



# ABO Blood Type does not Influence Blood Pressure Levels in Healthy Indian Adolescents

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## Abstract

**Background & Aims:** ABO blood group antigens are well known genetic risk factors for various diseases. These antigens were reported as a non-modifiable risk factor for the development of hypertension independent of conventional modifiable risk factors. These findings were based on populations with pre-existing hypertension; however, such a relationship was rarely evaluated in normal healthy subjects.

**Materials & Methods:** This cross-sectional study consisted of 400 healthy adolescents (203 males and 197 females) aged 17 to 25 years. The slide agglutination method was used for the determination of ABO blood typing. A standardized mercury sphygmomanometer was used for recording BP. Pulse Pressure (PP) and Mean Arterial Pressure (MAP) were also calculated. JNC-8 guidelines were used for calculation of the prevalence of elevated BP across ABO groups. ANOVA test was used to compare BP values in ABO blood groups. Chi-square correlation was used to assess frequency distribution of ABO blood groups among hypertensive and normal subjects.

**Results:** Blood group B was most prevalent (35.2%) in our study. The highest average values of SBP, DBP, PP, and MAP were recorded in blood group AB. The observed differences in the mean values of BP indices across ABO blood groups were statistically insignificant. Maximum subjects with elevated blood pressure were found in blood group A (n=12;10.81%) but no significant association was observed between ABO blood groups and elevated blood pressure.

**Conclusion:** Tendencies for developing elevated BP levels have no significant association with ABO blood groups in young healthy subjects of any gender.

**Keywords:** ABO Blood-Group System, Blood pressure, Adolescent

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## Introduction

Karl Landsteiner in 1901 was the first to discover the

ABO blood group system in human blood. These groups were classified on the basis of the presence of A and B

antigens on the surface of red blood cells. Genes for blood group antigens are located on autosomes and they show a co-dominant pattern of inheritance (1-3).

Determination of the association of ABO blood group with disease is an interesting area of research due to the ease of testing these antigens and their inheritance from one generation to the next. As a result, the understanding of ABO antigen has grown up and the clinical significance of blood groups has extended beyond transfusion medicine and organ transplantation (1, 3-6). ABO blood group antigens become well-known genetic risk factors for diseases such as gastric malignancies, cognitive impairment, metabolic diseases, thrombotic cardiovascular adverse events, life expectancy, etc (3, 7-10).

Association of ABO blood group with cardiovascular disease was first reported in 1962 (2). Previous epidemiological studies suggested that chances of ischemic heart diseases and thrombotic cardiovascular adverse events are low in blood group O as compared to non-O blood group individuals (1-4). The findings suggest a link between ABO blood type and hypertension independent of conventional cardiovascular modifiable risk factors (11-14). These observations were based on the familial pattern of inheritance of ABO groups and its racial distribution which resembles the distribution of hypertension in the population (15). Furthermore, due to the linkage of ABO antigen with angiotensinogen gene, it is suggested that it might be involved in the pathogenesis of hypertension (4,5).

These findings provide the basis for the hypothesis that O-blood groups are less prone to cardiovascular adverse events such as myocardial ischemia, infarction, hypertension, venous thrombosis, peripheral vascular disease, cerebral ischemia, etc. However, the exact mechanisms for the observed associations of ABO blood groups with cardiovascular disease are inconclusive and are still under investigation.

The prevalence of cardiovascular diseases and hypertension is rapidly increasing in developing countries due to changes in socioeconomic conditions. It is expected that deaths due to coronary artery diseases

in South East Asian countries will increase by 50% by the year 2030 (1).

Previous studies explored the association of ABO blood groups and blood pressure on populations with pre-existing hypertension, however; such a relationship was rarely evaluated in normal subjects. Therefore, this study is designed to explore the possible association of the ABO blood type and blood pressure levels in a healthy adolescent population. This might be useful in offering some insights for early recognition and better control of the subjects at risk of developing high blood pressure on the basis of their blood group (4, 10). This may be useful in reducing the global burden of cardiovascular diseases.

## Materials & Methods

This cross-sectional study consisted of a sample of 400 healthy medical students (203 males and 197 females) aged 17 to 25 years [Estimated sample size = 385, using 50% proportion, 95% confidence interval, and 5% margin of error]. Seven students (n=07) did not fulfill the inclusion criteria due to various reasons such as acute illness, history of medications, apprehension, and no willingness to participate in the study and they were excluded from the study group. Prior ethical clearance from the Institutional Ethics Committee was obtained. The study protocol was explained and written informed consent was obtained prior to the data collection.

The anthropometry of the participants was done following standard protocol. A blood sample for blood grouping was obtained from the left ring-finger under full aseptic precautions. Slide agglutination method with antisera (Eryscreen Total Monoclonal ABO Rh-D reagent, Tulip Diagnostic Ltd. Goa, India) was used for the determination of blood group (16).

A standardized mercury sphygmomanometer was used for blood pressure measurement. The subjects were given rest for 5 min, thereafter appropriate size of the cuff was applied to the right upper arm and BP was recorded in a seated position. Korotkoff phase-I was recorded as systolic blood pressure (SBP) and Korotkoff phase-V as diastolic blood pressure (DBP). Mean of last

two readings with a time interval of one minute was used as final readings. Pulse Pressure (PP) was calculated by subtracting DBP from SBP and Mean Arterial Pressure (MAP) was calculated using the formula  $MAP = DBP + 1/3 (PP)$ .

All the BP recordings were made at a fixed time (after 10:30 AM) by the investigator of the project without wearing a white coat. Due care was taken to alleviate anxiety, fear, and stress in the participants.

Joint National Committee (JNC-8) guidelines for the management of high blood pressure was used for calculation of the prevalence of elevated BP across ABO blood groups. As per these guidelines, high BP was defined as systolic blood pressure (SBP) >140 mm Hg or a diastolic blood pressure (DBP) >90 mm Hg. However, due to the cross-sectional design, the term elevated BP is used instead of hypertension in this study.

Statistical analysis was carried out on MedCalc (V.18.10.2) statistical software. Categorical variables

were reported as numbers and percentages whereas continuous variables were reported as mean and standard deviations. Analysis of variance (ANOVA) test was used to compare the values of BP indices across ABO blood groups. Pearson chi-square correlation was used to assess the frequency distribution of ABO blood groups among elevated BP and normal BP subjects. The level of significance for all the tests was fixed at  $p < 0.05$ .

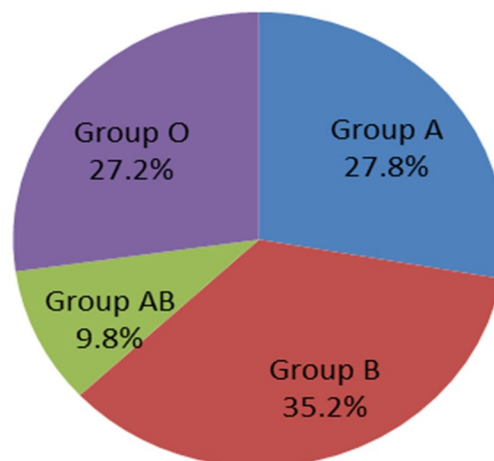
## Results

Table 1 presents the mean values of the anthropometric and BP indices of the entire study sample (n=400).

The percentage distribution of ABO blood groups is depicted in the Figure 1. In the present study blood group B is most prevalent (35.2%), followed by A (27.8%) and O (27.2%). Whereas blood group AB is the least prevalent (9.8%) (Figure 1).

**Table 1.** Summary of the study parameters

Parameter	Mean $\pm$ SD	95% CI	Minimum	Maximum
Age (Years)	18.78 $\pm$ 1.08	18.65 to 18.90	17	24
Weight (Kg)	57.75 $\pm$ 13.66	56.41 to 59.09	32.5	132.85
Height (cm)	164.08 $\pm$ 9.40	163.16 to 165.00	144	192
BMI (Kg/m <sup>2</sup> )	21.37 $\pm$ 4.32	20.95 to 21.80	14.1	40.8
Pulse(Beats/min)	86.41 $\pm$ 13.18	85.11 to 87.71	48	128
SBP (mmHg)	120.43 $\pm$ 13.16	119.13 to 121.72	88	178
DBP (mmHg)	72.97 $\pm$ 7.99	72.18 to 73.75	52	96
PP (mmHg)	47.81 $\pm$ 9.93	46.83 to 48.78	24	104
MAP (mmHg)	88.86 $\pm$ 9.31	87.95 to 89.78	66	130.67



**Fig 1.** Distribution of ABO blood groups in study population

A comparison of blood pressure indices across ABO blood groups of the entire study population is given in Table 2. The highest average values of the SBP

(124.89±13.53mmHg), DBP (74.41±8.26 mmHg), PP (50.48±9.37mmHg), and MAP (91.23±9.31mmHg) were recorded in blood group AB.

**Table 2.** Comparison of Blood Pressure Indices in ABO blood groups

BP Indices	Blood Group				ANOVA (f- statistic)	p-value
	A (n=111)	B (n=141)	AB (n=39)	O (n=109)		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
SBP (mmHg)	120.20±15.28	119.83±11.86	124.89±13.53	119.83±12.13	1.68	0.169
DBP (mmHg)	73.59±8.63	73.06±8.00	74.41±8.26	71.70±7.09	1.56	0.196
PP (mmHg)	47.35±12.24	47.19±8.77	50.48±9.37	48.12±8.80	1.24	0.293
MAP (mmHg)	89.37±11.01	88.67±8.66	91.23±9.31	87.74±8.09	1.49	0.215

Table 3 depicts a comparison of the mean values of BP indices in the non-O blood group versus the O-blood group. The mean values of BP indices were higher in the non-O blood group as compared to the O-blood group. On further analysis with respect to the gender across

ABO blood groups, the highest mean values of BP indices were recorded in the AB blood group with exception of DBP (72.94 ±8.05mmHg). The highest mean value of DBP was recorded in blood group A (Tables 4 & 5).

**Table 3.** Comparison of Blood Pressure Indices in Non O & O Blood Groups

BP Indices	Blood Groups		t- statistic	p-value
	Non O (n=291)	Group O (n=109)		
	Mean±SD	Mean±SD		
SBP (mmHg)	120.65±13.54	119.83±12.13	-0.553	-0.553
DBP (mmHg)	73.44±8.26	71.70±7.09	-1.946	0.0524
PP (mmHg)	47.69±10.33	48.12±8.80	0.389	0.6977
MAP (mmHg)	89.28±9.71	87.74±8.09	-1.472	0.1419

**Table 4.** Comparison of Blood Pressure Indices in ABO blood groups in Male

BP Indices	Blood Group				ANOVA(f- statistic)	p-value
	A (n=55)	B (n=76)	AB (n=16)	O (n=56)		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
SBP (mmHg)	124.58±17.09	123.67±11.61	133.93±11.93	123.58±12.53	2.581	0.055
DBP (mmHg)	74.12±9.03	73.76±7.31	77.53±6.73	73.10±6.78	1.348	0.26
PP (mmHg)	51.94±14.29	50.03±8.42	56.4±9.74	50.48±9.57	1.646	0.18
MAP (mmHg)	91.44±12.52	90.44±8.11	96.31±7.47	89.93±7.91	1.949	0.123

**Table 5.** Comparison of Blood Pressure Indices in ABO blood groups in Female

BP Indices	Blood Group				ANOVA (f- statistic)	p-value
	A (n=56)	B (n=65)	AB (n=23)	O(n=53)		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
SBP (mmHg)	115.96±12.01	115.33±10.57	118.56±11.12	116.16±10.55	0.487	0.692
DBP (mmHg)	72.94±8.05	72.24±8.73	72.00±8.54	70.59±7.59	0.793	0.499
PP (mmHg)	43.01±7.67	43.86±8.01	46.56±7.15	45.57±7.13	1.782	0.152
MAP (mmHg)	87.28±8.84	86.61±8.88	87.52±8.86	85.78±8.01	0.36	0.782
SBP (mmHg)	100.13±21.18	104.41±18.38	105.33±23.65	103.94±19.32	0.622	0.602

Based on the analysis of variance (ANOVA), these observed differences (Tables 2 to 5) of the average values of BP indices in different study groups were statistically insignificant ( $p>0.05$ ).

In the present study prevalence of elevated blood pressure was 6.00%, out of which the highest number of subjects ( $n=12$ ; 10.81%) belongs to the blood group A and lowest number of subjects belong to the blood group O ( $n=4$ ; 4.08%). However, the chi-square test of independence showed that the difference in the prevalence of elevated BP across ABO blood groups was statistically insignificant ( $\chi^2 = 6.7428$ ;  $p= 0.3452$ ). Furthermore, a similar trend in the prevalence of elevated BP was observed in non-O blood groups versus O- blood group. Highest number of subjects in non-O blood group ( $n=20$ ; 6.62%) as compared to O-blood group ( $n=4$ ; 4.08%). No significant association with elevated blood pressure in these study groups was observed ( $\chi^2 = 0.847$ ;  $p= 0.6547$ ).

## Discussion

Based on the previous epidemiological studies, differences exist between individuals of ABO blood types, indicating that blood groups may play a biological role (1, 3, 6, 10). Previous studies attempted to explore this relationship but they have often been criticized due to their inconsistent results.

The influence of ABO blood groups on blood pressure levels in healthy individuals is underexplored, therefore the present study attempted to explore this relationship in a sample of 400 healthy individuals (male  $n=203$ ; female  $n=197$ ).

In the present study, blood group B was most prevalent (35.2%) whereas AB (9.8%) was least prevalent (Figure 1). The distribution of ABO blood groups in the study subjects was similar to previous reports from northern India (11). However, a recent Indian study reported almost equal predominance of both O and B groups (2, 17). These reported differences in the prevalence might be due to ethnic variations in the study sample which has affected the genetic expression of ABO phenotype since India has several diversities within the population itself (11).

Previous studies tried to establish the association of ABO blood group with BP in subjects with pre-existing hypertension but their findings were diverse and inconclusive. They have reported a positive correlation of DBP with ABO blood groups and proneness of blood group B for high blood pressure (11, 12, 13, 18). On the contrary, in other studies the highest mean SBP and DBP levels were observed in blood group O (3, 15, 19). Furthermore, Amela et al from Bosnia have reported the highest average values of BP in blood group A (20, 21).

The findings of the present study are not in agreement with these reports, the highest values of BP indices like SBP (124.89±13.53mmHg), DBP (74.41±8.26 mmHg), PP (50.48±9.37mmHg), and MAP (91.23±9.31mmHg) were observed in blood group AB (Table-2). A similar trend in the mean values of BP indices was observed in non-O blood group versus O-blood group (Table-3) and male and female groups (Table-4&5). The observed differences in the mean values of BP indices remained statistically insignificant ( $p>0.05$ ) (Tables 2 to 5). These findings are in

agreement with the previous reports.<sup>15, 19, 22</sup> indicating that the ABO blood group does not significantly affect BP indices.

On further analysis, the highest number of subjects with elevated blood pressure were found in blood group A (n=12;10.81%) (Table 6)]. A similar trend in the prevalence of elevated BP was noted in non-O blood groups versus O- blood group (Table-7). However, the observed association between blood groups and elevated blood pressure remained statistically insignificant ( $p>0.05$ ). Our results are in agreement with other previous studies disapproving of any relationship between high BP levels and ABO phenotype (15, 19, 21, 23-25).

The variances in the findings of different studies exploring the association of ABO blood groups and blood pressure might be due to heterogeneity in sample size and ethnicity of the study population. Genetic risk factors do not remain consistent between races and they show dissimilar associations with multifactorial complex traits like blood pressure (26).

Furthermore, it is to be mentioned that for cardiovascular diseases, environmental factors may be more important than genetic factors (20). Perhaps ABO antigens play an indirect role in influencing BP (27).

The study emphasizes that physiological differences exist between individuals belonging to ABO blood types; however, their genetic expression varies among different ethnicities. To elucidate the relationship between ABO blood group and blood pressure in greater detail further research on a large sample is required.

### Limitations of the study:

We were unable to include clinically diagnosed cases of hypertension for comparison of BP indices in this study. The role of Rhesus and other blood group systems were not considered in this study which is another limitation of this study.

### Conclusion

The findings of the present study suggest that tendencies for developing elevated BP levels has no

significant association with ABO blood groups in young healthy subjects of any gender.

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Nil.

### Conflict of Interest

There are no known conflicts of interest associated with this publication.

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