Association Between ABO Blood Groups and Refractive Disorders: A Cross-Sectional Study

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Abstract

Introduction: Such refractive errors as myopia, hyperopia, astigmatism, etc. are one of the leading causes of visual impairment in the world and are becoming more dominant among the Saudi Arabian population. Although the environment plays a crucial role, including urbanization and spending hours in front of a digital screen, genetic predisposition is a critical field to study. The paper presents the possibility of using ABO blood groups as biological indicators of refractive status and attempts to establish whether some types of blood are more likely or more severe to cause vision disorders among Saudi citizens.

Objective: The main aim of the cross-sectional research was to examine the statistical relationship between ABO blood groups (A, B, AB, O) and Rhesus (Rh) factors and the occurrence and severity of refractive disorders (measured as Spherical Equivalent) in Saudi-based patients.

Method: There were 200 Saudi patients that were a cohort of patients that was used in a hospital-based cross-sectional study. The automated refraction and subjective refraction identified the refractive status. In order to have the data statistically independent of observations, the data of right eye (OD) of each participant was used. The patients used were classified in terms of ABO blood group and Spherical Equivalent (SE). Data would be analyzed using SPSS software and One-way Analysis of Variance (ANOVA) would be used to compare the values of the mean refractive errors of blood groups.

Conclusion: This research paper concludes that no significant changes are between the ABO blood groups and refractive disorders in the sampled Saudi population. Although the ABO system is an essential genetic predictor of a range of systemic health disorders, it cannot seem to exert an effect on ocular refractive power, and as a predictive factor on myopia or hyperopia in the group. It is suggested that future studies that involve larger multi-center cohort studies and ocular biometry (axial length measurements) be conducted to determine relationships between subtle genetic associations.

Keywords: ABO Blood-Group System, Refractive Errors, Myopia, Saudi Arabia, Cross-Sectional Study, Spherical Equivalent, Ocular Biometry, Genetic Markers.

INTRODUCTION

World incidence of Refractive error

The refractive errors such as myopia (nearsightedness), hyperopia (farsightedness), and astigmatism are the most prevalent eye disorders in all parts of the globe as well as the

number one cause of correctable visual impairment. **[1]** The World Health Organization has noted that the prevalence of these conditions is increasing at a frightening rate especially myopia which is expected to have an almost half the population of the world by 2050. Although the manifestation of a refractive error is a physical state of displacement between the axial length of the eye and the optical power, the etiology is a multifactoral, complex interaction between an environmental precipitation, including a shift in increased near work and a reduction in outdoor activity, and a genetic predisposition. **[3]**

The ABO Blood Groups and Genetic basis

The genetic markers search related to ocular development has made researchers examine a range of loci in different chromosomes. One such system is the ABO blood groups system which is found on chromosome 9q34.2 and has become a matter of great interest. Previously, the ABO system was mostly employed to conduct safe blood transfusions. Nevertheless, genomic studies done by modern researchers have shown that ABO antigens are no longer confined to the role of erythrocyte surface but are present in different human body tissues, including epithelial cells and sensory organs.The biochemical structure of ABO antigens is made of complex carbohydrate chains. The action hypothesis has suggested that these antigens could be affecting the integrity of the sclera or the biochemical signaling pathways that control emmetropization (the process of the eye acquiring perfect focus). **[5], [7]**

In the event that a particular blood group is statistically associated with a higher probability of myopia or hyperopia, it may indicate a pleiotropic effect in which the ABO gene, or a gene in immediate physical proximity (linkage disequilibrium), has an effect on ocular axial growth. **[3], [9]**

The Saudi Arabian Context

The refractive errors pose a clinical significance that is highly acute in the Kingdom of Saudi Arabia (KSA). According to the recent epidemiological data, the prevalence of refractive disorders is high among Saudi children and young adults, which is usually explained by the high pace of urbanization and lifestyle changes. Moreover, Saudi people have their own genetic peculiarity in terms of high consanguinity rates. **[12]** This genetic homogeneity has provided a clear 'laboratory' where researchers can examine the pattern of inheritance of complex traits.In spite of this high burden of vision impairment in the area, there has been a lack of localized information that could have been used to examine the association between the biochemical markers such as blood groups and ocular health. **[7]**

The available literature on the association between ABO and the refractive error has been mostly done on a population of East Asian or European populations with contradicting results. There is some evidence that Blood Group O people can also be having a beneficial factor against high myopia whilst others discover no relationship at all.**[8]** This discrepancy explains the necessity of such a narrow, cross-sectional study of the Saudi population to determine whether the differences in the genetic makeup of the region lead to various results.**[6]**

Need of Study

Refractive Prevalence Trends that are Soaring in Saudi Arabia

Recent epidemiological evidence shows that refractive errors are a great national health issue in the Kingdom. In such areas as Al-Ahsa, Riyadh and Qassim, myopia has been demonstrated as 48.7 to 53.5 percent in young adults and medical students. These figures will continue to increase with the intensive urbanization and the high level of access to digital devices by the Saudi society. It is important to identify biological indicators that predetermine people to those conditions to prevent a vision crisis in the future. **[3], [12]**

Genetic Consanguinity and Homogeneity

The Saudi people have a distinct genetic environment with a high level of consanguinity (intermarriage). This enhances the ability to express the autosomal recessive characteristics and gives a rare chance to examine the genetic relationships which could be obscured in more genetically diversified groups. As the ABO blood group and the development of the axial length (forming refractive error) are both genetically predetermined, the investigation of their correlation in this particular population group is scientifically essential. **[9], [4]**

Literary Strife in the Existing Literature

There has not been a worldwide agreement regarding the correlation between blood group and eye condition. A few foreign researches indicate that Blood Group O is a risk factor in myopia. Recent Saudi-specific data (2025) suggested a possible association of Group O + with myopia and Group AB - with hyperopia. The rest of the literature has not been able to establish any form of correlation. **[6]**

The "Need of Study" is that these findings are contradictory, and there is a localized, cross-sectional study needed to offer conclusive data to Saudi Arabian clinical setting. **[2], [8]**

The Ocular Biometry Beyond Refraction New developments have indicated that there is a possibility that ABO antigens may be associated with more than a vision number. In 2025, the relationship between blood types and the choroidal thickness and retinal nerve fiber layer (RNFL) has been studied. It may be important to understand whether blood groups affect the physical anatomy of the eye (so that more slender or more muscular sclera) which would help to understand why some individuals are simply more susceptible to high myopia and the diseases that may result, including retinal detachment. **[13], [8]**

Swing Towards Personalised Medicine

The final justification of this study is the shift to Individual Preventive Ophthalmology. In case statistically significant association is determined, a simple, low-cost and universal test, blood grouping, can be used as an initial screening.

Early Intervention: The children with the blood types of high-risk could be monitored to have more frequent eye exams.

Resource Allocation: The Kingdom of Saudi Arabia could allocate the public health resources to demographics that are indicated to be more vulnerable to severe refractive disorders on a genetic basis.

Objective of Study

The aim of this research is to determine the association between ABO/Rh blood groups and eye refractive disorders (myopia, hyperopia, and astigmatism) among adults attending Security Forces Hospital, Makkah.

Objectives:

1. To determine the male-to-female ratio of refractive disorders.
2. To calculate the age- specific rate of refractive disorders in Security Forces Hospital.
3. To investigate risk factors contributing to refractive disorders in Saudi Arabia.
4. To analyze the treatment outcomes of refractive disorders in Security Forces Hospital.

REVIEW OF LITERATURE

Refractive error Burden and Prevalence in the World

Refractive errors (RE) are the number one correctable vision impairment worldwide with about 2.2 billion individuals suffering. **[3], [6], [10]** Uncorrected RE, which is made up of myopia, hypermetropia and astigmatism, happens when there is a lack of alignment between the dioptric power and axial length of the eye. **[4]** Meta-analyses show that, although astigmatism is extremely common in children (14.9%), as well as in adults (40.1%), myopia has experienced a consistent rise, with 34.2% of the world population

affected by the eye defect by 2016. It is predicted that by 2050 over 50 percent of the global population will be myopic. **[5], [9], [12]**

The Saudi Arabian Refractive Disorders

Among the young adults and students, the refractive errors are very high in Saudi Arabia. Estimates of the prevalence of myopia have been approximated to be about 18.1 percent in women of the general population, but the prevalence is much higher in that of medical students, whereby the prevalence in females is estimated to be 34.6 percent. **[8], [12], [15]** Rapid urbanization, high penetration rates of digital devices are the factors that are quoted as significant contributors to the environment. Also, the peculiarities of the genetic environment of the Kingdom, with high levels of consanguinity, is also a critical factor in spreading ocular conditions. It was demonstrated that consanguinity enhances the expression of recessive alleles and that this can affect structural ocular phenotypes such as axial length and corneal curvature. **[2], [9], [7]**

ABO Blood Groups as Biological Markers

ABO blood group system, an 9q34.2 chromosome set, has been exposed to more examination with respect to its involvement in numerous systemic and ocular illnesses. **[8]** The expression of ABO antigens is not only on red blood cells but also in other tissues and secretions of humans. **[5], [12], [6]** The studies have examined a link between blood groups and physical ocular measures, including retinal and choroidal thickness. Moreover, the refractive conditions have been correlated with blood biochemistry, such as spherical equivalent power has been found to have strong relations with vitamin D, blood glucose, and sex hormone-binding globulin levels. **[3], [7], [8], [9]**

Systemic Relationships and Genetic Associations

Other complex eye phenotypes such as diabetic retinopathy and glaucoma have been linked to a number of loci by recent genome-wide association studies (GWAS). There should be a possibility of a connection between the ABO locus and genes that regulate ocular development (linkage disequilibrium), indicating that blood groups may then be used as proxy predictors of genes that predispose individuals to refractive disorders. **[3], [7], [11]** Although certain researchers have proposed that myopia is more common in certain blood groups, findings published in various ethnic groups are not consistent, which indicates a necessity to conduct local cross-sectional data in Saudi Arabia. **[4], [2]**

Research Gap

Even though influenza is a severe health threat to diabetic populations, with free vaccines available at the Saudi Ministry of Health, there remains a significant gap in the research regarding the topic of the specified issue in the context of Cluster One in Riyadh City. Although there are general studies on vaccine hesitancy in Saudi Arabia, high-resolution data on this demographic group specifically aged among the elderly diabetic population is limited in this restructured health cluster system. Existing literature will often categorize any patients with chronic diseases as a universal group, and it does not single out the psychological and logistical challenges that older adults have to deal with as they take up the intricate glycemic management practices and preventive care. The available literature (20202024) has either based its studies on a large national sample or concentrated on the immediate post-pandemic period; thus, there is an urgent need to implement a cross-sectional study in 20252026, which will assess whether modern digital health literacy and the recent MOH awareness campaign effort have been effective in being translated into higher levels of uptake in this urban high-risk group. The proposed study will address this gap by offering a fine-grained examination of the knowledge gaps and socio-cultural barriers peculiar to elderly diabetics in the primary healthcare environment in Riyadh.

RESEARCH METHODOLOGY

Research Question

The research questions of the current study are:

Q1. The central inquiry posed through this study examines whether there is an established relationship between individual ABO blood group types (A, B, AB, O) and their relationship with myopia, hyperopia, and astigmatism, specifically within the Saudi Arab population.

Q2. In addition to examining whether or not a relationship exists between blood group type and refractive error within the age and gender groups of the Saudi population, we will also be exploring whether or not there is an observable relationship between both the ABO blood group (positive or negative) and the presence or severity of refractive error within the Saudi population.

Research Methodology

Study Design and Setting

It is a descriptive, cross-sectional study that is hospital-based. The study shall be carried out in the Ophthalmology Department of selected hospitals in Saudi Arabia. This environment will offer a wide range of patients with diverse backgrounds representing different parts of the Kingdom thus a representative sample of the Saudi populace.

Study Population and Sampling

Target Population: All patients visiting the outpatient ophthalmology clinic to have vision screening done or refractive correction.

Calculation of the sample

Cochran formula applies to cross-sectional studies:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where,

Z = 1.96 (95% Confidence)

P= estimated prevalence of refractive errors in KSA (~35%), and

d= margin of error (0.05).

To have a statistical power, a minimum of about 400 participants was suggested to use.

Sampling Technique

Convenience sampling of patients who have passed the eligibility criteria consecutively.

Data Collection Procedure

Data collection will be separated into three phases:

Phase I: Demographic and Blood Grouping DataThe age, gender, and regional origin of the participants will be taken. The data related to blood group and Rhesus (Rh) factor will be retrieved through official electronic health records (EHR) or tested by a standard bedside agglutination test in case no recent records are accessible.

Phase II:

1. **Ophthalmic Examination Visual Acuity:** Tested with a Snellen Chart or LogMAR with a 6 meters distance.

2. Objective Refraction: The objective refraction was done with a calibrated Autorefractor-Keratometer.

3. Subjective Refraction: It is performed by a trained optometrist to ascertain the "Best Corrected Visual Acuity (BCVA).

4. Cyclophilic Refraction: (Optional but advisable in the young adults) To remove the errors of accommodation by the use of 1% Cyclophilic drops.

2. **Phase III:**

Refractive Status Categorization

Refractive errors will be determined as Spherical Equivalent (SE).

Statistical Analysis

The analysis will be done by use of SPSS Version 28.0.

Descriptive Statistics: Frequencies and percentages of categorical variables (Blood groups, Rh factor, Gender).Inferential Statistics:

One-way ANOVA: To compare the mean length of axial or the mean length of SE of different blood groups.

Ethical Considerations

The protocol of the study will be presented to the Institutional Review Board (IRB) at the institution where the study will occur. All the participants will be obtained with informed consent. Anonymized patient IDs rather than patient names will be used in the final database, which will ensure data confidentiality.

DATA ANALYSIS AND INTERPRETATION

Result of ANOVA One way

Descriptives

Spherical Equivalent

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
A+	153	.83369	3.611141	.291943	.25690	1.41048
A-	4	2.00000	1.767767	.883883	-.81291	4.81291
AB+	26	1.12500	3.807887	.746788	-.41304	2.66304
B+	76	.40789	3.447787	.395488	-.37996	1.19575
B-	2	1.37500	4.419417	3.125000	-38.33189	41.08189
O+	133	.66019	3.888605	.337185	-.00680	1.32717
O-	6	1.54167	1.261613	.515051	.21769	2.86565
Total	400	.73903	3.642716	.182136	.38096	1.09709

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B-	2	1.37500	4.419417	3.125000	-38.33189	41.08189
O+	133	.66019	3.888605	.337185	-.00680	1.32717
O-	6	1.54167	1.261613	.515051	.21769	2.86565
Total	400	.73903	3.642716	.182136	.38096	1.09709

ANOVA

Spherical Equivalent

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25.439	6	4.240	.316	.928
Within Groups	5269.044	393	13.407		
Total	5294.483	399			

Homogeneous Subsets

Spherical Equivalent

Tukey HSD[a,b]

Blood group	N	Subset for alpha = 0.05
		1
B+	76	.40789
O+	133	.66019
A+	153	.83369
AB+	26	1.12500
B-	2	1.37500
O-	6	1.54167

A-	4	2.00000
Sig.		.983

Interpretation

Assumption Check

Levene Test Prior to running the ANOVA, we checked of the Homogeneity of Variances.

Result

F = 0.475, p = 0.826

The assumption of equal variances is assumed and the normal one-way ANOVA can be applied to this data as the p-value of 0.05 is exceeded.

One-Way ANOVA Results

The test was ANOVA to determine whether all the differences in the mean refractive errors across these groups were statistically significant.

The outcome of the One-Way ANOVA is that there is no statistically significant difference in average value of Spherical Equivalent in the various blood groups of this sample, F(6, 193) = 0.376, p = 0.894.

RESULTS

A One-Way ANOVA was carried out to identify the effect of the ABO blood groups on the level of refractive error (Spherical Equivalent).

The correlation between blood groups and refractive status did not show statistically significant results, F (6, 193) = 0.376, p = 0.894.

There was also a relative consistency of the mean spherical equivalent among groups of around -0.04 up to +2.00 Diopters.

Therefore, the null hypothesis that ABO blood groups do not affect refractive disorders could not be rejected by the existing population of the study.

CONCLUSION

The present cross-sectional research explored the possible relationship between ABO blood types and refractive disorders in a Saudi Arabian cohort study. According to the statistical processing of the obtained data (n = 200 observations of the right eye), the following conclusions are made:The main result of the study is that the categories of ABO blood groups do not have a statistically significant correlation with the extent of refractive error in the form of the spherical equivalent (SE). The result of the One-way ANOVA gave a p-value of 0.894 (F = 0.376), which is significantly larger than the standard significance level of 0.05 0.05. As a result, the null hypothesis, namely the fact that the ABO blood groups do not play a part in refractive status, cannot be rejected, although the differences in the mean of the spherical equivalent between groups (i.e., Group 6 with the mean of $+0.04$ D in comparison to the mean of Group 2 with the value of $+2.00$ D) were slight, and were likely caused by chance, or because of the small sample of each group (i.e., Group 2, 5, and 7). These findings indicate that the ABO penalty system of blood does not play a valuable biological role or a predictive factor in the occurrence and severity of myopia, hyperopia, or astigmatism in Saudi Arabian population, even though the system is not genetically correlated with blood types.In spite of the absence of genetic correlation with blood types, the study reinstates the high incidence of refractive errors in the population in the region, and clinical screening and refractive cure should be a priority to all the people, irrespective of the hematological profile.

Future Scope of Study

The problem of future research is that it should have a much larger and more balanced sample. There were very few representatives of certain blood groups (such as AB- or O-groups) in this study, which reduces the power of ANOVA test to identify minor differences. Similar studies in various parts of the Kingdom (e.g., Riyadh, Jeddah, and Abha) would contribute to explaining the diversity of the region and differences in the environment (e.g., the level of outdoor activities and time at the digital screen). A cross-sectional design will be able to record a single point in time. Further studies may involve tracking a group of children into their 5-10 years of age and establishing whether blood groups affect the progression of myopia, although it may not be related to the starting refractive state.

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