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ORIGINAL ARTICLE

Association of β-Thalassemia and its Types with ABO and Rh Blood Groups in Pakistan

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ABSTRACT

Background: β-Thalassemia is a common inherited blood disorder in Pakistan, with considerable clinical and genetic heterogeneity. Exploring its association with ABO and Rh blood group systems may help uncover patterns that support early identification and management strategies.

Objective: To determine the association between β-thalassemia and its subtypes with ABO and Rh blood group distributions in a cohort of Pakistani patients.

Methodology: This cross-sectional study was conducted at The Children's Hospital Lahore from Feb 2023 to July 2023 and included 85 diagnosed β-thalassemia patients. Demographic details including age and gender, clinical characteristics such as the type of β-thalassemia (major, intermedia, or minor), consanguinity status, and family history of thalassemia were recorded.

Results: Among 85 β-thalassemia patients, blood group B was most common (36.5%), followed by O (30.6%), A (24.7%), and AB (8.2%). Rh-positive status was observed in 91.8% of cases. No statistically significant association was found between ABO or Rh blood groups and thalassemia subtypes ($p > 0.05$). Consanguinity and family history were significantly higher in β-thalassemia major patients ($p < 0.01$).

Conclusion: It is concluded that there is no significant correlation between β-thalassemia subtypes and ABO or Rh blood group systems. However, the predominance of blood group B and Rh-positive status among β-thalassemia patients aligns with trends observed in the general population. Further large-scale studies are recommended to validate these findings.

Keywords: β-Thalassemia, patients, Rh distribution, ABO, Blood group

INTRODUCTION

β-Thalassemia is one of the most common inherited blood disorders worldwide, resulting from mutations in the β-globin gene that lead to deficient or absent production of the β-globin chains of hemoglobin[1]. This causes imbalanced globin chain synthesis, leading to ineffective erythropoiesis, hemolysis, and varying degrees of anemia. β-Thalassemia can be clinically classified into three major types: thalassemia major, thalassemia intermedia, and thalassemia minor[2]. The severity of the disease depends on the nature of the genetic mutations and their effects on β-globin chain production. Globally, β-thalassemia poses a significant health burden, particularly in countries of the Mediterranean basin, the Middle East, India, and Southeast Asia[3]. Pakistan ranks among the countries with the highest prevalence of β-thalassemia, with an estimated carrier rate of 5% to 8% of the population and over 5,000 new cases of β-thalassemia major born annually[4]. A major contributing factor to this high incidence is the practice of consanguineous marriages, which is socially and culturally prevalent in Pakistan[5]. Despite growing awareness, routine premarital screening and genetic counseling programs are still not widely implemented, leading to the sustained transmission of β-thalassemia mutations.

The ABO and Rh blood group systems, though primarily important for transfusion compatibility, have also been investigated in relation to the prevalence and progression of various diseases[6]. Associations between blood groups and susceptibility to infections, cardiovascular diseases, and malignancies have been documented. Similarly, some studies have explored potential links between blood group distribution and hereditary hematologic disorders, including thalassemia[7]. It has been hypothesized that certain blood groups may show differing prevalence patterns in individuals with β-thalassemia, possibly due to genetic linkage disequilibrium or population genetic factors. Previous studies in different countries have reported varying patterns in the distribution of ABO blood groups among thalassemia patients[8,9]. Some studies have found blood group B or O to be more frequent among thalassemia patients, while others have shown no significant difference compared to the general population. Similarly, Rh-positive status tends to predominate among thalassemia patients, although again without strong evidence of a direct association with disease type or severity[10]. The findings across different studies are somewhat inconsistent, suggesting that population genetics, sample size, and regional differences may influence the observed distributions. Understanding the blood group patterns in thalassemia patients may have practical implications, particularly for planning blood transfusion programs, setting up donor registries, and designing early screening strategies. Since β-thalassemia major patients often require lifelong regular transfusions, having knowledge of prevalent blood groups in these populations can assist healthcare systems in anticipating transfusion needs and optimizing resource allocation[11]. Despite the clinical relevance, there is limited data from Pakistan examining the association between β-thalassemia types and ABO/Rh blood groups. Most available studies focus on the general epidemiology of thalassemia without exploring potential correlations with blood group distribution[12]. Given the high burden of thalassemia in the Pakistani population and the socio-cultural factors promoting its persistence, there is a pressing need to study such associations in local settings.

Objective: To determine the association between β-thalassemia and its subtypes with ABO and Rh blood group distributions in a cohort of Pakistani patients.

METHODOLOGY

This cross-sectional study was conducted at The Children's Hospital Lahore from Feb 2023 to July 2023 and included 85 diagnosed β-thalassemia patients.

Inclusion Criteria:

- Patients aged 1 to 18 years.
- Confirmed diagnosis of β-thalassemia major, intermedia, or minor.
- Available records of ABO and Rh blood grouping.

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Exclusion Criteria:

- Patients with other hematological disorders such as sickle cell disease or hereditary spherocytosis.
- Incomplete medical records.

Data Collection: After obtaining ethical approval and informed consent, data were collected retrospectively from the hospital records of patients diagnosed with β-thalassemia. Demographic details including age and gender, clinical characteristics such as the type of β-thalassemia (major, intermedia, or minor), consanguinity status, and family history of thalassemia were recorded. ABO and Rh blood groups were retrieved from laboratory reports; in cases where blood group information was missing, standard tube agglutination method was performed for confirmation. Patients were classified based on their thalassemia subtype and blood group characteristics to assess the potential association between blood group distribution and types of β-thalassemia.

Statistical Analysis: Data were analyzed using SPSS v17. Continuous variables such as age were summarized as means with standard deviations, while categorical variables such as gender, blood group type (A, B, AB, O), Rh status (positive or negative), consanguinity, and family history were presented as frequencies and percentages. The association between ABO and Rh blood groups with different types of β-thalassemia was evaluated using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The mean age of the patients was 8.9 ± 4.1 years, with 48 males (56.5%) and 37 females (43.5%). Among β-thalassemia major cases (n=50), the mean age was 8.6 ± 3.9 years, and among minor/intermedia cases (n=35), it was 9.4 ± 4.4 years (p = 0.44). Consanguinity was present in 61 patients (71.8%), significantly higher in major cases (42 out of 50, 84%) compared to minor/intermedia cases (19 out of 35, 54.3%, p = 0.002). Similarly, a family history of thalassemia was noted in 57 patients (67.1%), significantly more common in major cases (40/50, 80%) than minor/intermedia (17/35, 48.6%, p = 0.001).

Table 1: Demographic Characteristics of Patients

Characteristic	Total (n=85)	β-Thalassemia Major (n=50)	β-Thalassemia Minor/Intermedia (n=35)
Age (years, Mean ± SD)	8.9 ± 4.1	8.6 ± 3.9	9.4 ± 4.4
Gender			
Male	48 (56.5%)	29	19
Female	37 (43.5%)	21	16
Consanguinity			
Yes	61 (71.8%)	42	19
N	24 (28.2%)	8	16
Family History of Thalassemia			
Yes	57 (67.1%)	40	17
No	28 (32.9%)	10	18

Table 2: ABO Blood Group Distribution

Blood Group	Total (n=85)	β-Thalassemia Major (n=50)	β-Thalassemia Minor/Intermedia (n=35)
A	21 (24.7%)	13 (26%)	8 (22.9%)
B	31 (36.5%)	20 (40%)	11 (31.4%)
AB	7 (8.2%)	4 (8%)	3 (8.6%)
O	26 (30.6%)	13 (26%)	13 (37.1%)

Blood group B was the most common, found in 31 out of 85 patients (36.5%), followed by blood group O in 26 patients (30.6%), A in 21 patients (24.7%), and AB in 7 patients (8.2%). Among β-thalassemia major patients, 20 had blood group B (40%), 13 had A (26%), 13 had O (26%), and 4 had AB (8%). In the minor/intermedia group, 11 had B (31.4%), 13 had O (37.1%), 8 had A (22.9%), and 3 had AB (8.6%). No statistically significant difference in ABO blood group distribution was observed among the thalassemia subtypes (all p-values > 0.05).

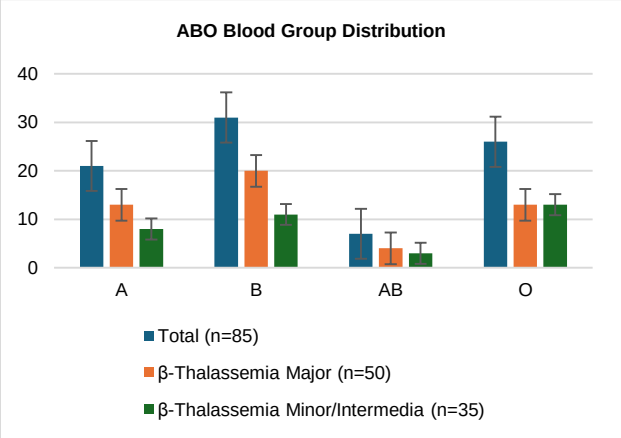

Figure 1: ABO Bloof group distribution

Out of 85 patients, 78 (91.8%) were Rh-positive and 7 (8.2%) were Rh-negative. Among β-thalassemia major patients, 46 were Rh-positive (92%) and 4 were Rh-negative (8%); in minor/intermedia patients, 32 were Rh-positive (91.4%) and 3 were Rh-negative (8.6%). The association between Rh status and thalassemia type was not statistically significant (p = 0.92).

Table 3: Rh Blood Group Distribution

Rh Status	Total (n=85)	β-Thalassemia Major (n=50)	β-Thalassemia Minor/Intermedia (n=35)
Rh Positive	78 (91.8%)	46 (92%)	32 (91.4%)
Rh Negative	7 (8.2%)	4 (8%)	3 (8.6%)

The most frequent ABO-Rh combinations were B+ (28 patients, 32.9%), O+ (23 patients, 27.1%), A+ (20 patients, 23.5%), and AB+ (7 patients, 8.2%). Among Rh-negative patients, there were 1 A-, 3 B-, and 3 O- cases. No AB- cases were found.

Table 4: ABO-Rh Combination Patterns

ABO-Rh Group	Total (n=85)
A+	20
B+	28
AB+	7
O+	23
A-	1
B-	3
AB-	0

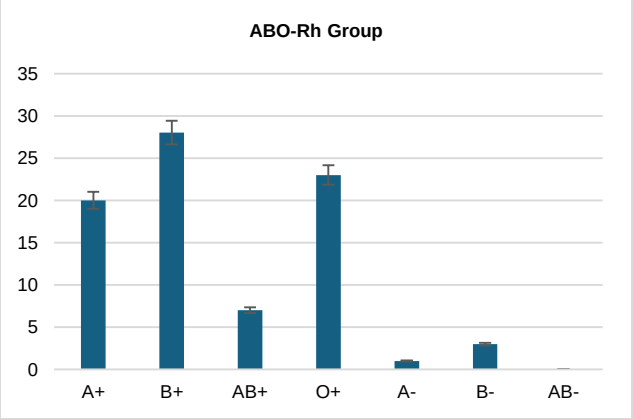

Figure 2: ABO-Rh Combination Patterns

(91.2%) were Rh-positive and 5 (8.8%) were Rh-negative. Among those without a family history (n=28), 26 (92.9%) were Rh-positive and 2 (7.1%) were Rh-negative. No statistically significant association was found between family history status and Rh positivity (p = 0.83).

Table 5: Rh Status vs Family History

Rh Status	Family History Present (n=57)	Family History Absent (n=28)	p-value
Rh Positive	52 (91.2%)	26 (92.9%)	0.83
Rh Negative	5 (8.8%)	2 (7.1%)	0.83

DISCUSSION

This study aimed to evaluate the association between ABO and Rh blood groups and the different types of β-thalassemia among patients in Pakistan. While β-thalassemia major was the most frequently observed subtype, no significant association was found between blood group types (A, B, AB, or O) or Rh status and thalassemia subtype. However, demographic and genetic factors such as consanguinity and family history showed a strong and statistically significant relationship with thalassemia major, highlighting the role of inherited genetic transmission in the disease's expression. In our sample of 85 patients, blood group B was the most prevalent (36.5%), followed by O (30.6%), A (24.7%), and AB (8.2%). These findings are consistent with general blood group distributions reported in various Pakistani population studies, where blood groups B and O tend to be more common[13]. Among β-thalassemia major patients, group B was most represented (40%), but this distribution did not reach statistical significance (p > 0.05), indicating that blood group is not predictive of thalassemia type. Previous regional studies have shown similar trends: although some variations in blood group distribution have been noted among thalassemia patients, most failed to establish a statistically significant correlation[14]. This reinforces the understanding that ABO blood group alleles and β-globin mutations are inherited independently and likely show population-level overlap rather than direct disease linkage. Rh status, too, was heavily skewed toward Rh-positive (91.8% overall), reflecting the natural distribution in the Pakistani population where Rh-negative individuals are relatively rare. Again, there was no statistically significant associationbetween Rh status and thalassemia subtype (p = 0.92). This finding is consistent with previous studies conducted in South Asian and Middle Eastern populations, which reported similar Rh distribution among thalassemia patients without significant subgroup variation [15][16]. Thus, while Rh status is of major clinical importance in transfusion planning for thalassemia patients, it does not appear to influence the likelihood or severity of β-thalassemia types.

On the other hand, consanguinity (71.8%) and family history of thalassemia (67.1%) were significantly more common among β-thalassemia major patients (p = 0.002 and p = 0.001, respectively). This strongly supports existing evidence from both national and international literature, which highlights consanguineous marriages as a critical factor in the inheritance of severe thalassemia phenotypes. In countries like Pakistan, where cousin marriages are culturally accepted, the presence of undetected carrier status in both parents markedly increases the probability of having children affected by thalassemia major. These findings reaffirm the urgent need for premarital screening and public health education to reduce the incidence of the disease through informed reproductive decisions. Additionally, analysis of ABO-Rh combinations revealed B+ (32.9%) and O+ (27.1%) as the most common blood groups in thalassemia patients, again paralleling national transfusion data. These findings are particularly relevant from a blood banking perspective, as patients with β-thalassemia major often require lifelong regular transfusions[17,18]. Knowing the most common blood group types among these patients can aid blood banks in inventory management, targeted donor recruitment, and minimizing the risk of transfusion delays. The lack of association between blood group types and β-thalassemia in this study suggests that ABO and Rh blood types do not serve as predictive markers for differentiating thalassemia subtypes. However, this does not diminish their practical clinical significance in transfusion medicine. Instead, the focus should remain on carrier screening, family counseling, and early diagnosis through newborn screening and hemoglobin electrophoresis in high-risk populations. It is worth noting that while our sample size of 85 patients offers meaningful insight, larger multicenter studies with more diverse ethnic representation and genetic analysis may provide greater power to detect subtle associations, if any exist. Furthermore, including a healthy control group in future studies would help assess whether the distribution of ABO and Rh blood groups in thalassemia patients significantly deviates from that of the general population.

CONCLUSION

This study found no statistically significant association between β-thalassemia subtypes and ABO or Rh blood groups among Pakistani patients. Blood group B was the most prevalent among patients, followed by groups O, A, and AB, mirroring patterns seen in the general population. Rh-positive status was highly dominant (91.8%) across all thalassemia types. While consanguinity and family history were significantly associated with the occurrence of β-thalassemia major, blood group distribution showed no influence on the clinical severity or type of thalassemia. These findings suggest that although ABO and Rh blood groups are important for transfusion management, they do not appear to have a predictive relationship with thalassemia subtype.

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