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

Nazeem Ishrat Siddiqui1, Ajay Soni2, Vijay BS Gaur3, Pratik Akhani*4, Mohammad Shoeb5

1 Professor and Head, Department of Physiology, Government Medical College, Khandwa-450001, Madhya Pradesh, India
2 Demonstrator, Department of Physiology, MGM Medical College, Indore, Madhya Pradesh, India
3 Associate Professor, Department of Physiology, Government Medical College, Khandwa-450001, Madhya Pradesh, India
4 Assistant Professor, Department of Physiology, Government Medical College, Khandwa-450001, Madhya Pradesh, India
5 Assistant Professor, Department of Zoology, Government LCS College, Rajnandgaon, Chhattisgarh, India

*Corresponding authors: Dr. Pratik Akhani, Address: Department of Physiology, Government Medical College, Khandwa-450001, Madhya Pradesh, India, Email: pratikakhani@yahoo.com, Tel: +919429665389

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

Received 04 February 2021; accepted for publication 10 March 2021

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 modifyable 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 ± SD       | 95% CI          | Minimum | Maximum |
|-----------------|-----------------|-----------------|---------|---------|
| Age (Years)     | 18.78 ± 1.08    | 18.65 to 18.90  | 17      | 24      |
| Weight (Kg)     | 57.75 ± 13.66   | 56.41 to 59.09  | 32.5    | 132.85  |
| Height (cm)     | 164.08 ± 9.40   | 163.16 to 165.00| 144     | 192     |
| BMI (Kg/m²)     | 21.37 ± 4.32    | 20.95 to 21.80  | 14.1    | 40.8    |
| Pulse (Beats/min) | 86.41 ± 13.18 | 85.11 to 87.71  | 48      | 128     |
| SBP (mmHg)      | 120.43 ± 13.16  | 119.13 to 121.72| 88      | 178     |
| DBP (mmHg)      | 72.97 ± 7.99    | 72.18 to 73.75  | 52      | 96      |
| PP (mmHg)       | 47.81 ± 9.93    | 46.83 to 48.78  | 24      | 104     |
| MAP (mmHg)      | 88.86 ± 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 | Mean±SD | ANOVA (f-statistic) | p-value |
|------------|-------------|---------|---------------------|--------|
|            | A (n=111)   | B (n=141) | AB (n=39) | O (n=109) |        |        |
| 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±9.09 | 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) |       |
| 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 | Mean±SD | ANOVA (f-statistic) | p-value |
|------------|-------------|---------|---------------------|--------|
|            | A (n=55)    | B (n=76) | AB (n=16) | O (n=56) |        |        |
| 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  |
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 (χ² = 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 (χ² = 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, Amelia 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

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

| Blood Group | A (n=56) | B (n=65) | AB (n=23) | O(n=53) | ANOVA (f- statistic) | p-value |
|-------------|---------|---------|-----------|---------|----------------------|---------|
| SBP (mmHg) | Mean±SD | 115.96±12.01 | 115.33±10.57 | 118.56±11.12 | 116.16±10.55 | 0.487 | 0.692 |
| DBP (mmHg) | Mean±SD | 72.94±8.05 | 72.24±8.73 | 72.00±8.54 | 70.59±7.59 | 0.793 | 0.499 |
| PP (mmHg)  | Mean±SD | 43.01±7.67 | 43.86±8.01 | 46.56±7.15 | 45.57±7.13 | 1.782 | 0.152 |
| MAP (mmHg) | Mean±SD | 87.28±8.84 | 86.61±8.88 | 87.52±8.86 | 85.78±8.01 | 0.36 | 0.782 |
| SBP (mmHg) | Mean±SD | 100.13±21.18 | 104.41±18.38 | 105.33±23.65 | 103.94±19.32 | 0.622 | 0.602 |
agreement with the previous reports.\textsuperscript{15, 19, 22} 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.

Acknowledgements

None

Financial Support

Nil.

Conflict of Interest

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

References

1. Ewald DR, Sumner SC. Blood type biochemistry and human disease. Wiley Interdiscip Rev Syst Biol Med 2016;8(6):517-35.
2. Zhang H, Mooney CJ, Reilly MP. ABO Blood Groups and Cardiovascular Diseases. Int J Vasc Med 2012;2012:641917.
3. Franchini M, Favaloro EJ, Targar G, Lippi G. ABO blood group, hypercoagulability, and cardiovascular and cancer risk. Crit Rev Clin Lab Sci 2012;49:137–49.
4. Delanghe J, Duprez D, de Buyzere M, Robbrecht D, Bergez B, Leroux-Roels G, et al. MN blood group, a genetic marker for essential arterial hypertension in young adults. Eur Heart J 1995;16(9):1269-76.
5. Sachdev B. Prevalence of hypertension and associated risk factors among Nomad Tribe groups. Antrocom Online Journal of Anthropology 2011; 7(2):181-9.
6. Miller JZ, Grim CE, Conneally PM, Weinberger MH. Association of blood groups with essential and secondary hypertension. A possible association of the MNS system. Hypertension 1979;1(5): 493- 7.
7. He M, Wolpin B, Rexrode K, Manson JE, Rimm E, Hu FB. ABO blood group and risk of coronary heart disease in two prospective cohort studies. Arterioscler Thromb Vasc Biol 2012;32(9):2314-20.
8. Chen Z, Yang SH, Xu H, Li JJ. ABO blood group system and the coronary artery disease: an updated systemic review and meta-analysis. Sci Rep 2016;6:01-11.
9. Dentali F, Sironi AP, Ageno W, Crestani S, Franchini M. ABO blood group and vascular disease: an update. Semin Thromb Hemost 2014;40(1):49-59.
10. Garratty G. Blood groups and disease: a historical perspective. Transfus Med Rev 2000;14:291–301.
11. Chandra T, Gupta A. Association and Distribution of Hypertension, Obesity and ABO Blood groups in Blood Donors. Iran J Ped Hematol Oncol 2012;2(4):140-5.
12. Nemesure B, Wu SY, Hennis A, Leske MC. Hypertension, type 2 diabetes, and blood groups in a population of African ancestry. Ethn Dis 2006;16(4):822-9.
13. Supratik B, Ganaraja B, Ramesh M. Correlation between the blood groups, BMI and pre-hypertension among medical students. Journal of Chinese Clinical Medicine 2010; 5: 78-82.
14. Robinson MT, Wilson TW, Nicholson GA, Grell GA, Etienne C, Grim CM, et al. AGT and RH blood group polymorphisms affect blood pressure and lipids in Afro-Caribbeans. J Hum Hypertens 2004;18(5):351-63
15. Kondam A, Chandrashekar M, Suresh M, Purushothaman G, Madhuri BA, Qairunnisa S. A study of incidence of hypertension in ABO and rhesus blood group system. Int J Biol Med Res 2012;3:1426-9.
16. Lewis SM, Bain BJ, Bates I, Dacie J. Dacie and Lewis practical haematology. 9th Ed. Churchill Livingstone; 2006.P.483-503.
17. Agrawal A, Tiwari AK, Mehta N, Bhattacharya P, Wankhede R, Tulsiani S, et al. ABO and Rh (D) group distribution and gene frequency: the first multicentric study in India. Asian J Transfus Sci 2014;8(2):121-5.
18. Varghese A, Abraham ML, Ramachandran R, Thomas S. A prospective study on the relationship between blood pressure and blood group among adult male blood donors in a Tertiary care center. Int J Clin Exp Physiol 2015;2:51-5.
19. Asafa MA, Ogunlade O, Bolarinwa RA. Effect of ABO Blood Group on Blood Pressure Indices among Apparently Healthy Young Adults of Yoruba Ethnicity in Ille-Ife J Blood Lymph 2018;201:8(1): 1000198.
20. Anvari MS, Boroumand MA, Emami B, Karimi A, Soleymanzadeh A, Abbasi SH, et al. ABO blood group and Coronary Artery Disease in Iranian patients awaiting Coronary Artery bypass Graft surgery: A review of 10,641 cases. LabMedicine 2009;40:528–30.
21. Sushil K, Binod R, Rani G. Association of ABO blood groups with blood pressure in young male adults of Bhaktapur: A cross-sectional study. World Family Medicine Journal: Incorporating the Middle East Journal of Family Medicine 2018; 7 (10):9-12.
22. Alam M, Wardell J, Anderson E. Effects of first myocardial infarction on left ventricular systolic and diastolic function with the use of mitral annular velocity determined by pulsed wave Doppler tissue imaging. J Am Soc Echocardiogr 2000;13(5):343-52.
23. Kaur M, Gill K, Bassi R, Kaur D. Association of ABO and Rhesus blood groups with hypertension. Pak J Physiol 2016;12(2):11-4.
24. Tabatabaie AH, Ali-Madadi M. Possible association between ABO and Rh(D) blood groups and hypertension. Pak J Med Sci 2012;28(1):235-7.
25. Abdollahi AA, Qorbani M, Salehi A, Mansourian M. ABO Blood Groups Distribution and Cardiovascular Major Risk Factors in Healthy Population. Iranian J Publ Health 2009;38:123–6.
26. Loh M, Koh KK, Yeo BH, Song CM, Chia KS, Zhu F, et al. Meta-analysis of genetic polymorphisms and gastric cancer risk: Variability in associations according to race. Eur J Cancer 2009;45:2562–8.
27. Nishi K, Gupta NK, Sharma SC. Study on the incidence of hypertension and migraine in ABO blood groups. ISCA J Biol Sci 2012;1(2):12-6.