30 antigens as of date [1, 2]. The four common blood group antigens (A, B, AB and O) of the ABO system, along with the D (Rhesus/Rh) and Kell antigens are the most important in blood transfusions and organ transplantation and are commonly tested due to their clinical significance [3]. The ABO gene codes for glycosyltransferases that transfer complex oligosaccharide antigens to the H antigen on the surface of red blood cells (RBCs). N-acetylgalactosamine and galactose are transferred in the case of A and B blood groups, respectively. Individuals with the O blood group do not produce the glycosyltransferase due to a single point deletion (guanine-258) and, as a result, lack these antigens on the surface of their RBCs [4, 5]. The distribution of the ABO/Rh blood groups among different populations within the MENA region as well as some the diseases that are associated with these blood groups will be addressed in this review.

The distribution of the ABO blood groups in the MENA region

Ever since the discovery of the ABO blood groups by Landsteiner in 1900, the studies on human population genetics were on the rise [6]. Blood group typing entails finding the antigenic properties of RBCs. These antigenic properties are found to vary between different racial/ethnic groups. Population and prevalence studies are therefore important to help elucidate the distribution of the ABO/RH blood groups and to help prevent possibly deadly mismatches before blood transfusions or organ transplantation [7]. **Table 1** shows the distribution of the ABO and Rh blood groups among different populations in the MENA region.

In healthy blood donors, blood group O was consistently found to be the most prevalent and AB the least prevalent blood group. Turkey and the UAE were the only exception where A was found to be the most prevalent in Turkey and B was the least prevalent in the UAE.

Blood group antigens and disease association

ABO blood groups have been statistically associated with many diseases including diabetes, venous thromboembolism, ovarian cancer, hepatocellular carcinoma, lung cancer, pancreatic cancer and other gastrointestinal cancers [15, 18-22]. However, reports have been variable and inconsistent between studies. Some of these diseases and their associated blood group antigens will be addressed.

Venous thromboembolism and blood group antigens

One of the most described associations between non-O blood groups (A, B, and AB) and other diseases is that of

venous thromboembolism (VTE). Multiple studies have established a relationship between the ABO blood groups and its influence on normal haemostasis [19, 23]. This relationship is attributed to the expression of the ABO antigens on the surface of other human cells, including cells of the epithelium, vascular endothelium and platelets [24]. In addition, the blood group antigens largely determine the plasma levels of the von Willebrand Factor (VWF) where VWF levels are reported to be 25% higher in non-O blood groups [23, 25-27]. Elevated VWF would prompt platelet adhesion as well as maintain the coagulation factor VIII (FVIII) in the plasma increases the risk of VTE [24]. It is also important to note that individuals of the A2 blood groups are reported to have low levels of the VWF and FVIII. The risk of developing VTE in these individuals is said to be lower when compared to the other blood groups (A1, B and AB) [19]. In concordance with this phenomenon, higher risk of myocardial infarction and ischemic strokes were also previously described in individuals with blood group A and AB [28].

Table 1. Distribution of the ABO and RH blood groups among different populations within the MENA region.

Country	Population studied	Sample size	A (%)	B (%)	AB (%)	O (%)	RH+ (%)	RH- (%)	Ref.
Iraq	Blood donors	5,000	32.6	22.8	7.6	37.0	91.3	8.7	[8]
Pakistan	Blood donors	3679	31.87	21.71	12.22	34.2	88.86	11.14	[9]
Qatar	Blood donors	1,650	27.6	20.4	6.5	45.4	-	-	[10]
	T2DM patients	1,633	29	25.7	6.8	38.5	-	-	[10]
Saudi Arabia	Blood donors	57,396	26.0	18.0	4.0	51.0	92.0	8.0	[11]
	Male blood donors	944	33.4	6.0	3.8	56.8	92.8	7.2	[7]
	T2DM female patients	214	24.8 (A+)	27.1 (B+)	7.0 (AB+)	36.9 (O+)	95.8	4.21	[12]
	T2DM male patients	128	22.6 (A+)	30.5 (B+)	4.7 (AB+)	39.1 (O+)	96.88	3.13	[13]
Sudan	Blood donors	3,087	19.14	14.0	-	66.8	74.4	25.6	[14]
Turkey	Blood donors	3,022,883	42.2	16.4	7.5	33.9	87.7	12.3	[15]
	Blood donors	86,797	44	16.2	6.5	33.3	88.2	11.8	[16]
	Lung cancer patients	2,044	43.9	17.3	8.1	30.7	86.2	13.8	[15]
United Arab Emirates	Blood donors	661	24.0	22.8	31	48.4	91	8.9	[17]

Type 2 Diabetes Mellitus and blood group antigens

A study done in Qatar revealed that Type 2 Diabetes Mellitus (T2DM) patients are significantly more likely to be of blood type B as compared to healthy individuals (25.7% vs. 20.4%; $P < 0.001$) (table 1). In the same study, blood group O was significantly higher in healthy individuals than in T2DM patients (38.5% vs. 45.4%; $P < 0.001$) [10]. A study done in Kingdom of Saudi Arabia (KSA) found a 52.2% decrease (2.1 fold reduction) in Rh (-) blood groups in T2DM female patients as compared to healthy controls (4.21% vs. 8.8%; $P = 0.043$) [12]. Similar findings were reported for male T2DM patients in KSA where males had a 3.4 fold reduction in RH (-) blood group in comparison to healthy controls (3.13% vs. 10.6%; $P = 0.028$) [13]. Blood group B was higher in both male and female T2DM patients in KSA, however, these findings were not statistically significant [12, 13]. In Iraq, it was reported that blood group O individuals had significantly higher levels of total cholesterol, glucose and blood pressure in comparison to other blood groups ($P < 0.01$). These parameters showed a decreasing trend starting from group O to A to B and then AB [22]. Although all the reported results were of high significance in all populations, it is clear that these findings cannot be extrapolated to other populations

due to the conflicting reports. These variations between populations could be explained by the multifactorial nature of T2DM.

Cancer and blood group antigens

Multiple studies consistently report that individuals with the O blood group have reduced risk of developing pancreatic cancer than non-O individuals [4, 20, 29, 30]. One study reported that the risk of pancreatic cancer increases with each addition of non-O allele. In this study, individuals with AO and AA genotypes had odds ratios (ORs) of 1.33 and 1.66 respectively when compared with individuals of the OO genotype. Whereas BO and BB individuals had ORs of 1.45 and 2.42, respectively [30]. It was also recently reported that the genetic variant of the ABO gene, rs505922 (T allele), which is said to confer protective properties against pancreatic cancer, is in complete linkage disequilibrium ($r^2 = 1.0$) with the guanine-258 deletion that encodes the O allele [4, 31]. This variant entails a single nucleotide polymorphism in the first intron of the ABO gene.

Comparable findings were reported for hepatocellular carcinoma (HCC) where blood group O was found to improve the disease's prognosis after hepatectomy [21].

Studies conducted by Wu *et al.*, revealed the mean overall survival (OS) of HCC after hepatectomy to be 55, 39, 34 and 34 months for blood groups O, A, B and AB, respectively. The overall hazard ratio for non-group O individuals in this study was 1.485 (95% CI, 1.204–1.830; $P < 0.001$) [21].

Studies done by Urun *et al.* in Turkey found that having O and Rh- blood decreased the risk of lung cancer by 14% and 13% respectively [15]. However, another study, also done in Turkey, showed no correlation between blood groups and lung cancer status of patients [32].

Finally, Zhang *et al.* compared findings for 89 studies with 30 different cancer types. For these studies, the pooled OR for A blood groups vs. non A blood groups was 1.12 (95%CI: 1.09-1.16) showing a significantly increased risk of blood group A. In the other hand, individuals with the O blood group had a significantly reduced risk of cancer compared to other blood groups with an OR of 0.84 (95%CI: 0.80-0.88) [33]. In all the reported cases, the exact mechanism by which blood group O causes a risk reduction is not fully understood. However, many possible explanations were suggested. For instance, the intracellular adhesion molecule-1 (sICAM-1) levels were found to be higher in group O individuals [34]. It is possible that the reduced levels of sICAM-1 promote tumor metastasis in non-group O individuals [35]. Furthermore, the single nucleotide polymorphism (SNP) of the ABO gene (rs505922) was found to be associated with higher levels of tumor necrosis factor (TNF) levels. [31] These findings could explain the relationship between specific blood groups and carcinogenesis [36].

Conclusion

In conclusion, an understanding of blood group data between different populations is important for effective management of blood bank inventory and for more efficient transfusion practices. The present study collected data from different populations of the MENA region to reveal that blood group O is the most common blood group type, while AB is the least prevalent. Some of the diseases associated with specific blood groups were also addressed. However, more studies are required to fully understand the reported associations and to address the inconsistencies between studies.

Author Contributions

IM conceived and planned the manuscript writing. RZ took the lead in writing the manuscript with equal contribution. All authors provided critical feedback and helped shape the research, analysis and manuscript.

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