ORIGINAL ARTICLE

Association between ABO Blood Group System and Refractive Errors: A Cross-Sectional Study from Islamabad, Pakistan

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Abstract

Background: Around the world, refractive defects are the most common cause of impaired vision. There is contradictory and insufficient data to support a potential link between blood types (ABO) and refractive disorders.

Objective: This study was carried out to assess the association between refractive defects and ABO blood group in participants (aged 10-35 years) who visit Al-Kubra Health and Eye Clinic in Islamabad, Pakistan.

Methods: The cross-sectional study was conducted from September 2023 to December 2023. Three hundred patients were selected using purposive sampling (100 per refractive error category). Participants with other ocular diseases or who were unwilling to provide informed consent were excluded from the study. A slandered eye examination was followed to evaluate refractive errors, and cycloplegic refraction is used where needed. SPSS 2021 was used to analyze the data. Frequencies and percentages are presented as descriptive data, and correlations are assessed using Fisher's Exact test at $p < 0.05$.

Results: A distinctive pattern of the ABO blood group was shown by all three refractive error categories of the sampled data. B positive showed a significant number of refractive errors (43.7%). The refractive error form was significantly associated with ABO blood group ($p < 0.05$).

Conclusion: In this clinic-based sample, a significant association was found between ABO blood group and refractive disorders, with B+ being the most frequent blood type across all refractive types. However, due to limitations in study design and sampling, the results should be interpreted with caution. It is advised to do larger multicenter studies with population-based sampling and adjusted analysis.

Keywords: *Myopia, hyperopia, astigmatism, ABO blood group.*

INTRODUCTION

Refractive errors are a major public health concern that affects people of all ages and are one of the main causes of visual impairment worldwide [1, 2]. Refractive error occurs when axial length, corneal curvature, or lens power anomalies prevent parallel beams of light from the eye's optical structures from being focused on the retina. Astigmatism, hyperopia, and myopia are the three types that considerably affect visual function and quality of lifestyle [3]. Myopia causes the eye to focus images in front of the retina, leading to blurry vision when observing distant objects. On the other hand, images focus behind the retina rather than directly on it due to hyperopia, another common refractive defect, which occurs when the eye is excessively short or lacks proper convergence. Furthermore, astigmatism causes light rays to converge at multiple points within the eye, resulting in blurry vision at both near and distant distances. Myopia is a multifactorial disorder primarily influenced by environmental factors, such as increased near work and reduced outdoor exposure, whereas hyperopia and astigmatism are more closely associated with hereditary characteristics [4-6].

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According to recent global estimates, refractive errors have become increasingly common over the past 20 years, particularly among younger generations [1, 4]. In addition to the complex and multifactorial issues, several external factors also play an important role in the variation in the prevalence of refractive errors across populations, including education, population demographics, ocular morphology, and genetic susceptibility. Genome-wide association studies have identified numerous genetic loci associated with the development of refractive defects, highlighting the importance of genetic factors in the aetiology of refractive disorders [6, 7]. The ABO blood type system is one of the most extensively researched genetic characteristics in humans and has been linked to numerous systemic and ophthalmic disorders [8]. In early studies, many eye diseases, such as corneal diseases and glaucoma, as well as microvascular anomalies, have been associated with blood type (ABO) [8, 9]. These interactions may be related to how blood type antigens affect the immunological, circulatory, or genetic systems [10]. Numerous researchers have investigated the association between different populations' ABO blood types and refractive errors [11].

According to several studies, people with specific refractive defects are more likely to have certain

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blood types [12]. In addition to other complex and multifaceted problems, the frequency of refractive errors varies across populations due to many factors, including genetic background, population demographics, ocular parameters, and external factors such as literacy [13, 14]. 50 patients were enrolled in a research project at the College of Ophthalmology & Allied Vision Sciences to examine the association between blood type and vision problems. Among them, 32% with blood type O had myopia, while 24% had blood types A and B combined. Hyperopic patients had a distribution of 6% with blood type A and 8% with blood type B. Notably, blood type O showed a slight predominance in myopia. In contrast, other blood types did not show specific associations with refractive errors [11]. However, some studies have found no statistically significant relationship between blood type distribution and refractive condition [15]. Previous findings may have been inconsistent due to changes in study methodology, sample size, geographic variance, and the demographic characteristics of the examined populations. Furthermore, a limited study has been conducted in South Asian communities to investigate any possible association between ABO blood groups and refractive errors [16].

Therefore, the present study aimed to determine whether ABO blood group is associated with different types of refractive errors (myopia, hyperopia, and astigmatism) among patients aged 10-35 years attending an Al-Kubra Health and Eye Clinic in Islamabad, Pakistan.

METHODOLOGY

This clinic-based cross-sectional study was conducted at Al-Kubra Health and Eye Clinic in Islamabad, Pakistan, from September 2023 to December 2023, after obtaining ethical approval from the Institutional Review Board (IRB) (REF letter No. ALKHEC/EC/3525) of Al-Kubra Health and Eye Clinic and written informed consent from all participants. The study comprised 300 participants aged 10 to 35 years who were diagnosed with refractive errors following a comprehensive ocular examination. The sample size was calculated using OpenEpi software version 3.01 with a 95% confidence level, a 6% margin of error, and an expected prevalence of myopia of 32.5% based on existing literature [3]. The minimum sample size was determined to be 235 respondents. Three hundred patients were included in the study to enhance statistical accuracy and ensure balanced evaluation of refractive error groupings.

Participants are included in the study using a purposive sampling technique, ensuring that each refractive error category receives an equal number of patients. Every participant provided written informed consent before they participated in this study. To provide a balanced evaluation of refractive defects, the research design included 100 volunteers with hyperopia, 100 with myopia, and 100 with astigmatism. The study emphasizes variation in ABO blood types across refractive error categories rather than determining population prevalence, as the total number of respondents in each refractive error category was predefined.

Refractive errors were identified following the standard ocular examination. Myopia is described as a spherical equivalent of -0.50 diopters (D) or less, hyperopia as +0.50 diopters (D) or more, and astigmatism as a cylindrical error of 0.75 diopters (D) or more. Participants with mixed refractive errors were excluded from the study. Classification of bilateral refractive errors was based on the spherical equivalent of the poorer eye. Cycloplegic refraction was performed on younger participants, as clinically recommended, to ensure accurate evaluation of refractive status.

Patients aged 10 to 35 years with refractive defects who agreed to participate were eligible. Patients having cataracts, glaucoma, macular degeneration, corneal pathology, or a history of ophthalmic surgery were excluded. The age range of 10-35 years was chosen because refractive defects are most commonly diagnosed during this period, and the impact of age-related refractive changes, such as presbyopia, is very small.

Statistical analysis was carried out using SPSS software (version 2021). Categorical variables were analyzed using frequencies and percentages. Fisher's Exact test was used to assess the association between ABO blood groups and refractive error categories, with a significance level of $p < 0.05$. In addition, logistic regression was performed to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for the association between blood groups and refractive error types.

RESULTS

The study included 300 participants. Table **1** summarizes the demographic characteristics of the study participants. Among the 300 participants, 53.7% were men and 46.3% were women. The most common age range was 21-25 years (31.7%), followed by 26-30 years (24.3%) and 16-20 years (23.3%).

Table 1: Demographic characteristics of study participants (n=300).

Variable	Category	Frequency	Percentage
Gender	Male	161	53.7
	Female	139	46.3
Age group (years)	10-15	11	3.7
	16-20	70	23.3
	21-25	95	31.7
	26-30	73	24.3
	31-35	51	17.0

According to the study, each refractive error group included 100 individuals (33.3%). In the study population, B+ blood was the most frequent (43.7%), followed by O+ (21.0%) and A+ (12.0%), with AB- being the least common (1.7%) (**Table 2**).

Table 2: Overall distribution of ABO blood groups (n=300).

Blood Groups	Frequency	Percentage
A+	36	12.0
A-	19	6.3
B+	131	43.7
B-	14	4.7
O+	63	21.0
O-	13	4.3
AB+	19	6.3
AB-	5	1.7

Out of the 300 patients, 100 were diagnosed with myopia, and their blood groups were examined. Notably, the prevalence of myopia was found to be higher in individuals with blood group B+. Among the myopic patients, 63 had blood group B+, 16 had O+, 9 had A+, 6 had AB+, and only 2 had AB- (**Table 3**). The study found that those with blood types B+ and O+ exhibited a greater percentage of myopia than people with other blood categories.

One hundred of the three hundred patients had hyperopia. It is worth noting that 30 participants with blood group B+ had hyperopia, followed by 17 with blood group O+ and 13 with blood group A+ (**Table 3**). It's important to remember that among the general population, hyperopia is comparatively less common than myopia. Additionally, hyperopia is frequently found in both children and older adults.

Out of the 300 patients, 100 were diagnosed with astigmatism. Similar to other refractive errors, astigmatism was more prevalent in individuals with blood group B+, with 38 cases. Following this, blood group O+ had 30 cases, and A+ had 14 cases (**Table 3**). This suggests a noteworthy association between blood group B+ and astigmatism in our study population.

Logistic regression was used to investigate the relationship between ABO blood groups and refractive errors, with O+ blood group as the reference category. Individuals with B+ blood group had a greater chance of myopia than those with O+ blood group (OR = 2.72, 95% CI: 1.40-5.28) (**Table 4**). Due to a smaller sample size, other blood types did not show statistically significant associations.

Table 4: Logistic regression analysis for association between blood group and myopia (Reference = O+) (n=300).

Blood Group	Odds Ratio (OR)	95% Confidence Interval
A+	0.98	0.38 – 2.51
A−	0.16	0.02 – 1.32
B+	2.72	1.40 – 5.28
B−	0.49	0.09 – 2.42
O−	0.24	0.03 – 2.03
AB+	1.35	0.44 – 4.16
AB−	1.95	0.29 – 12.79
A+	0.98	0.38 – 2.51

DISCUSSION

The current study examined the association between blood group ABO and refractive error classifications in a clinical community. It observed a statistically significant association between blood group distribution and refractive error types, with B+ being the most common blood group overall and exhibiting higher

Table 3: Distribution of ABO blood groups across refractive error types (n=300).

Blood group	Myopia n (%)	Hyperopia n (%)	Astigmatism n (%)	p-value
A+	9 (25.0)	13 (36.1)	14 (38.9)	<0.001
A−	1 (5.3)	11 (57.9)	7 (36.8)	
B+	63 (48.1)	30 (22.9)	38 (29.0)	
B−	2 (14.3)	7 (50.0)	5 (35.7)	
O+	16 (25.4)	17 (27.0)	30 (47.6)	
O−	1 (7.7)	9 (69.2)	3 (23.1)	
AB+	6 (31.6)	11 (57.9)	2 (10.5)	
AB−	2 (40.0)	2 (40.0)	1 (20.0)	

odds of myopia. It is important to take into account that myopia is mostly influenced by environmental factors, while astigmatism and hyperopia are more strongly related to genetic variables. As a consequence, any observed relationship between ABO blood groups and refractive defects should be interpreted with caution, particularly in the context of myopia, where environmental factors may play an essential role [4-6].

Refractive error (RE) is among the most widespread vision issues (problems) in adolescents as well as children [17]. It has been identified as a serious economic [18] and public health issue, and has become an important concern for healthcare policymakers [19]. It is the second most prevalent cause of vision loss after cataracts, according to the WHO and IAPB (the International Agency for the Prevention of Blindness) [20]. Our research findings revealed interesting insights into the distribution of refractive errors across different blood groups. The most prevalent blood group was B+ (43.7%), followed by O+ (21.0%) and A+ (12.0%). Conversely, AB- was the least prevalent blood group observed in our study population. The results of this study are consistent with recent local research, which found that the B+ blood group was the most common among patients with refractive problems, specifically myopia [12]. In Pakistan, B+ and O+ blood groups are reported to be the most prevalent in the general population, which is consistent with the distribution observed in our study [21]. When examining the association between blood groups and specific refractive errors, we found that myopia, hyperopia, and astigmatism exhibited varying prevalence rates across different blood groups. Reduced educational and job possibilities as a result of uncorrected refractive problems (myopia, hyperopia, and astigmatism) affect both the individual and the community. Conservative estimates place the worldwide economic burden of lost productivity at $269 billion annually. Therefore, uncorrected refractive error is a public health issue that impacts humanity; uncorrected astigmatism and hyperopia are linked to worse educational achievement [20].

Notably, blood group B+ emerged as a common denominator across all three types of refractive errors, with a higher prevalence than other blood groups. Similarly, previous observational studies have reported that individuals with blood group B have a higher prevalence of refractive errors than those with other blood groups [22]. A study in Bangalore assessed ABO Blood Group Distribution and Myopia among 142 first-year medical students. B+ (33%) was the most common blood group, followed by O+ (30%). Myopia prevalence was 32.39%, with the B blood group showing a higher prevalence. While the odds ratio indicated a higher risk of myopia in the B blood group, it was not statistically significant. Similarly, the relative risk was higher in Rh-positive individuals, but also not statistically significant [23]. A study at Fatima Jinnah Medical University found a significant link between blood groups and myopia among 289 medical students. Myopia prevalence was highest in blood group O (49%), followed by B (32%), A (20%), and AB (8%). Statistical analysis confirmed the association ($p<0.05$), with blood group O showing the highest relative risk of myopia [24].

However, not all studies support this correlation. A few studies found no statistically significant correlation between ABO blood group and refractive errors, suggesting that the proposed associations may differ by population [22]. Variations in research design, sampling procedures, and population characteristics can account for differences in outcomes across studies [25]. In this study, each refractive error group had the same number of patients, limiting generalizability to a diverse population. As refractive errors vary with age and are influenced by many environmental factors, variations in ethnic background and age grouping may also yield different results. At present, there is insufficient data to support an association between eye diseases and blood group types. A few studies show an association between ABO blood type and certain eye anomalies, such as glaucoma and cataracts. Still, the data remain inconsistent and fail to establish a significant association with a specific blood type [25]. Recently, many studies have examined a significant association between blood type (ABO) and other systemic diseases, but results have varied across studies due to various conditions. From a biological perspective, it remains unclear and largely theoretical how ABO blood groups and refractive errors are associated. A genetic connection between the ABO gene loci and genes related to ocular development has been suggested as a possible factor.

Furthermore, blood group antigens are known to alter vascular and inflammatory pathways, which may affect ocular growth and refractive development; this has not been clearly proven. Another proposed explanation is population stratification, in which fundamental genetic or environmental variables influence both blood group distribution and refractive errors rather than a direct causal connection. There is currently insufficient and conflicting evidence connecting ABO blood types to eye disorders, and no clear causal connection has been found [26].

LIMITATIONS

It is important to note that the findings of this study are associations rather than causal inferences, as the cross-sectional design does not allow for temporal or causal inference. The current study has a few limitations. It is more difficult to assess population prevalence when an equal sample size (100 respondents per refractive error category) is used. The study's a limited generalization may result from its isolated site. The confounding factors (gender and age) were present, but important factors such as proximity to employment, environmental exposure, and family history were not included in the study. Although this study has many limitations, it highlights the importance of new research to identify the relative correlation between refractive error types and ABO blood groups. The future study should focus on large-scale, population-based sampling using multivariate analysis to identify the possible role of ABO blood groups in refractive errors.

CONCLUSION

The study showed a higher percentage of B+ blood group associated with refractive errors and a statistically significant association between ABO blood group and refractive errors. But these results are interpreted cautiously due to the balanced sample design, inadequate adjustment for relevant variables, and the study's cross-sectional methodology. These results indicate a significant association within this clinical population, but they do not claim a population-level association. A further comprehensive, population-based study with multivariable analysis is advised to reevaluate these results and to further elaborate on the possible association between ABO blood group and the development of refractive errors before finalizing the clinical and counseling implications.

ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Committee of Al-Kubra Health and Eye Clinic, Islamabad (REF letter No. ALKHEC/EC/3525, Dated: September 16th, 2023). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Written informed consent was obtained from all participants before data collection. For participants under 18 years of age, consent was obtained from parents or legal guardians.

AVAILABILITY OF DATA

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

NY: Study design, data analysis, and final approval.

MA: Study concept, study design, critical review of initial draft, data collection, data analysis and interpretation, and final approval.

IH: Study design, critical review of initial draft, data collection, and final approval.

HA: Critical review of initial draft, data analysis and interpretation, manuscript drafting and final approval.

JM: Data collection, data analysis and interpretation and final approval.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the author(s) used ChatGPT (GPT-4, OpenAI) sparingly to generate language suggestions and perform minor proofreading in some parts of the manuscript. After using this tool/ service, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the published article.

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