

Association of ABO Blood Groups and Rh Systems with Body Mass Index, Body Surface Area and Body Fat Percentage.

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Abstract:

Background: The ABO blood group system is an important genetic marker in humans. Blood groups have been associated with susceptibility to various diseases and physiological characteristics. BMI, BSA and BF% are important parameters used to assess nutritional status, obesity, and overall health.

Aim: To analyse the association of ABO blood groups and the Rh system with BMI, BSA, and BF% among undergraduate dental students.

Methodology: A cross-sectional study was conducted among 155 undergraduate dental students aged 18–25 years. Blood grouping was carried out using the slide agglutination method. Anthropometric measurements were recorded using standard protocols. Statistical analysis was performed using Python version 3.11.4.

Results: A total of 155 undergraduate dental students participated in the study. Male students showed significantly higher BMI and BSA compared to females, while female students had significantly higher body fat percentage. Among the blood groups, AB blood group showed slightly higher median BMI and BSA values, whereas blood group O showed relatively higher body BF%. However, differences among blood groups were not statistically significant ($p > 0.05$).

Conclusion: Study suggests possible variations in body composition parameters among different ABO blood groups no statistically significant association was observed. Findings may help in understanding the relationship between genetic factors and anthropometric characteristics..

Keywords: Body Mass Index (BMI), Body Surface Area (BSA), Body Fat Percentage (BF%)...

INTRODUCTION

ABO blood groups and Rh systems are traditionally known for blood transfusions and compatibility, but recently there are studies regarding the associations between the blood groups and anthropometric parameters which include BMI, BSA and BF%. The ABO blood group and Rh system are inherited biological markers which might influence the susceptibility to various health problems.

The pattern of distribution of the ABO blood antigen varies by the prevalence type among different populations in the world. The relation between ABO blood group and several elements of the human population like intelligence, socioeconomic status, diet, diseases, etc., are suggested from a long time.^[9, 13]

The clinical significance of the ABO blood group system extends beyond transfusion medicine.^[5,6] ABO blood groups have been shown to be particularly linked with different diseases, as observed in some studies. The evidence of the relation between some ABO blood types with diseases is accumulating as this might relate to a direct or indirect role of ABO blood types.^[15, 26]

Previous studies report the link between blood groups and various diseases, like diabetes mellitus, obesity^[20], hypertension and cardiovascular disorders.^[14] In the current scenario, this study is very important as the prevalence of overweight and obesity is increasing day by day and has escalated into developing countries like India.^[1-3]

BMI is widely used marker of obesity which has been studied with ABO system to find out the potential risk of a particular ABO antigen and propensity for increased body fatness.^[23, 24]

Many studies have been done regarding the relationship between several metabolic and cardiovascular disorders with the ABO blood groups. However, the findings for the association of blood groups with BMI, BSA and BF% remain inconsistent.

Excess body fat is also an important contributor to diseases. There is growing interest in conducting studies which involve body composition assessment.^[7]

Variations in the blood which results from the presence or absence of antigens on the surface of red blood cells corresponding to specific blood types, have indirect implications for susceptibility to diseases.^[17, 18, 22, 25]

Some studies show that individuals having blood group B may be more susceptible to higher BMI while other studies report the same for blood groups A or O. Therefore, these conflicting results highlight the need for conducting further research. This study focuses on revealing the difference across blood groups by measuring the body composition.

Materials and Methods

A cross-sectional study was conducted among healthy 155 undergraduate dental students in the Department of Physiology at Manav Rachna Dental College, Faridabad, India. The students were of age group between 18-25 years old. The procedure of the study was explained and an informed consent was taken before conducting the study. The students' medical history was taken which included family history, current and past illness.

Blood group determination was carried out by slide agglutination technique. The height and weight of the students were recorded and BMI, BSA and BF% was calculated. The following formulae were used:

$$BMI = \frac{weight(kg)}{height(m^2)}$$

$$BSA = \sqrt{\frac{weight(kg) \times height(m)}{3600}}$$

$$BF\% \text{ (males)} = (1.20 \times BMI) + (0.23 \times \text{Age}) - 16.2$$

$$BF\% \text{ (females)} = (1.20 \times BMI) + (0.23 \times \text{Age}) - 5.4$$

According to WHO, BMI is divided into four groups as follows:

<18.5 kg/m² = Underweight

18.5 - 24.9 kg/m² = Normal

25.0 - 29.9 kg/m² = Overweight

>30 kg/m² = Obese

The statistical analysis was conducted at a 5% significance level. Initial data preprocessing, including

data cleaning and integration, was performed using Microsoft Excel. Assumption testing for normality was carried out using the Shapiro-Wilk test. As the data were not normally distributed, descriptive statistics were summarised using median and interquartile range (Q1-Q3).

For hypothesis testing, the Mann-Whitney U test was applied for comparisons between two groups, and the Kruskal-Wallis test was used for comparisons across multiple groups, with corresponding p-values reported. Explorative data analysis (EDA) and visualisation, including bar plots with interquartile ranges, were performed using Microsoft Power BI.

All statistical analyses were conducted using Python version 3.11.4 with Pandas, NumPy and SciPy libraries. Statistical analysis was conducted by Biostatistician, Research and Development Cell, MRIIRS

Result

Table 1: Comparison of BMI, BSA, and Body Fat % Between Males and Females (Median [Q1–Q3], Mann–Whitney U Test)

(Asterisk sign represent the significance)

Parameters	Male [Q1, Median, Q3]	Female [Q1, Median, Q3]	Mann Whitney U test P-Value
BMI (kg/m ²)	[20.80, 23.40, 26.20]	[19.00, 21.45, 25.30]	0.0237*
BSA (m ²)	[1.72, 1.83, 1.97]	[1.49, 1.58, 1.67]	0.0000**
BODY FAT %	[13.10, 17.10, 22.50]	[22.40, 26.60, 33.17]	0.0000**

The comparison of anthropometric parameters between males and females using the Mann-Whitney U test shows statistically significant differences for all three variables.

For BMI, males (Median = 23.4; IQR: 20.8–26.2) have a significantly higher distribution compared to females (Median = 21.45; IQR: 19.0–25.3) ($p = 0.0237$), indicating relatively greater body mass among males.

Similarly, BSA is significantly higher in males (Median = 1.83; IQR: 1.72–1.97) than females (Median = 1.58; IQR: 1.49–1.67) ($p < 0.001$), reflecting larger body surface area in males.

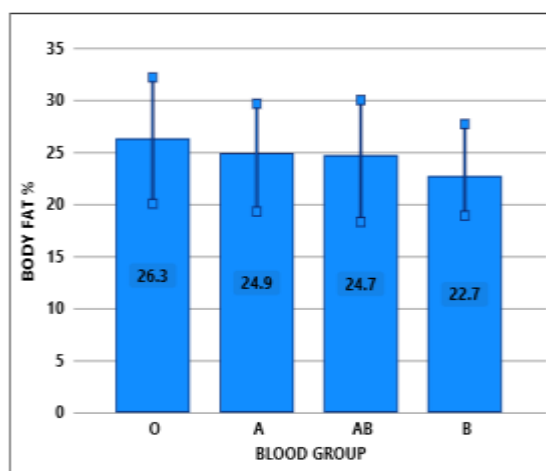
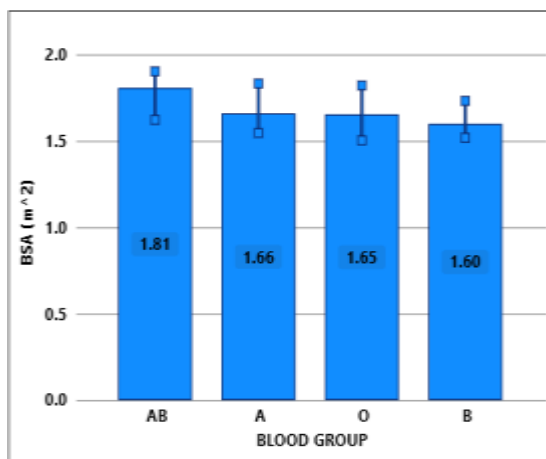
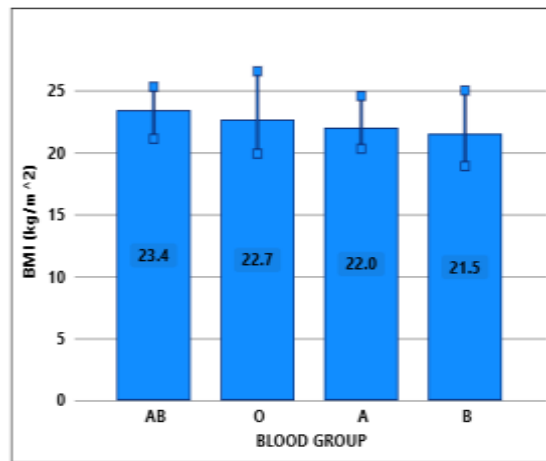
In contrast, Body Fat % is significantly higher in females (Median = 26.6; IQR: 22.4–33.17) compared to males (Median = 17.1; IQR: 13.1–22.5) ($p < 0.001$), suggesting greater fat composition among females.

The bar plots, representing medians with interquartile ranges (Q1-Q3), visually support these findings, showing clear separation between groups for each parameter

Table 2: Comparison of BMI, BSA, and Body Fat % Across Blood Groups (Median [Q1–Q3], Kruskal–Wallis Test)

Parameters	BLOOD GROUP-A [Q1, Median, Q3]	BLOOD GROUP-B [Q1, Median, Q3]	BLOOD GROUP-AB [Q1, Median, Q3]	BLOOD GROUP-O [Q1, Median, Q3]	Kruskal Wallis test P-Value
BMI (kg/m ²)	[20.35, 22.00, 24.55]	[18.90, 21.50, 25.00]	[21.20, 23.40, 25.30]	[20.12, 22.65, 26.55]	0.3562

BSA (m ²)	[1.55, 1.66, 1.83]	[1.52, 1.60, 1.73]	[1.62, 1.81, 1.90]	[1.50, 1.65, 1.82]	0.0922
BODY FAT %	[19.30, 24.90, 29.65]	[18.90, 22.70, 27.70]	[18.30, 24.70, 30.00]	[20.05, 26.30, 32.17]	0.2722



The comparison of anthropometric parameters across different blood groups using the Kruskal Wallis test indicates no statistically significant differences among the groups. For BMI, although blood group AB (Median = 23.4) appears slightly higher compared to O (22.65), A (22.0), and B (21.5), the difference is not statistically significant ($p = 0.3562$).

Similarly, BSA shows a relatively higher median in blood group AB (1.81) compared to A (1.66), O (1.65), and B (1.60), but this variation also does not reach statistical significance ($p = 0.0922$). For Body Fat %, blood group O (Median = 26.3) tends to have higher values compared to A (24.9), AB (24.7), and B (22.7);

however, the differences are again not statistically significant ($p = 0.2722$).

The bar plots with median and interquartile ranges (Q1-Q3) further support these findings, showing overlapping distributions across all blood groups, indicating comparable anthropometric characteristics irrespective of blood group.

Discussion

This study evaluated the relation between ABO blood groups and Rh systems with anthropometric factors like BMI, BSA and BF% among 155 undergraduate dental students. The variations in body composition parameters were studied across different blood groups. The associations were not statistically significant. However, significant differences were observed between male and female, where males had higher BMI and BSA, and females exhibited significantly higher BF%.

The observed gender-based differences are consistent with normal physiological characteristics as the males possess greater skeletal muscle mass and body size, and the females naturally have higher body fat proportion due to hormonal and reproductive factors. These observations are consistent with previous studies which supports the present observations.

Among the ABO blood groups, the students having blood group AB exhibited comparatively higher median BMI and BSA, whereas the students having blood group O demonstrated relatively higher BF%. Although these trends were evident, they did not reach the statistical significance ($p > 0.05$). This gives an idea that while some blood groups may show trends toward differences in body composition, ABO blood alone might not be a strong predictor of obesity or anthropometric status, environment and lifestyle are factors which play a greater role in determining the anthropometric characteristics.

The findings of this study are comparable with the study done by Siddiqui et al., who also reported the variations in body fat percentage and lean body mass among ABO blood groups and BMI. It suggested that BMI might not completely reflect variations in body composition as it did not differentiate between fat mass and lean mass.^[1]

Similar observations were found in the study of Shrivastava et al. It showed that blood group B had a relatively higher prevalence of overweight and obesity among the medical students. The association between ABO blood groups and BMI was not statistically significant.^[4]

The lack of statistically significant associations in this study might attribute to many factors, including a small sample size, homogeneity of the study population which comprises young, healthy dental students and unequal distribution of the students among the blood groups.

Environmental factors, level of physical activity, lifestyle characteristics and habits of diet are not controlled in this study, and this might influence the outcomes and also might have covered any underlying genetic relations^[21]. Genetic factors are also important risk factors in developing diseases like hypertension and ABO blood group system is one such factor which needs deep research.^[10-12]

Despite all these limitations, this study contributes to growing body of evidence which explores the relationship between anthropometric factors and genetically inherited markers.

The findings of the present study indicates that ABO blood groups might influence certain factors of body composition, but their effects appear to be modest and interact with multiple physiological and environmental determinants.

Future multi-centric studies involving larger and more diverse populations with more advanced body composition techniques which include direct measurements of the body fat and also the lean body mass, are advised to further clarify the potential role of ABO blood groups and Rh systems in determining anthropometric characteristics.

Conclusion

This study demonstrated the possible variations in BMI, BSA and BF% among different blood groups with AB blood group showing comparatively higher BMI and BSA values and O blood group showed higher value for BF%. However, the variations were not statistically significant. Significant gender-based variations in anthropometric parameters were seen which suggests that biological and physiological factors might have a greater impact on the body composition than blood group alone. The relationship between anthropometric measures and measured BF% are not independent of age and gender.^[16]

The ABO blood group system is associated with many parameters of healthy aging and development of disease. The knowledge of ABO blood groups might be of interest for more personalized approaches

towards health maintenance and the prevention of diseases.^[19, 25]

Excess body weight and increase in BMI has emerged as one of the most significant global health challenges of the 21st century, with its prevalence rising at an alarming rate across many countries. It is recognized as a complex, multifactorial condition that not only increases the risk of metabolic disorders but also exerts profound effects on cardiovascular function.^[8]

The findings of this study contribute to the growing body of evidence exploring the role of genetic makers in anthropometric research.

Further studies with larger sample sizes and broader population representation are recommended to better elucidate the potential influence of ABO blood groups and Rh systems on body composition..

REFERENCES

1. Abu Khatwa, Ahmed Shawqi, 2007, Explanation of the General Provisions of the Penal Code, Dar Al Nahda Al Siddiqui, Nazeem Ishrat et al. "Association of ABO blood types and novel obesity markers in healthy adolescents." Journal of education and health promotion vol. 8 153. 30 Aug. 2019, doi:10.4103/jehp.jehp_462_18
2. Rush EC, Goedecke JH, Jennings C, Micklesfield L, Dugas L, Lambert EV, Plank LD. BMI, fat and muscle differences in urban women of five ethnicities from two countries. *Int J Obes (Lond)*. 2007 Aug;31(8):1232-9. doi: 10.1038/sj.ijo.0803576. Epub 2007 Mar 6. PMID: 17342075.
3. Kagawa M, Kerr D, Uchida H, Binns CW. Differences in the relationship between BMI and percentage body fat between Japanese and Australian-Caucasian young men. *Br J Nutr*. 2006 May;95(5):1002-7. doi: 10.1079/bjn20061745. PMID: 16611393.
4. Shrivastava, Abha & Uniyal, Akanksha & Nautiyal, Anupama. (2022). ASSOCIATION BETWEEN ABO BLOOD GROUP AND OBESITY IN MEDICAL STUDENTS. *INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH*. 12-14. 10.36106/paripex/0500528.
5. Franchini, Massimo et al. "Relationship between ABO blood group and von Willebrand factor levels: from biology to clinical implications." *Thrombosis journal* vol. 5 14. 25 Sep. 2007, doi:10.1186/1477-9560-5-14.
6. Liunbruno GM, Franchini M. Beyond immunohaematology: the role of the ABO blood group in human diseases. *Blood Transfus*. 2013 Oct;11(4):491-9. doi: 10.2450/2013.0152-13. Epub 2013 Oct 3. PMID: 24120598; PMCID: PMC3827391.
7. Anjos LA, Teixeira Fda C, Wahrlich V, Vasconcellos MT, Going SB. Body fat percentage and body mass index in a probability sample of an adult urban population in Brazil. *Cad Saude Publica*. 2013 Jan;29(1):73-81. doi: 10.1590/s0102-311x2013000100009. PMID: 23370026.
8. Sharma A, Sekhon S, Sandhu JS. Association of Body Fat Percentage, Body Mass Index, and Waist Circumference With Hemodynamics: Insights From a Healthy Adult Population. *Cureus*. 2025 Nov 6;17(11):e96198. doi: 10.7759/cureus.96198. PMID: 41357017; PMCID: PMC12681071.
9. Beardmore, J A, and F Karimi-Booshehri. "ABO genes are differentially distributed in socio-economic groups in England." *Nature* vol. 303,5917 (1983): 522-4. doi:10.1038/303522a0
10. Kavita Singh, Rinku Garg, Shikha Gautam, Yogesh Tripathi, (2018), "To Study the Relation between ABO Blood Groups, Prehypertension and BMI", *International Journal of Science and Research (IJSR)*, 7(11), 1506-1509. <https://dx.doi.org/10.21275/ART20193066>, <https://www.ijssr.net/getabstract.php?paperid=ART20193066>.
11. M., S., and B. V. "Correlation Between ABO Blood Groups and Body Mass Index Among Medical Students". *International Journal of Research in Medical Sciences*, vol. 7, no. 10, Sept. 2019, pp. 3878-81, doi:10.18203/2320-6012.ijrms20194325.
12. Cusack, Leila et al. "Blood type diets lack supporting evidence: a systematic review." *The American journal of clinical nutrition* vol. 98,1 (2013): 99-104. doi:10.3945/ajcn.113.058693.
13. Smith, Samuel et al. "Association of ABO Blood Group and Body Mass Index: A Cross-Sectional Study from a Ghanaian Population." *Journal of nutrition and metabolism* vol. 2018 8050152. 27 Mar. 2018, doi:10.1155/2018/8050152
14. Biswas, Santanu et al. "Distribution of ABO blood group and major cardiovascular risk factors with coronary heart disease." *BioMed research international* vol. 2013 (2013): 782941. doi:10.1155/2013/782941
15. Alwasaidi, Turki A et al. "Relation between ABO blood groups and obesity in a Saudi Arabian population." *Journal of Taibah University Medical Sciences* vol. 12,5 407-411. 30 Jun. 2017, doi:10.1016/j.jtumed.2017.05.011
16. Jackson, A S et al. "The effect of sex, age and race on estimating percentage body fat from body mass index: The Heritage Family Study." *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity* vol. 26,6 (2002): 789-96. doi:10.1038/sj.ijo.0802006
17. Alqahtani, Reem Mohammed et al. "Association of ABO Blood Groups and Obesity in Patients With Diabetes Mellitus in King Abdulaziz University Hospital." *Cureus* vol. 16,1 e51569. 3 Jan. 2024, doi:10.7759/cureus.51569

18. Abegaz, Silamlak Birhanu. "Human ABO Blood Groups and Their Associations with Different Diseases." *BioMed research international* vol. 2021 6629060. 23 Jan. 2021, doi:10.1155/2021/6629060
19. Anstee, David J. "The relationship between blood groups and disease." *Blood* vol. 115,23 (2010): 4635-43. doi:10.1182/blood-2010-01-261859
20. AlShahrani, Mohammad S. "Prevalence of obesity and overweight among type 2 diabetic patients in Bisha, Saudi Arabia." *Journal of family medicine and primary care* vol. 10,1 (2021): 143-148. doi:10.4103/jfmprc.jfmprc_1349_20
21. Alasmari, Sultan Z et al. "Body Mass Index and Its Association with Genetically Transmitted Traits." *BioMed research international* vol. 2020 3469316. 21 Dec. 2020, doi:10.1155/2020/3469316
22. Asafa MA, Ogunlade O, Bolarinwa RA, Bisiriyu LA, Asafa ST (2019) ABO Blood Group: Its Relationship with Anthropometric Parameters Among Young Adult Nigerians of Yoruba Ethnicity. *Int J Blood Res Disord* 6:040. doi.org/10.23937/2469-5696/1410040
23. Aboel-Fetoh, Nagah M et al. "ABO blood groups and risk for obesity in Arar, Northern Saudi Arabia." *The Journal of the Egyptian Public Health Association* vol. 91,4 (2016): 169-173. doi:10.1097/01.EPX.0000508457.31670.20
24. Chandra, Tulika, and Ashish Gupta. "Association and Distribution of Hypertension, Obesity and ABO Blood groups in Blood Donors." *Iranian journal of pediatric hematology and oncology* vol. 2,4 (2012): 140-5.
25. Salem, Gehan I et al. "Clinical Impact of the ABO Blood Type in Patients with Rheumatic Diseases: Is there a Link to the ABO and Rhesus?." *Mediterranean journal of rheumatology* vol. 32,3 237-242. 30 Sep. 2021, doi:10.31138/mjr.32.3.237
26. Groot, Hilde E et al. "Genetically Determined ABO Blood Group and its Associations With Health and Disease." *Arteriosclerosis, thrombosis, and vascular biology* vol. 40,3 (2020): 830-838. doi:10.1161/ATVBAHA.119.313658