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Original Research Article

A Comprehensive Study of ABO-Rh Blood Groups and Their Relation to Type 2 Diabetes and Hypertension

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Abstract:

Introduction: High blood pressure (hypertension) and Type 2 diabetes are two of the most widespread health issues in the modern world. While lifestyle choices like diet and exercise play a huge role in these diseases, our genetics also matter. Specifically, the blood group we inherit from our parents (like A, B, AB, or O) might make us more or less likely to develop these conditions.

Aims and Objectives: To evaluate the prevalence of ABO-Rh blood groups among patients suffering from hypertension and type 2 diabetes mellitus.

Setting and Design: A Cross-sectional, population-based study conducted at P.D.U medical college, Rajkot among patients with hypertension and type 2 diabetes of civil hospital, Rajkot.

Materials and Methods: This study was conducted among patients attending Civil Hospital, Rajkot. The study included 100 subjects aged 30–60 years consisting of 50 hypertensive and 50 type 2 diabetic patients. Blood pressure was measured using palpatory and auscultatory methods. Blood glucose levels were assessed using a glucometer. ABO-Rh blood groups were determined by slide haemagglutination technique.

Results: Among hypertensive patients, the most common blood group was O Rh positive (44%), followed by B Rh positive (26%), A Rh positive (14%), and AB Rh positive (10%). Among diabetic patients, B Rh positive (38%) was the most prevalent blood group followed by O Rh positive (26%), A Rh positive (14%), and AB Rh positive (8%).

Conclusion: The findings suggest that O Rh positive blood group is more prevalent among hypertensive patients, whereas B Rh positive blood group is more prevalent among individuals with type 2 diabetes mellitus. These results indicate a possible association between ABO-Rh blood groups and susceptibility to these diseases.

Keywords: ABO-Rh, Blood group, Hypertension, Type 2 diabetes mellitus.

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Introduction

The health problems facing the world today look very different than they did a century ago. Instead of infectious diseases, hospitals are now mostly dealing with chronic, long-lasting conditions. High blood pressure (which doctors call hypertension) and Type 2 diabetes are at the top of this list. These two diseases often go hand-in-hand, and over time, they can cause severe damage to the heart, brain, and kidneys. Because these diseases affect so many people, medical researchers are constantly looking for clues to help predict who might get sick.

High blood pressure is basically what happens when the force of the blood pushing against your artery walls is consistently too high. According to the 2017 guidelines from the American Heart Association, a normal blood pressure reading should be strictly under 120/80 mmHg. The guidelines classify a systolic pressure of 120 to 129 mmHg as "Elevated," while true hypertension begins at 130/80 mmHg (Stage 1) and becomes severe at 140/90 mmHg or higher (Stage 2). [1]

Table 1: Classification of Blood Pressure (Source: American Heart Association Guidelines, 2017)

Blood Pressure Category	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Normal	<120	<80
Elevated	120–129	<80
Hypertension Stage 1	130–139	80–89
Hypertension Stage 2	≥140	≥90

Globally, it is estimated that over 1.13 billion people suffer from this condition, translating to roughly one in four women and one in five men. [2] Alarmingly, having high blood pressure can increase a person's risk of developing broader cardiovascular disease by ten times, and if they also smoke, that risk jumps by at least another three times. Gender also plays a role; before menopause, men are about three times more likely to die from coronary artery disease than women, but a woman's risk increases sharply after menopause due to a sudden drop in protective estrogen hormones. It is often called a "silent killer" because people usually do not feel sick until the disease causes a major event, like a heart attack, kidney failure, or a stroke.

Parallel and frequently intersecting with the hypertension epidemic is the escalating global prevalence of Type 2 diabetes mellitus. Diabetes mellitus is a complex clinical syndrome primarily characterized by chronic hyperglycemia, which arises from absolute or relative deficiencies in insulin secretion, structural defects in insulin action at the cellular receptor level, or a combination of both deleterious factors. [3] Distinct genetic and metabolic defects give rise to the common phenotype of hyperglycemia in Type 2 diabetes mellitus, driven by a multifaceted, lifelong interaction between inherited genetic susceptibilities and modern environmental factors, such as sedentary lifestyles and hypercaloric diets. The pathological processes involved in the development of diabetes range from the autoimmune destruction of the beta-cells of the pancreas (more characteristic of Type 1) to profound cellular abnormalities that result in robust resistance to insulin action in skeletal muscle, hepatic tissue, and adipose tissue (the hallmark of Type 2). The number of people with diabetes is growing very fast. From around 30 million cases in 1985, the number shot up to 422 million people by 2021. [4] Health experts predict this number could reach an astonishing 693 million by the year 2045. [5] Currently, the continent of Asia is the global center of this diabetes epidemic, with China and India leading the world in cases. In India alone, the number of diabetic patients is expected to grow from roughly 40.9 million up to nearly 69.9 million in the near future. [6]

So, how do our blood types fit into this picture? In the year 1901, a scientist named Karl Landsteiner discovered that human blood is not all the same. He found the ABO blood group system, showing that people have either type A, B, AB, or O blood. [7] We now know that the specific instructions for building these blood types are located on a specific part of our DNA, known as chromosome 9q34. [8] A person's "Rh" status (whether they are positive or negative) is controlled by a set of closely linked genes that create specific proteins on the blood cells.

For decades, doctors mostly used this information just to make sure blood transfusions were safe. However, modern science has discovered that the tiny markers (called antigens) that decide your blood type are not only floating on your red blood cells. They are also attached to the walls of your blood vessels and other organs. Because these blood group markers are spread throughout the body, scientists believe they might influence how our bodies react to inflammation, how well our blood clots, or how we handle sugar. Beyond their role in transfusion medicine, blood group antigens have been linked to the development of various diseases. Several investigations have suggested associations between certain blood groups and disorders such as gastric carcinoma, peptic ulcer disease, thromboembolic conditions, and cardiovascular diseases. [9,10] The mechanisms underlying these associations may involve differences in inflammatory mediators, endothelial function, coagulation factors, and metabolic pathways.

Understanding whether specific blood groups are more frequently associated with hypertension or diabetes may provide insight into potential genetic susceptibility. Therefore, this research paper explores whether the specific blood type a person is born with can act as an early warning sign for high blood pressure or diabetes within our local community.

Materials and Methods

The present study was conducted as a cross-sectional observational study in the Department of Physiology at P.D.U. Government Medical College and Civil Hospital, Rajkot, Gujarat, India. The study protocol received formal approval from the Institutional Ethical Committee, and written informed consent was obtained from all participants in accordance with the Declaration of Helsinki principles.

The study included patients diagnosed with hypertension and type 2 diabetes mellitus who attended the Department of Medicine. A total of 100 subjects were enrolled in the study after obtaining written informed consent. Among them, 50 subjects

were hypertensive patients, and 50 subjects were diagnosed with type 2 diabetes mellitus. All participants were within the age group of 30 to 60 years.

A. **Inclusion Criteria:** Both male and female participants aged 30–50 years were eligible. For the high blood pressure group, patients were required to have a top blood pressure number (systolic) strictly over 130 mm Hg and a bottom blood pressure number (diastolic) over 80 mm Hg. Additionally, they must have had a documented medical history of taking blood pressure medication for at least the last two years, which proved that their condition was long-term and not just a temporary spike from stress. For the Type 2 diabetes group, patients were included if their random blood sugar levels or their sugar levels two hours after eating were higher than 200 mg/dl, or alternatively, if their fasting blood sugar (before eating in the morning) was higher than 126 mg/dl. Just like the hypertensive group, these diabetic patients needed to show they had been taking diabetes medication continuously for at least the last two years.

B. **Exclusion Criteria:** Individuals outside the age range of 30–50 years were excluded. Pregnant women were not part of the study, because pregnancy naturally causes temporary but significant changes in blood pressure and blood sugar. Furthermore, anyone who had both diabetes and high blood pressure at the same time was left out, as the goal was to study the diseases separately to see the pure effect of the blood groups on each condition without overlap.Patients with other cardiovascular, endocrine, neurological, or hematological disorders were also excluded to avoid confounding factors.

C. **Procedure and Data Collection:** Standard, highly trusted medical tools were used to clinically assess the patients. To accurately check blood pressure, the traditional method of feeling the pulse (palpatory) and listening with a stethoscope (auscultatory) while using a standard blood pressure cuff was utilized, as this remains the most reliable way to obtain an accurate reading. For checking blood sugar levels, a tiny capillary blood sample was taken, and a calibrated digital glucometer was used to instantly and accurately measure the amount of glucose in the system.

Table 2: Criteria for the diagnosis of diabetes mellitus (Source: American Diabetes Association, 2011) [3]

Criteria
Symptoms of diabetes plus random blood glucose concentration ≥11.1 mmol/L (200 mg/dL)
OR
Fasting plasma glucose ≥7.0 mmol/L (126 mg/dL)
OR
Glycosylated haemoglobin (HbA1c) ≥6.5%
OR
Two-hour plasma glucose ≥11.1 mmol/L (200 mg/dL) during an oral glucose tolerance test

Finally, to find the specific blood group and determine if a patient was type A, B, AB, or O (along with their Rh-positive status), the classic slide haemagglutination method was performed. [8] In this method, anti-A and anti-B antisera were used to detect the presence of A and B antigens on the surface of red blood cells, while anti-D serum was used to determine the Rh factor. Agglutination reactions were observed visually, and the blood group of each subject was determined accordingly.

Table 3: Interpretation of results by slide haemagglutination technique

Anti-A	Anti-B	Blood Group
+	−	**A**
−	+	**B**
+	+	**AB**
−	−	**O**

Key: '+' = agglutination, '–' = No agglutination

D. **Statistical Analysis:** After the clinical measurements and blood group types were collected from all the participants, the collected data were compiled and analyzed using Microsoft Excel. The distribution of ABO–Rh blood groups among hypertensive and type 2 diabetic patients was expressed in terms of numbers and percentages. The association between ABO–Rh blood groups and the occurrence of hypertension and type 2 diabetes mellitus was evaluated using the Chi-square

test, and a p value of less than 0.05 was considered statistically significant.

Results

A total of 100 subjects participated in the study, including 50 hypertensive patients and 50 patients with type 2 diabetes mellitus. The distribution of ABO–Rh blood groups among these subjects was analyzed.

Distribution of ABO–Rh Blood Groups Among Hypertensive Patients: Among the 50 hypertensive patients, O Rh positive blood group was the most prevalent, observed in 22 subjects (44%), followed by B Rh positive in 13 subjects (26%). A Rh positive blood group was found in 7 subjects (14%), while AB Rh positive blood group was present in 5 subjects (10%). A small proportion of subjects belonged to O Rh negative (4%) and B Rh negative (2%) blood groups.

Table 4: Distribution of ABO–Rh blood groups among hypertensive patients (n=50)

Blood Group	Number of Patients	Percentage (%)
O Rh positive	22	44
O Rh negative	2	4
B Rh positive	13	26
B Rh negative	1	2
A Rh positive	7	14
A Rh negative	0	0
AB Rh positive	5	10
AB Rh negative	0	0

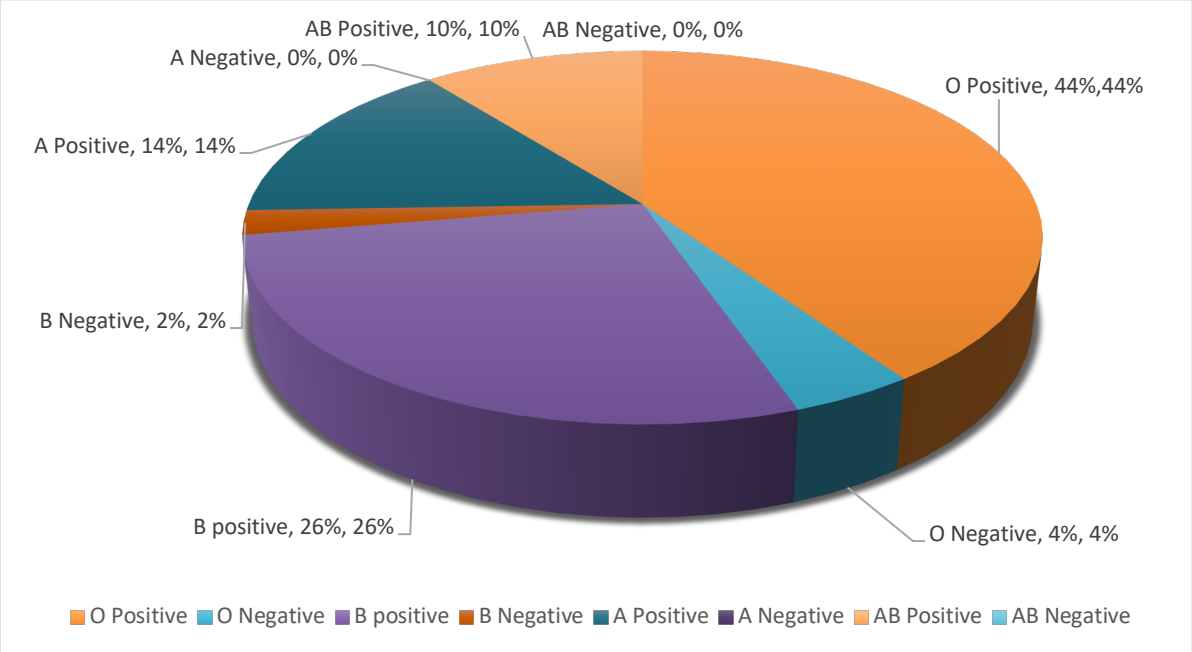

Figure 1: This figure shows the prevalence percentage of ABO-Rh positive blood groups among the hypertensive subjects

Distribution of ABO–Rh Blood Groups Among Type 2 Diabetic Patients: Among the 50 patients with type 2 diabetes mellitus, B Rh positive blood group showed the highest prevalence, accounting for 19 subjects (38%). This was followed by O Rh positive blood group in 13 subjects (26%). A Rh positive blood group was observed in 7 subjects (14%), while AB Rh positive blood group was found in 4 subjects (8%). Rh negative blood groups were less common, including B Rh negative (6%), O Rh negative (4%), A Rh negative (2%), and AB Rh negative (2%).

Table 5: Distribution of ABO–Rh blood groups among type 2 diabetic patients (n=50)

Blood Group	Number of Patients	Percentage (%)
B Rh positive	19	38
B Rh negative	3	6
O Rh positive	13	26
O Rh negative	2	4
A Rh positive	7	14
A Rh negative	1	2
AB Rh positive	4	8
AB Rh negative	1	2

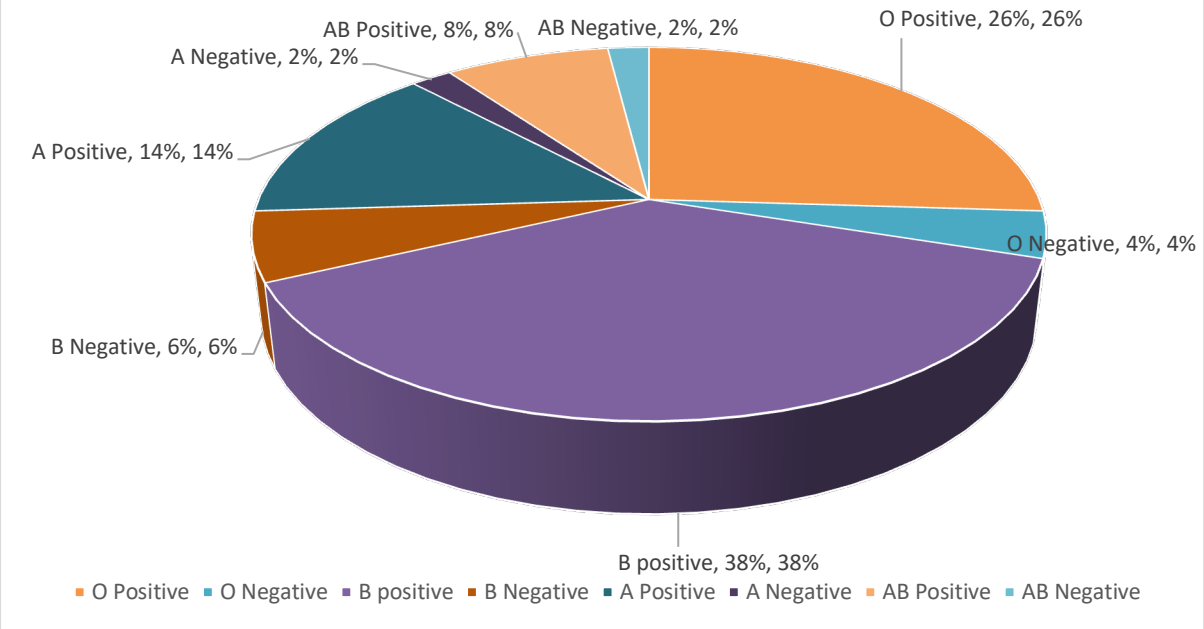

Figure 2: This figure shows the prevalence percentage of ABO-Rh positive blood groups among the subjects suffering from type 2 diabetes mellitus.

Comparison of ABO–Rh Blood Groups Between Hypertensive and Diabetic Patients: Comparison of blood group distribution between the two study groups showed that O Rh positive blood group was more common among hypertensive patients (44%), whereas B Rh positive blood group showed the highest prevalence among diabetic patients (38%). Other blood groups showed relatively lower frequencies in both groups.

Table 6: Comparison of ABO–Rh blood group distribution among hypertensive and diabetic patients

Blood group	Hypertension (n=50)	Diabetes mellitus (n=50)
O Rh positive	22 (44%)	13 (26%)
O Rh negative	2 (4%)	2 (4%)
B Rh positive	13 (26%)	19 (38%)
B Rh negative	1 (2%)	3 (6%)
A Rh positive	7 (14%)	7 (14%)
A Rh negative	0 (0%)	1 (2%)
AB Rh positive	5 (10%)	4 (8%)
AB Rh negative	0 (0%)	1 (2%)

Statistical Analysis: A chi-square test was applied to determine the association between ABO–Rh blood groups and the occurrence of hypertension and type 2 diabetes mellitus. The analysis suggested a variation in the distribution of blood groups between the two groups; however, the association was not statistically significant ($p > 0.05$).

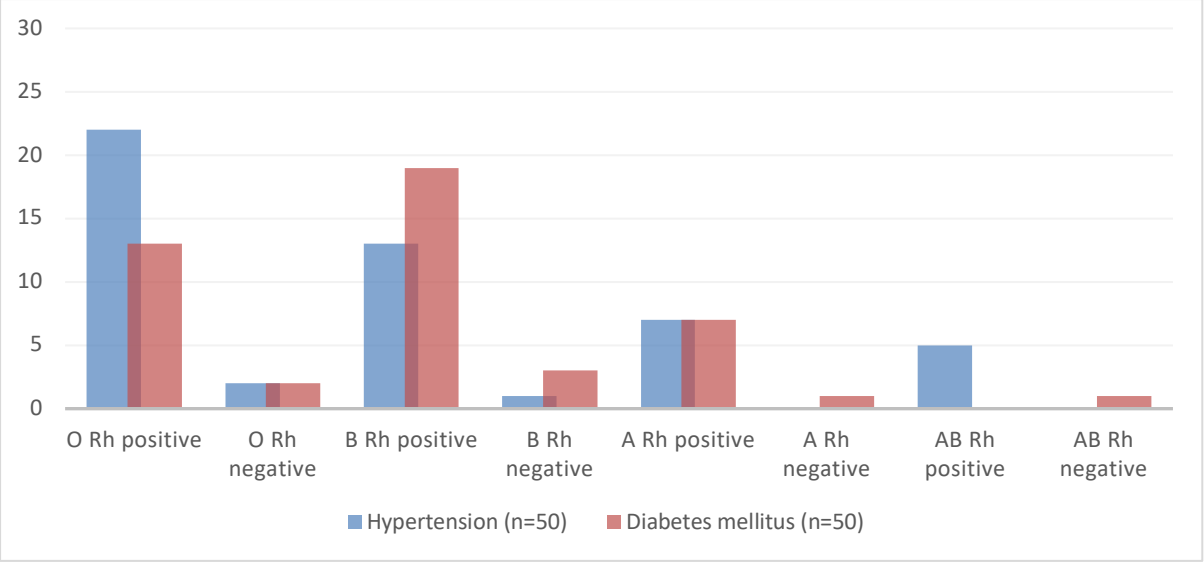

Figure 3: This figure shows Comparison of ABO–Rh blood group distribution among hypertensive and diabetic patients

Discussion

The present cross-sectional study was undertaken to examine the distribution of ABO–Rh blood groups among patients with hypertension and type 2 diabetes mellitus. The analysis revealed noticeable variation in the frequency of blood groups between the two disease categories.

In the current study, O Rh positive blood group was the most common among hypertensive patients (44%), followed by B Rh positive (26%), A Rh positive (14%), and AB Rh positive (10%). A study conducted by Gogoi et al. reported that O Rh positive blood group constituted the largest proportion of hypertensive subjects in their population. [11] Their findings indicated that blood group O was more frequently observed among individuals with elevated blood pressure compared with other ABO blood groups. The distribution observed in the present study follows a comparable pattern.

Evidence from the work of Nemesure et al. also suggests that ABO blood group alleles may influence blood pressure regulation. [12] Their research demonstrated an association between certain blood groups and hypertension in a population of African ancestry, indicating that genetic determinants linked with ABO antigens could contribute to variations in cardiovascular risk.

The physiological explanation for this relationship may involve differences in circulating coagulation factors. O'Donnell and Laffan demonstrated that individuals belonging to blood group O generally have lower plasma levels of von Willebrand factor and factor VIII. [13] These molecules play an essential role in vascular integrity and thrombosis, and variations in their concentration may affect cardiovascular function and blood pressure regulation.

With regard to type 2 diabetes mellitus, the present study showed that B Rh positive blood group was the most prevalent (38%), followed by O Rh positive (26%), A Rh positive (14%), and AB Rh positive (8%). Findings reported by Meo et al. also indicated a higher occurrence of blood group B among patients with type 2 diabetes mellitus, suggesting that individuals with this blood group may have increased susceptibility to metabolic disorders. [14]

Research conducted by Jassim also documented a greater frequency of blood group B in diabetic patients when compared with other blood groups. [15] In addition, Waseem et al. reported that blood groups B and O were more commonly observed among individuals suffering from diabetes mellitus. [16] These observations support the possibility that genetic characteristics associated with ABO blood groups may influence metabolic regulation.

The association between blood groups and metabolic diseases may be explained by the expression of ABO antigens on several tissues including vascular endothelium, epithelial cells, and platelets. Variations in these antigens may influence inflammatory mediators and endothelial function. Previous investigations have shown that polymorphisms in the ABO gene locus are associated with increased levels of inflammatory markers such as intercellular adhesion molecule-1 (ICAM-1) and E-selectin, both of which play a role in insulin resistance and vascular inflammation.

However, not all studies have demonstrated a consistent relationship between ABO blood groups and disease risk. For example, Abdollahi et al. did not find a significant association between ABO blood groups and cardiovascular risk factors in their

study population. [17] Differences in ethnicity, genetic background, environmental exposures, and lifestyle factors may account for these variations in findings across different regions.

Overall, the present study indicates that O Rh positive blood group predominates among hypertensive patients, whereas B Rh positive blood group is more frequently observed among individuals with type 2 diabetes mellitus. These findings suggest that ABO blood group antigens may contribute to genetic predisposition to certain metabolic and cardiovascular conditions.

The present study has certain limitations that should be considered while interpreting the findings. First, the sample size of the study was relatively small, as only 100 subjects were included. A larger sample size would provide more reliable and generalizable results. Second, the study was conducted in a single tertiary care hospital, and therefore the findings may not represent the distribution of ABO–Rh blood groups in the general population or in other geographic regions. Third, the study included subjects from a limited age group (30–50 years), which may restrict the applicability of the results to other age groups. Additionally, various environmental, genetic, and lifestyle factors that may influence the development of hypertension and type 2 diabetes mellitus were not evaluated in this study.

Therefore, further studies involving larger and more diverse populations are required to confirm the association between ABO–Rh blood groups and susceptibility to hypertension and type 2 diabetes mellitus.

Conclusion

This study examined 100 patients attending Civil Hospital, Rajkot to explore whether ABO–Rh blood groups are related to chronic conditions such as hypertension and type 2 diabetes mellitus. The results showed that O Rh positive blood group was most common among patients with hypertension, while B Rh positive blood group was more frequently observed among patients with type 2 diabetes mellitus.

Although a person's blood group cannot be changed, understanding this association can be useful in preventive healthcare. If certain blood groups are found to have a higher tendency to develop hypertension or diabetes, this information may help doctors identify individuals who may be at greater risk. Since blood grouping is a simple and inexpensive test, it can be used as an early screening tool.

Early identification of individuals who may be more prone to these conditions can encourage timely lifestyle modifications such as maintaining a balanced diet, engaging in regular physical activity, and undergoing routine medical check-ups. Such preventive measures may help reduce the risk of developing hypertension and diabetes in the future. Further studies with larger populations are required to confirm these findings and to better understand the relationship between blood groups and these diseases.

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