African Journal of Advanced Pure and Applied Sciences (AJAPAS)
Online ISSN: 2957-644X
Volume 5, Issue 3, 2026
Page No: 238-247
Website: https://aaasjournals.com/index.php/ajapas/index
ISI 2025: 1.126 SJIFactor 2024: 6.752 معامل التأثير العربي: 1.62

Association Between ABO Blood Groups and Diabetes Duration: A Large Cross-Sectional Study from Al-Marj City, Eastern Libya

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العلاقة بين فصائل الدم *ABO* ومدة الإصابة بداء السكري: دراسة مقطعية واسعة النطاق من مدينة المرج، شرق ليبيا

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Received: May 15, 2026	Accepted: August 02, 2026	Published: August 12, 2026

Abstract
The correlation of ABO and Rhesus (Rh) blood group with diabetes mellitus is still debated. A cross-sectional study was carried out at the Al-Marj Specialized Hospital for Diabetes and Endocrinology in eastern Libya In the period from September 2025 to January 2026..A consecutive sampling method was employed to recruit a total of 4,361 diabetic individuals (2,030 males and 2,331 females). The duration of diabetes, ABO blood group and Rh factor were collected from medical records. Statistical analyses One-way ANOVA with Tukey's HSD was used to analyze the data, as well as independent t-test (SPSS v20.0, $p<0.05$). The frequency distribution of ABO blood type was: type A (45.2%), followed by type O (31.2%), type B (16.9%) and type AB (6.6%). RhPositive patients accounted for 89.7%. The average length of diabetes was 11.80±9.42 years. Significant differences were observed among ABO groups ($F=10.262$, $p<0.001$) and ABO/Rh phenotypes ($F=5.358$, $p<0.001$). Diabetes duration was significantly shorter in patients with blood group A (11.05±9.13 years) than in patients with blood group B (12.86±9.57 years) and blood group O (12.76±9.92 years) ($p<0.001$). The longest duration was observed in AB^- (15. 25±10.24 years). There was no significant sex difference ($p=0.401$). This is the first large-scale report in eastern Libya revealing a strong correlation between ABO blood groups and diabetes duration, This study represents the first large-scale investigation in eastern Libya to demonstrate a significant association between ABO blood groups and diabetes duration, with blood group A showing the shortest duration and AB^- the longest. In contrast, Rh factor alone and sex were not identified as significant predictors for diabetes duration.

Keywords: ABO blood groups; Rhesus factor; diabetes mellitus; Libya; cross-sectional study.

الملخص:
لا يزال الجدل قائمًا حول العلاقة بين فصيلة الدم ABO وعامل ريسوس (Rh) وداء السكري. أُجريت دراسة مقطعية في مستشفى المرج التخصصي للسكري والغدد الصماء في شرق ليبيا في الفترة الممتدة من سبتمبر 2025 إلى يناير 2026. استُخدمت طريقة المعاينة المتتالية لاختيار 4361 مريضًا بالسكري (2030 ذكرًا و2331 أنثى). جُمعت بيانات مدة الإصابة بالسكري، وفصيلة الدم ABO، وعامل ريسوس من السجلات الطبية. استُخدم تحليل التباين الأحادي (ANOVA) مع اختبار توكي HSD لتحليل البيانات، بالإضافة إلى اختبار t المستقل (برنامج SPSS الإصدار 20.0، $p<0.05$). كان التوزيع التكراري لفصائل الدم ABO كما يلي: الفصيلة A (45.2%)، تليها الفصيلة O (31.2%)، ثم الفصيلة B (16.9%)، وأخيرًا الفصيلة AB (6.6%). وشكّل المرضى ذوو العامل الريزوسي الموجب 89.7% من إجمالي المرضى. بلغ متوسط مدة الإصابة بداء السكري 11.80 ± 9.42 سنة. لوحظت فروق دالة إحصائيًا بين مجموعات فصائل الدم ABO ($F=10.262$، $p<0.001$) وبين أنماط ABO/Rh ($F=5.358$، $p<0.001$). كانت مدة الإصابة بداء السكري أقصر بشكل ملحوظ لدى المرضى ذوي فصيلة الدم A (11.05 ± 9.13 سنة) مقارنةً بالمرضى ذوي فصيلة الدم B (12.86 ± 9.57

سنة) وفصيلة الدم O (12.76 ± 9.92 سنة) (p<0.001). لوحظت أطول مدة إصابة بالسكري لدى فصيلة الدم AB⁻ (15.25 ± 10.24 سنة). لم يُلاحظ فرقٌ ذو دلالة إحصائية بين الجنسين (p=0.401). يُعد هذا التقرير الأول من نوعه واسع النطاق في شرق ليبيا الذي يكشف عن وجود ارتباط قوي بين فصائل الدم ABO ومدة الإصابة بالسكري، حيث أظهرت فصيلة الدم A أقصر مدة، بينما أظهرت فصيلة الدم AB⁻ أطول مدة. في المقابل، لم يُعتبر عامل Rh وحده أو الجنس من العوامل المؤثرة بشكلٍ كبير على مدة الإصابة بداء السكري.

الكلمات المفتاحية: فصائل الدم ABO, عامل ريسوس, داء السكري, ليبيا, دراسة مقطعية.

Introduction

Diabetes mellitus is a common chronic disease all over the world and is increasingly becoming a burden to the healthcare system and the economy, more so in the developing countries. Diabetes mellitus is a chronic metabolic disease characterized by hyperglycemia due to absolute or relative deficiencies of insulin secretion and/or its action [1]. The disease is divided into three main forms: type 1 (insulin-dependent diabetes), caused by autoimmune destruction of pancreatic beta cells; type 2 (non-insulin-dependent diabetes), characterized by insulin resistance and impaired insulin secretion; and gestational diabetes, which develops during pregnancy and regresses after parturition [2], [3]. The International Diabetes Federation (IDF) estimates that there were about 537 million people with diabetes globally in the year 2021 and that this number will increase to 783 million by 2045 [4]. A few local studies have reported an increasing prevalence in Libya, with one from the Aljabal Alakhdar region revealing a marked rise in the proportion of sufferers, predominantly males [5].

For one thing, blood types are rigid properties of an individual's genes that they inherit from their ancestors based on Mendelian genetic principles, and are nearly universally categorized within the ABO system and the Rh factor. The Austrian scientist Karl Landsteiner who classified blood into four major types, A, B, AB and O on the basis of certain antigenic substances on the surface of red blood cells had identified the ABO system in 1901 [6]. Identified in 1937 with Alexander Wiener, the Rhesus factor refers to the existence of a protein (D antigen) on the surface of a cell, and people are divided into Rhesus positive (Rh+) if the protein is present and Rhesus negative (Rh-) if it is not [7]. And since blood groups are essential for the performance of blood transfusion and organ transplantation, they have also been linked to associations with various clinical outcomes. It has been reported that subjects with blood group A are at a higher risk for gastric cancer, whereas in peptic ulcer disease, an association between group O and gastric and duodenal ulcers has been reported [8,9]. There have also been a few studies that have suggested a correlation between blood groups and the Rhesus factor and certain chronic ailments including the risk of hypertension and cardiovascular diseases [10].

Although there are many world reports on the association of blood groups with diabetes mellitus, the findings were not consistent and conclusive. In a study in Iraq at Azadi Teaching Hospital among 400 type 2 diabetic patients, blood group O was significantly positively correlated with risk of diabetes and a negative correlation was observed with group A, but there was no association with the Rhesus factor [11]. In Kenya, a research carried out at Kandara Sub-County Hospital, Murang'a County revealed no definite association between the ABO blood groups and blood glucose levels, with AB+ being the blood group with the highest glucose levels [12]. In Libya, there was no statistically significant link between blood group and type 1 or type 2 diabetes (P = 0.258) among 893 patients who underwent a study at Misurata Specialized Center for Diabetes and Endocrine Regulation and Treatment [13]. Conversely, a diabetic male sample study in the region of Aljabal Alakhdar failed to reveal any associations, and it was reported that O^+ is the most common blood group among type 1 diabetes patients, and B^- is the most active among type 2 diabetes patients, which may indicate a potential involvement of the Rhesus factor in the determination of diabetes type with the ABO blood groups [5].

The differences in the results could be explained by a number of reasons, such as the geographic, racial and environmental differences between the populations as well as the differences in the sample size and design of the studies [14]. Moreover, the genetic expression of the disease is affected by several factors such as gene-environment interactions, and therefore, investigations on associations between genetic markers, for instance, blood groups and chronic diseases are complicated and much more research is needed [15].

The problem of the study begins with the obvious contradiction and conflict in the earlier results about the association of blood groups with diabetic mellitus and lack of enough study in Libyan that depend on the big samples size and accurate statistical analysis. In addition, many of the earlier Libyan studies were either confined to small geographic areas (Misurata, Aljabal Alakhdar) or did not perform further analysis of the differences between blood types utilizing a post-hoc test (Tukey HSD) which prevents the generalization of their results or the application in medical practice.

On the basis of these, the current research was conducted with four goals in mind: (1) to identify the prevalence of ABO and Rhesus (Rh) blood groups in patients who have either type 1 or type 2 diabetes mellitus at Al Marj Specialized Hospital, (2) to investigate whether the mean duration of diabetes differs statistically significantly between the blood groups, (3) to investigate the association between the blood groups and a number of demographic variables including sex, and (4) to discuss the results in comparisons with previous studies in the country and abroad and to suggest future research. This study was aimed to find out association Between ABO

Blood Groups and Diabetes Duration at Al-Marj City, Eastern Libya.

Material and methods

1. Study Design

A descriptive cross-sectional study was conducted to determine the association between ABO blood groups, Rhesus (Rh) factor, and diabetes mellitus at the Al-Marj Specialized Hospital for Diabetes and Endocrinology in eastern Libya. A consecutive sampling method was used, whereby all eligible diabetic patients who attended the hospital during the data collection period were approached to participate until the required sample size was reached. This approach ensured a representative sample of the diabetic population in the area and minimized selection bias. No control group was included because the primary objective was to describe the distribution of blood groups and disease duration within the patient population, not to compare with healthy individuals; however, this limitation should be addressed in future studies.

2. Study Area

The study was conducted at the **Al-Marj Specialized Hospital for Diabetes and Endocrinology**, located in Al-Marj city, eastern Libya. This hospital is the main referral center for diabetic patients in the district of Al-Marj and neighboring areas, offering a full spectrum of diabetes services, including diagnosis, treatment, and regular follow-up. Al-Marj has a Mediterranean climate and a diverse population, making it suitable for studying blood group distribution and chronic diseases.

3. Study Population

Total sample size: 4,361 diabetic patients (both type 1 and type 2).
Data collection period: September 2025 to January 2026 (five months).
Sex distribution: 2,030 males (46.5%) and 2,331 females (53.5%), reflecting the gender ratio of patients attending the facility.

Inclusion criteria:

- Patients with type 1 or type 2 diabetes mellitus confirmed by a specialist physician based on standard diagnostic criteria (fasting plasma glucose ≥ 126 mg/dL or HbA1c ≥ 6.5%).
- Both sexes, all ages.
- Subjects who provided written informed consent to participate.
- Eligible patients had full medical records, including blood group typing and clinical information.
- Libyan citizens residing in Al-Marj district or nearby areas.

Exclusion criteria:

- Gestational diabetes alone (no pre-existing or post-partum follow-up data).
- Incomplete **Electronic Health Records (EHRs)** or those that did not include blood group details.
- Subjects who declined to participate in the research.
- Subjects with potential interference in blood group determination (e.g., blood transfusion within the last three months).
- Patients with hematological disorders affecting red blood cell antigens.

4. Data Collection

Patients' records and personal files were retrieved from the statistics and documentation bureau at Al-Marj Specialized Hospital for Diabetes and Endocrinology. **Data were collected over a five-month period from September 2025 to January 2026.** A standardized data extraction form was developed to collect the following details for each patient:

Laboratory data: ABO blood group (A, B, AB, or O), Rhesus (Rh) factor (positive or negative).
Blood grouping had been performed previously for all patients, either at the time of initial diagnosis or during routine follow-up, using conventional serological methods. ABO blood group was determined by the slide agglutination test with anti-A, anti-B, and anti-D monoclonal reagents at room temperature, following the manufacturer's instructions [11,12]. The Rh factor was determined by the presence or absence of the D antigen. **To comply with Good Manufacturing Practice (GMP) guidelines**, all tests were conducted by qualified staff in an accredited laboratory, and fresh control blood samples from the blood bank were used to ensure the accuracy and reliability of the findings.

5. Ethical Considerations

Written informed consent was obtained from all participants or from their legal guardians before inclusion in the study. This study was conducted in accordance with the principles of the Declaration of Helsinki.

6. Statistical Analysis

Data were entered into a Microsoft Excel sheet and then exported to IBM SPSS (Statistical Package for the Social Sciences) for Windows version 20.0 (IBM Corp., Armonk, NY, USA) for statistical analysis. Data were cleaned and checked for errors prior to analysis.

Descriptive statistics:

Categorical variables (gender, blood group, Rh factor, type of diabetes) were expressed as frequencies and percentages. Normally distributed continuous variables were described as means and standard deviations; non-normally distributed continuous variables as medians and ranges.

Inferential statistics:

Comparison of diabetes duration among different blood groups:

The mean duration of diabetes among different blood groups (ABO alone and ABO with Rh factor combined) was compared using one-way analysis of variance (ANOVA). The assumptions of normality and homogeneity of variances were examined. When a significant difference among groups was determined by ANOVA ($p < 0.05$), post-hoc analysis with Tukey's Honestly Significant Difference (HSD) test was applied to detect significantly different pairs of blood groups. Tukey's HSD test corrects for type I error (false positive results) while maintaining reasonable power for multiple pairwise comparisons [16].

- **Comparison between genders:**

  An independent samples t-test was used to compare diabetes duration between males and females. Hartley's test (F-test for homogeneity of variances) was performed before the t-test. When variances were equal ($p > 0.05$), the standard t-test was reported; otherwise, Welch's t-test was used.

Results and discussion

1. Basic Information of the Study Population Characteristics

The study included 4,361 patients with diabetes. The baseline characteristics of the study subjects are shown in Table 1. Of the participants, 2,030 (46.5%) were male and 2,331 (53.5%) females, with a male-to-female ratio of approximately 1:1.15.

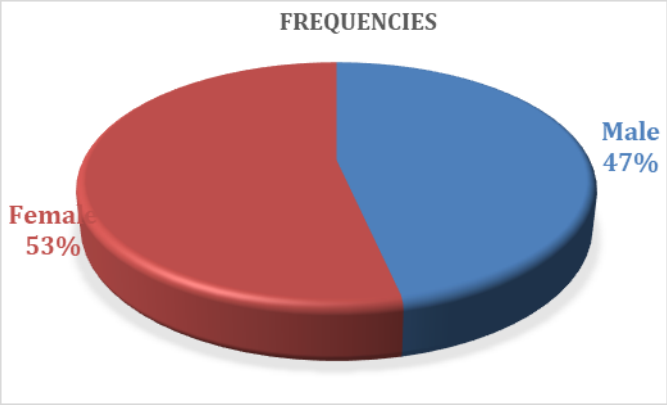

Fig 1: Diabetic Patients' Gender Distribution

2. Distribution of ABO Blood Groups Regardless of Rh Factor

Distribution of ABO Blood Groups with Rh Factor

As shown in Table 1, the most common ABO blood group among diabetic patients was A (45.2%), followed by O (31.2%), B (16.9%), and AB (6.6%).

Table 1: presents the distribution of ABO blood groups regardless of the Rh factor.

Blood Group	Frequency	Percent
A	1,973	45.2
B	739	16.9
AB	288	6.6
O	1,361	31.2
Total	**4,361**	**100.0**

- **Distribution of ABO Blood Groups with Rh Factor**

Table 2 presents the distribution of the eight combined ABO/Rh phenotypes. The most frequent phenotype was A^+ (41.7%), followed by O^+ (27.3%), B^+ (15.3%), and AB^+ (5.3%). The Rh-negative phenotypes were rare: O^- (3.9%), A^- (3.5%), B^- (1.7%), and AB^- (1.3%).

Table 2: Frequency of ABO blood groups with Rhesus factor in diabetic patients

Blood Group	Frequency	Percent
A^+	1,820	41.7
A^-	153	3.5
AB^+	233	5.3
AB^-	55	1.3
B+	666	15.3
B^-	73	1.7
O^+	1,191	27.3
O^-	170	3.9
Total	**4,361**	**100.0**

3. Diabetes duration by blood group

- **Duration of Diabetes by ABO Blood Group Without Rhesus Factor**: Considering the ABO blood groups alone, as outlined in Table 3, the B blood group showed the maximum average duration (12.86 ± 9.57 years) followed by the O (12.76 ± 9.92 years), AB (11.65 ± 9.17 years), and then the A blood group (11.05 ± 9.13 years).

Table 3: Duration (Mean) of Diabetes by ABO Blood Group (w/o Rh)

	N	Percent	Mean	Minimum	Maximum
A	1973	45.2	11.0456	1.00	49.00
B	739	16.9	12.8646	1.00	46.00
AB	288	6.6	11.6455	1.00	53.00
O	1361	31.2	12.7641	1.00	56.00
Total	4361	100.0	11.8037	1.00	56.00

- **Duration of Diabetes by Blood Group with Rhesus Factor:** The mean duration of diabetes for the study group as a whole was 11.80 ± 9.42 (mean ± standard deviation) years with a minimum of 1 year and a maximum of 56 years. Table 4 shows the mean duration of diabetes stratified by blood group phenotype.

Table 4: Mean Duration of Diabetes by Blood Group with Rhesus Factor

	N	**Percent**	**Mean**	**Minimum**	**Maximum**
A+	1820	41.7	10.9659	1.00	49.00
A-	153	3.5	11.9935	1.00	46.00
AB+	233	5.3	12.3004	1.00	46.00
AB-	55	1.3	15.2545	2.00	46.00
B+	666	15.3	11.5631	1.00	53.00
B-	73	1.7	12.3973	1.00	46.00
O+	1191	27.3	12.7305	1.00	56.00
O-	170	3.9	13.0000	1.00	48.00
Total	4361	100.0	11.8037	1.00	56.00

- One-way ANOVA showed a significant difference in mean diabetes duration among the eight phenotypes ($F = 5.358$, $p < 0.001$). Tukey's HSD post-hoc test confirmed that the significant differences were mainly driven by the ABO groups rather than the Rh factor itself, with A^+ patients having shorter duration than AB^- and O^+ ($p < 0.05$).

Table 5: ANOVA for Diabetes Duration across Blood Groups with Rhesus Factor

Source of Variation	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig. (p-value)**
Between Groups	3,325.878	7	475.125	5.358	< 0.001
Within Groups	386,040.102	4,353	88.684		
Total	**389,365.980**	**4,360**			

Post-hoc analysis with Tukey's HSD test showed that the mean duration of diabetes was significantly lower in A^+ patients compared to both AB^- and O^+ patients ($p < 0.05$ in both cases). None of the other pairwise comparisons achieved statistical significance.

- **Comparison of ABO Blood Groups (Rhesus Factor not considered):** One-way ANOVA revealed a significant difference in mean diabetes duration among the four ABO blood groups ($F = 10.262$, $p < 0.001$). Post-hoc analysis (Tukey's HSD) showed that patients with blood group A had significantly shorter diabetes duration than those with group B ($p < 0.001$) and group O ($p < 0.001$). No other pairwise comparisons reached statistical significance.

Table 6: ANOVA for diabetes duration across ABO groups (Rh factor not included)

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. (p-value)
Between Groups	2,731.964	3	910.655	10.262	< 0.001
Within Groups	386,634.016	4,357	88.739		
Total	**389,365.980**	**4,360**			

Post-hoc analysis with Tukey's HSD test confirmed that group A had a significantly lower mean diabetes duration than groups B and O ($p < 0.001$ for both comparisons). No statistically significant differences were found between A and AB, B and O, or AB and B/O ($p > 0.05$).

5. Comparison of Diabetes Duration by Gender

An independent samples t-test was performed to compare diabetes duration between males and females. Hartley's test for equality of variances indicated that variances were equal ($F = 1.010$, $p = 0.4085$), so the t-test for equal variances was used.

Table 7: Diabetes duration by gender – independent samples t-test

Gender	N	Mean (years)	Std. Deviation	Mean Difference	t	df	p-value
Male	2,030	11.92	9.48	0.241	0.840	4,359	0.401
Female	2,331	11.68	9.36				

The t-test showed no statistically significant difference in mean diabetes duration between males (11.92 ± 9.48 years) and females (11.68 ± 9.36 years), $t = 0.840$, $p = 0.401$.

Discussion It is vital to distinguish between 'diabetes duration' in hospitalized patients and 'diabetes risk' in the general population; this study addresses the former.

This study is the largest conducted to date among Libyan diabetic patients (n = 4,361), identified a significant association between ABO blood groups and the duration of diabetes at Al Marj Specialized Hospital for Diabetes and Endocrinology in eastern Libya.The major findings showed that blood group A^+ was the most dominant phenotype (41.7%), while the longest mean diabetes duration was observed in group AB^- (15.25 years). Statistical analysis revealed significantly shorter diabetes duration in group A compared to groups B and O ($p < 0.001$), with no significant sex difference ($p = 0.401$).

Our distribution of ABO blood groups (A: 45.2%, O: 31.2%, AB: 16.9%, B: 6.6%) differs markedly from previous Libyan reports. Abu Shaala and Asweb [13] in Misurata found group O as the most common (38.8%) with no significant association ($p = 0.258$). Qurtam [5] in Aljabal Alakhdar (males only) reported O^+ as the highest (47%), followed by A^+ (36%), and noted that B^- was most interactive in type 2 diabetes, suggesting a possible role of the Rh factor. Ameigaal and Ageel [17] in Bani Waleed (general population) also found group O as the highest (41.2%). More recently, Abubakeer et al. [18] in Zintan reported O blood group as the most common (49%) with no significant correlation. The lack of a healthy control group in our study prevents us from concluding whether the observed distribution reflects true susceptibility or simply the background population frequency in Al-Marj, highlighting the need for future case-control studies.

A review of previous studies in Libya demonstrates inconsistent results. Qurtam [5] studied 16,290 males in Aljabal Alakhdar and found O^+ to be the predominant phenotype, hypothesizing that B^- is the most reactive in type 2 diabetes, implicating the Rh factor. According to Abu Shaala and Asweb [13] in Misurata (893 patients), there was no significant correlation between ABO blood groups and diabetes ($p = 0.258$), with blood group O being the most predominant (38.8%). Likewise, Abubakeer et al. [18] in Zintan (99 patients) reported no association between blood group and diabetes, again finding group O the most common (49%). Contrary to this, the present study, which comprised 4,361 patients, revealed a statistically significant relationship ($p < 0.001$) with group A being the most prevalent (45.2%), A^+ the shortest diabetes duration, and AB^- the longest duration. These differences emphasize the diversity of the Libyan population.

Our finding that blood group A is associated with shorter diabetes duration is consistent with the study of Mizouri [11] in Iraq, who found significantly lower group A among diabetics ($p < 0.05$), and with Kamil et al. [19] in Malaysia, who suggested a protective role for group A. Conversely, the longer duration in groups B and O aligns

with Aggarwal et al. [20] in India, who reported a positive correlation between group O and type 2 diabetes ($p < 0.005$), and with Qureshi and Bhatti [21] in Pakistan, who observed a predominance of group B (34.4%). A meta-analysis by Getawa et al. [14] (26 studies, 6,870 patients) found that group B increased the risk of type 2 diabetes (OR 1.30, 95% CI: 1.03–1.64), while group O decreased it (OR 0.92, 95% CI: 0.86–0.98). Another meta-analysis [22] reported that group AB carried the highest risk (RR 1.25, 95% CI: 1.01–1.55), partially supporting our observation that AB^- had the longest duration.

However, our results diverge from some studies. The large French E3N cohort (82,104 women) [23] found that groups A and B were associated with an increased risk of type 2 diabetes compared to group O, with no role for the Rh factor. Similarly, Dali et al. [24] in Algeria (300 diabetic subjects) found no correlation between ABO/Rh groups and type 2 diabetes. These discrepancies likely stem from differences in geography, ethnicity, sample size, study design, non-standardised diabetes classification, and inadequate control for confounders such as age, obesity, family history, and lifestyle [14,15].

The longest mean diabetes duration in AB^- (15.25 years), despite representing only 1.3% (n=55) of the sample, is notable. Qurtam [5] also reported that B^- was highly interactive with type 2 diabetes, proposing that the Rh factor may modulate ABO-related diabetes risk. Afkhami-Ardekani et al. [25] in Iran found AB^- to be the rarest phenotype among diabetics, consistent with its low frequency in our study. Lithovius et al. [26] in the Finnish Diabetic Nephropathy Study reported that non-O groups were associated with increased cardiovascular complications, suggesting that the combination of ABO and Rh factors may influence disease progression.

The longer duration in AB^- might be explained by several mechanisms. First, the rarity of this phenotype may reflect genetic factors affecting diabetes susceptibility and progression. Second, individuals with blood group AB possess both A and B antigens on the surface of red blood cells and lack naturally occurring anti-A and anti-B antibodies [32]; this unique antigenic profile could influence immune-inflammatory pathways. Third, uncommon blood groups may receive different medical attention. However, due to the small sample size (n=55), these findings require validation in larger, multi-centre studies.

We found no significant association between Rh factor alone and diabetes duration, in agreement with most previous reports (e.g., Fagherazzi et al. [23]; Aggarwal et al. [20]). Although the ANOVA across eight phenotypes was significant ($F = 5.358$, $p < 0.001$), post-hoc analysis indicated that the effect was driven by ABO groups, not by Rh status. Nonetheless, the interaction between ABO and Rh may be relevant, as suggested by our AB^- finding and by Qurtam [5]. Gloria-Bottini et al. [27] hypothesised that Rh proteins could influence glucose transport or HbA1c glycation, a hypothesis that needs molecular exploration.

Regarding sex, we found no significant difference in diabetes duration between males and females ($p = 0.401$), consistent with Mizouri [11], Abu Shaala and Asweb [13], and Abubakeer et al. [18]. The slightly higher proportion of females in our sample (53.5%) may reflect health-seeking behaviour rather than a true demographic difference.

Key strengths include the large sample size (4,361), which provides high statistical power; this is the first large-scale study in eastern Libya; consecutive sampling minimised selection bias; and appropriate statistical methods (ANOVA with Tukey's HSD) were used.

Limitations

Several limitations must be acknowledged. The cross sectional design precludes causal inferences. The absence of a healthy control group prevents assessment of whether the blood group distribution differs from the general population. We did not adjust for potential confounders (age, BMI, family history, lifestyle). The single centre design limits generalisability within Libya's genetically heterogeneous population. Small numbers in some Rh negative subgroups (especially AB^-, n=55) increase the risk of type II errors. Lack of data on complications, treatment, and glycaemic control (HbA1c) limits clinical interpretation. Finally, age and diabetes type were not analysed, as noted above.

Although age and diabetes type (type 1 vs. type 2) were collected, they were not included in the current analysis because the primary objective was to compare diabetes duration across blood groups irrespective of these variables. Including them would have required a more complex multivariate model, which was beyond the scope of this descriptive cross sectional study. However, we acknowledge this as a limitation and recommend that future studies specifically examine the effects of age and diabetes type on the observed associations.

The high burden of type 2 diabetes and its complications in the southern region of Libya have been documented in a study from Brack AlShatti Hospital [38], [39]. This highlights the urgent need for research into risk factors for disease progression, such as the potential role of ABO blood groups, as examined in our study If confirmed in prospective studies, blood group typing could serve as a simple, inexpensive tool for risk stratification. Individuals with groups B, O, and especially AB^- showed distinct duration patterns that warrant further investigation in prospective studies. Future research should include case-control studies with healthy controls, prospective cohorts, multi-centre designs, separation of type 1 and type 2 diabetes, thorough adjustment for confounders, and molecular/genetic investigations to clarify mechanisms.

Conclusion

This large-scale study from eastern Libya demonstrates a significant association between ABO blood groups and diabetes duration in diabetic patients attending Al-Marj Specialized Hospital for Diabetes and Endocrinology. The most frequent ABO blood group was A (45.2%), followed by O (31.2%), B (16.9%), and AB (6.6%). Patients with blood group A had a significantly shorter mean diabetes duration (11.05 years) compared to those with group B (12.86 years) and group O (12.76 years) ($p < 0.001$). Considering the Rhesus factor, the A^+ phenotype had the shortest mean duration (10.97 years), while AB^- had the longest (15.25 years). No significant differences in diabetes duration were found for Rh factor alone or for sex.

The distribution of ABO blood groups in our diabetic population (A^+ most common, followed by O^+) differs from previous Libyan reports, highlighting the heterogeneous nature of the Libyan population and the need for regional studies.

Compliance with ethical standards

Future research should include large-scale case-control and prospective cohort studies with healthy controls, multi-centre collaboration across different Libyan regions, separation of type 1 and type 2 diabetes, adjustment for confounders (age, BMI, lifestyle), and molecular investigations to clarify underlying mechanisms. Although blood group typing may serve as an additional clinical observation tool for disease progression, particularly for individuals with groups B, O, and AB^-, it should not replace established screening methods until confirmatory studies are available.

Author Contributions:

Hana Hussin conceived and designed the study, collected and analyzed the data, interpreted the results, and drafted the manuscript. The author read and approved the final version of the manuscript.

Funding:

This research received no external funding.

Data Availability Statement:

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgments:

The author would like to express sincere appreciation to the administration and staff of Al-Marj Specialized Hospital for Diabetes and Endocrinology for their support and cooperation. The author also thanks all participants for their valuable contribution to this study.

Conflicts of Interest:

The author declares no conflict of interest

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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