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Study of relation between various ABO – Blood groups and body mass index

Pranoti P. Shinde[1], Sachin H Mulkutkar[2]
[1] Assistant Professor, Department of Physiology, Grant Government Medical College, Mumbai, Maharashtra, India
[2] Professor & Head, Department of Physiology, Grant Government Medical College, Mumbai, Maharashtra, India

Abstract
Introduction: Blood group is a classification of blood, based on the presence or absence of surface antigenic substance on the red blood cells. ABO blood group system is widely known and studied for its relation with various diseases and their complications. The idea of correlating diseases with blood groups started with the observation that certain diseases are common in persons with common racial and ethnic origin. For example, Arid *et al* [1] found that peptic ulcer is to predominate in blood group O and that gastric carcinoma is found more frequent in blood group A.
Obesity is defined by World Health Organization (WHO) as abnormal and excessive fat accumulation [2]. Obesity is an important risk factor for many non-communicable diseases such as metabolic syndrome, type 2 diabetes, cardiovascular diseases and cancer [3-5]. The prevalence of overweight and obesity in most developed and developing countries have been increasing markedly [6] over the few years. Obesity has been linked to more deaths than the underweight population [7].
Body Mass Index (BMI) is a good measure of general adiposity [8]. The proposed classification based on BMI is: underweight with BMI <18.5, 18.5-24.9 is normal BMI range, 25-29.9 are preobese, 30-34.9 are classified as obese class I, 35-39.9 obese class II and >40 are obese class III. Body mass index being a modifiable risk factor can be assessed in time and blood groups being non modifiable risk factor should be identified as being prone to developing obesity, so that population can be accordingly counseled for the life style modifications and thus be prevented from major diseases associated with increased BMI [5].
Hence this study was planned with an attempt to explore relationship between blood group antigens and BMI to predict the type of population which is more prone to be obese and hence at risk of many associated diseases, which can be modified by simple modification of lifestyle. And education of the community for the primary prevention in 'at risk' blood group to reduce emergence of the disease in the population.
Method: The present study was a prospective, cross sectional, single centric, open labeled, observational study conducted in the Department of Physiology in collaboration with blood bank in Tertiary care hospital. Before commencement of the project, approval was taken from the Institutional Ethical Committee. The data collection was done between December 2016 to August 2018 and data was analysed between September 2018 to November 2018. The study design involved 500 individuals who were the voluntary healthy blood donors (both male and female) participating in blood donation camp. Subjects were briefed about the rationale of the study and were assured that information provided by them — including name, identity and data — would not be disclosed at any time [9].
Written informed consent was taken after explaining to the subject about the study in English / Hindi / Marathi, language which they can understand. This study was carried out within the acceptable ethical norms [10].
Relevant information including name, age, sex, occupation, place of residence, medical history was documented and clinical examination of the subjects was carried out following a pre-designed proforma [9]. Donors were deferred or accepted according to their medical history regarding chronic or acute diseases [5].
It was followed by physical examination of the donor. Blood was taken from a donor only after fulfilling all the eligibility criteria of a healthy donor and healthy clinical parameters.
Observation: As observed, maximum number of people belonged to preobese category, which was predominated by the age group of 18 - 30 years. While analysis of obesity cadre gave a result as those belonging to 31 - 40 years of age group were the main population (50%) contributing to obese people than the major group of 18 - 30 years which predominated normal and preobese population.
Though the total population in the study was predominated by B blood group, maximum number of obese people were from O blood group. Normal and preobese groups were dominated by B positive blood group while obese by O positive blood group followed by B. Rh positive being the highest population available, the Rh relation to BMI was not studied.

Keywords: Body mass index, BMI, blood groups, ABO blood group, obesity

Introduction

Blood group is a classification of blood, based on the presence or absence of surface antigenic substance on the red blood cells. Till date, 30 human blood groups are recognized by the International Society of Blood Transfusion [1]. Nine of these systems namely ABO, Rh, Kell, Kidd, Duffy, MNS, P, Lewis and Lutheran are considered to be clinically important [2]. Among them ABO blood group system is widely known and studied for its relation with various diseases and their complications. The idea of correlating diseases with blood groups started with the observation that certain diseases are common in persons with common racial and ethnic origin. For example, Arid *et al* [3] found that peptic ulcer is to predominate in blood group O and that gastric carcinoma is found more frequent in blood group A.

ABO blood group system was the first human blood group system discovered by Austrian Scientist [4] Karl Landsteiner in 1900. It classifies blood groups into A, B, AB and O blood groups. It follows the Landsteiner's law which quotes a relation between the presence of agglutinogens and their corresponding agglutinin in the plasma of the individual. The reaction between the agglutinogen and agglutinin, the agglutination reaction, forms the basis of identification of the ABO blood group. Agglutinogen A and B are inherited as Mendelian dominant. Blood groups have been of great interest for the researchers because of their association with different types of diseases like hypertension, diabetes [5] cardiovascular diseases, gastric cancer, HIV infection and more to enumerate. Also blood group is one of the important and comparatively known parameter to the large number of population. During the world wars, it was discovered for the first time that the frequency of ABO and Rhesus blood groups was different in persons native to different parts of the world [6]. Blood group B is the most common blood group found in India followed by O blood group.

Obesity is defined by World Health Organization (WHO) as abnormal and excessive fat accumulation [7]. Obesity is an important risk factor for many non-communicable diseases such as metabolic syndrome, type 2 diabetes, cardiovascular diseases and cancer [8-10]. Decrease in quality of life is one of substantial psychosocial consequences of obesity [11-13]. The prevalence of overweight and obesity in most developed and developing countries have been increasing markedly [14] over the few years. Obesity has been linked to more deaths than the underweight population [15].

Among the different blood groups, ABO system was the first to be professed and has been characterized as a genetic marker for obesity [16]. Many studies show an association between ABO blood group and some obesity co-morbidities such as Type II Diabetes Mellitus, hypercholesteremia, hypertension, myocardial infarction and certain cancers [17-23].

Hence an attempt to quantify obesity is the important lead for today's world. In 1997, the practicable system for classification of overweight and obesity was first introduced in the report prepared by WHO [24]. After that, it has been adopted internationally [25]. This system was named as Body Mass Index (BMI), the weight in kilograms divided by the square of the height in meters [16] and known as Quetelet's Index. Body Mass Index (BMI) is commonly used to classify underweight, overweight and obesity in adults. It is age-independent and is same for both the genders. As an individual's height and weight can be readily and inexpensively measured, BMI has become a popular approximation for body fatness [26]. Body Mass Index (BMI) is a good measure of general adiposity [27]. The proposed classification based on BMI is: underweight with BMI <18.5, 18.5-24.9 is normal BMI range, 25-29.9 are preobese, 30-34.9 are classified as obese class I, 35-39.9 obese class II and >40 are obese class III.

Body mass index being a modifiable risk factor can be assessed in time and blood groups being non modifiable risk factor should be identified as being prone to developing obesity, so that population can be accordingly counseled for the life style modifications and thus be prevented from major diseases associated with increased BMI [5]. Bhattacharyya *et al* [10] and Haris *et al* [25] revealed in their study that subjects with blood group B had greater BMI than other blood types. Behera *et al* [28]. found that the blood group AB and Rh negative was associated with the highest number of obese subjects. Qunq *et al* [29] revealed that the patients with blood group B were more susceptible to be obese compared to those with the other blood groups. Ainee *et al*.[7] and Krishnakanth *et al* [30]. found higher incidence of obesity among the children with blood group O as compared to children with the other blood groups. On the other hand, Jafari *et al* [31]. revealed that there was no relationship between blood groups and BMI [16].

Hence this study was planned with an attempt to explore relationship between blood group antigens and BMI to predict the type of population which is more prone to be obese and hence at risk of many associated diseases, which can be modified by simple modification of lifestyle. And education of the community for the primary prevention in 'at risk' blood group to reduce emergence of the disease in the population.

Methods

The present study was a prospective, cross sectional, single centric, open labeled, observational study conducted in the Department of Physiology in collaboration with blood bank in Tertiary care hospital. Before commencement of the project, approval was taken from the Institutional Ethical Committee. The data collection was done between December 2016 to August 2018 and data was analysed between September 2018 to November 2018. The study design involved 500 individuals who were the voluntary healthy blood donors (both male and female) participating in blood donation camp. Subjects were briefed about the rationale of the study and were assured that information provided by them — including name, identity and data — would not be disclosed at any time [32]. Written informed consent was taken after explaining to the subject about the study in English / Hindi / Marathi, language which they can understand. This study was carried out within the acceptable ethical norms [33].

Relevant information including name, age, sex, occupation, place of residence, medical history was documented and clinical examination of the subjects was carried out following a pre-designed proforma [32]. Donors were deferred or accepted according to their medical history regarding chronic or acute diseases [33].

Inclusion Criteria

1. **Age:** 18 – 60 years
2. **Gender:** Male / Female
3. **Weight:** more than 50 kg
4. Voluntary healthy individuals giving consent to be a part of this study
5. Clinically normal [34] (BP evaluation: Systolic BP between 110 to 130 mm Hg and Diastolic BP between 80 to 90 mm Hg. If BP was found to be more than these values subjects were made to rest for 20 minutes and repeat Blood Pressure was taken. If found to be normal then was included in the study. Also Pulse rate within normal range for the age and gender, usually well within the range of 60 to 100/ min.)
6. **Hemoglobin levels:** more than 12.5 g%

Exclusion Criteria

1. History of any long-term disease which is on treatment (like Diabetes Mellitus, Hypertension, Tuberculosis, Thyroid, etc.)
2. Addictions like alcohol, tobacco, etc.
3. Pregnancy
4. Spinal deformities like kyphosis, kyphoscoliosis
5. Subjects administering: steroids, oral contraceptives, diuretics, and beta blockers [35]

B.M.I. Calculation

Body Mass Index (BMI) was calculated by Quetelet index weight (kg) divided by height squared (meter) by using Microsoft Excel for the calculation instead of BMI calculator to avoid the error of reporting [26]. B.M.I. so calculated was analyzed according to the World Health Organization standard classification.

1. **Underweight:** BMI <18.5
2. **Normal range:** 18.5 - 24.9
3. Overweight
   a. **pre-obese:** 25 - 29.9
   b. **obese class I:** 30 - 34.9
   c. **obese class II:** 35 - 39.9
   d. **obese class III:** >40

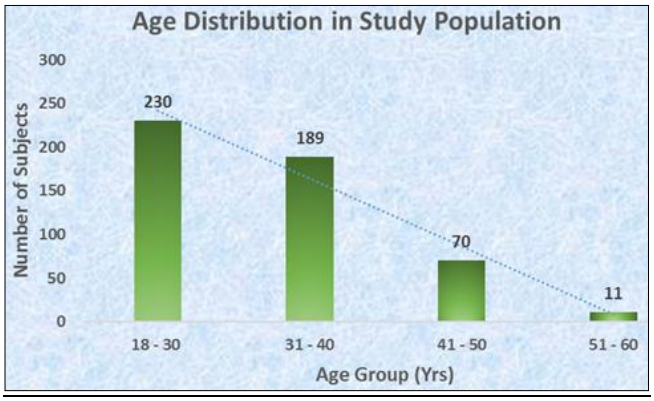
Data entry & statistical analysis

Descriptive data was expressed as percentage and was analysed by means, standard deviation and was represented in tabular and graphical format. While quantitative data was analysed by applying Chi - square test of independence. The confidence limit was kept at 95 % hence p value < 0.05 was considered to be statistically significant [16, 33].

Risk Factors

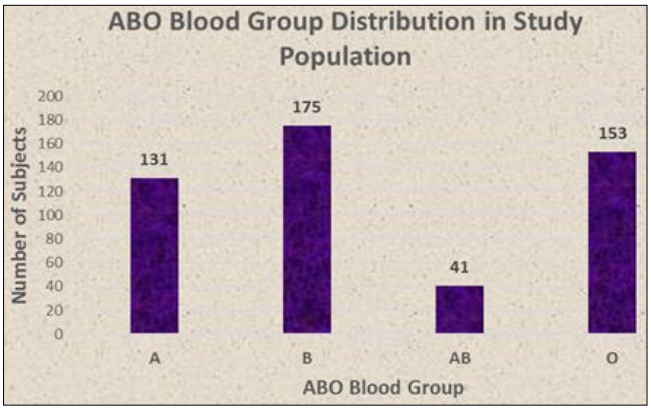
There was no risk factor for the subjects as well as clinician involved in the study.

Observation



Graph 1: Age Distribution in Study Population

The study population involved 500 participants in the age range of 20 - 56 years with the mean age as 32.62 ± 7.53. It was observed that maximum number of participants (230) were from the age group 18 - 30 years followed by age group 31 - 40 years with 189 participants.



Graph 2: ABO Blood Group Distribution in Study Population

It was observed that maximum number of participants in study population belonged to B blood group followed by O. 35% subjects were found to be of B blood group and 30.6% of O blood group. 26.2 % of the people were of A and very less number of people (8.2%) were found representing AB blood group in the normal study population with the sample size as 500.

Table 1: Number of subjects with different ABO blood groups with different BMI

ABO blood groups ↓ / BMI →	Normal	Preobese	Obese
A	37	73	21
B	64	79	32
AB	6	27	8
O	43	77	33
Total	150	256	94

p value: 0.0341

The study population was grouped into two groups as people with Normal BMI and with deranged BMI which included both preobese and obese categories. Hence the table for statistical analysis was

Table 2: Blood Group and BMI distribution in Study Population

ABO blood groups ↓ / BMI →	Normal	Deranged BMI
A	37	94
B	64	111
AB	6	35
O	43	110
Total	150	350

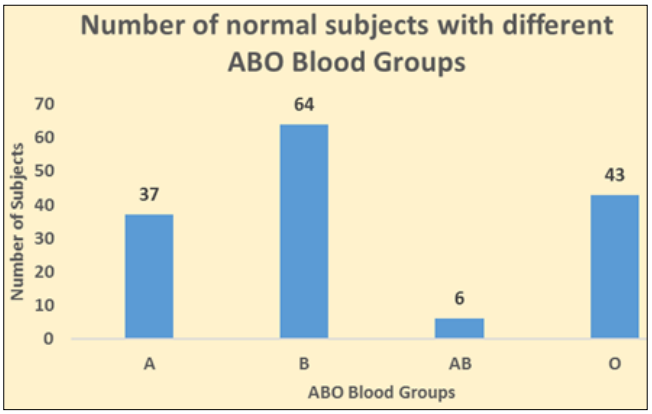
Chi square test of significance was applied to these observations with significance value set to 0.05. Where the p value was found as 0.0341 which was statistically significant.

Table 3: Percentage of subjects with different ABO blood groups with different BMI

ABO blood groups ↓ / BMI →	Normal (%)	Preobese (%)	Obese (%)
A	24.66	28.51	22.34
B	42.66	30.85	34.04
AB	4	10.54	8.51
O	28.66	30.07	35.10

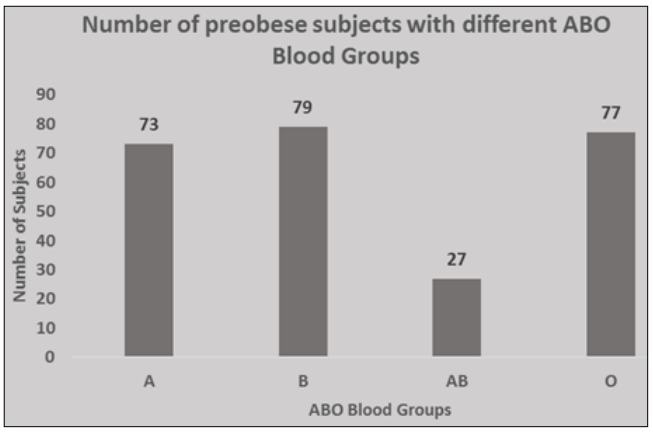
From the previous observation (Graph No 2) it is known that maximum population belonged to B blood group followed by O. On co-relating blood group to BMI it was found that O blood group people predominate the obese population with 35.10% contribution as compared to the blood group B which had contribution of 34.09%. Chi

square test of independence was applied. p value was found to be significant.



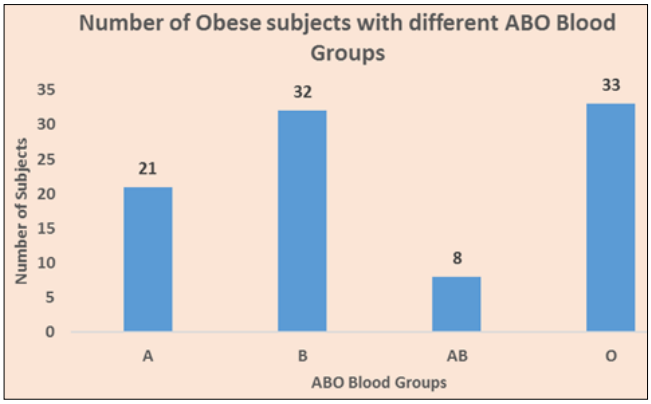
(Total number of normal subjects = 150)

Graph 3: Number of normal subjects with different ABO Blood Groups



(Total number of preobese subjects = 256)

Graph 4: Number of preobese subjects with different ABO Blood Groups



(Total number of obese subjects = 94)

Graph 5: Number of obese subjects (94 number) with different ABO Blood Groups

Table 4: Number of subjects with different ABO & Rh blood groups with different BMI

ABO & Rh blood groups ↓ / BMI →	Normal	Preobese	Obese
A Positive	34	70	20
A Negative	3	3	1
B Positive	60	75	31
B Negative	4	4	1
AB Positive	6	24	7
AB Negative	0	3	1
O Positive	41	70	32
O Negative	2	7	1
Total	150	256	94

Combined study of the above tables and charts gives this finding as normal and preobese dominated by B positive blood group while obese by O positive blood group.

Discussion

It was observed that maximum number of participants in study population belonged to B blood group followed by O. 35% subjects were of B blood group and 30.6% of O blood group. 26.2 % of the participants were of A and very less number of people (8.2%) were found representing AB blood group in the normal study population with the sample size as 500. The frequency of distribution of ABO blood groups in the current study population was B > O > A > AB with Rh positive being more to Rh negatives. Hence the blood group distribution in the study population in terms of both ABO and Rh blood groups was B positive > O positive > A positive > AB positive followed by the nearly similar distribution of Rh-negative blood group with AB negative being the least common blood group.

This result of ABO blood group distribution goes in accordance with Ashish Getaneh Alemu *et al* [36], Anjulika Mehta *et al* [37], Behra Rajshree *et al* [38], Qater Al-nada Ali Kanaem AL-Ibady *et al* [39], Shairoly Singh [40]. Tulika Chandra *et al* in "Association and Distribution of Hypertension, Obesity and ABO Blood groups in Blood Donors [33]" and Tulika Chandra *et al* in "Prevalence of ABO and Rhesus Blood Groups in Northern India Journal of Blood Disorders & Transfusion [34]." also state the similar finding of B blood group being the most common blood group seen within Indian population.

Various studies have shown different findings for the distribution of ABO blood groups as there is a wide variation of blood group frequency in different parts of the world due to the influence of genetic and environmental factors. Ahmed Khudhair Abdulridha AL-Ganimie *et al* [16], Teklu Zerihun *et al* [41]. Roland Bamou*et al* [42], Chandrika Rao *et al* [43] are found to state blood group distribution as O > B > A > AB.

Noting the fact that underweight population was not selected for both blood donation and the study group, 30% participants of the total study population of 500 were found to have normal BMI i.e. between 18.5 – 24.9 kg/m [2]. 51.2% of the study population was from BMI range 25 – 29.9 kg/m [2] i.e. preobese. While 18% of the population belonged to Obese category with BMI ≥ 30. The analysis of BMI was done between normal, preobese and obese group dividing them mainly into two groups first being of normal population and others with deranged BMI i.e. both preobese and obese. Average BMI of the study population was 26.8 Kg/m [2] ± 3.6. Though among the total of the study population B blood group was more, maximum number of obese people were from O blood group. Normal and preobese people were seen to have B blood group than any other. On application of Chi-square test of independence to find out the relation between ABO blood groups and obese and normal people, it was found that O blood group have higher tendency to be obese than to any other ABO blood group followed by B blood group. Since the p value was < 0.05, the finding was significant. Other studies with similar findings were KGV Siva *et al* [30] and S. Behera *et al* [28]. Some other studies with similar aim gave the finding as the tendency to develop obesity in relation to blood groups could be stated as B > O > A > AB Chandra Kala Rai *et al* [71] and YA Qung *et al* [29]. And the studies like Esra Hassan Al –Hashemy *et al* [44] and Hermann Slatis *et al* [45] gave a conclusion of there being no statistically significant association between ABO blood groups and BMI.

The analysis of relation between Rh blood group and obesity could not be done as there was wide variation in number of Rh positive and Rh negative population. Ahmed Khudhair Abdulridha AL-Ganimi *et al* [16] stated Rh negative as the population with higher BMI than Rh positive population.

Conclusion

Following conclusions can be drawn from the present study

- Maximum blood donors are from age group 18-40 years of age.
- Males predominate in blood donation when compared to females.
- B blood group is the most common blood group in this geographical area.
- Rh positive blood group is predominant to Rh negative blood group.
- O blood group people are more prone to be obese with followed by B blood group.
- Population with O and B blood group need to be encouraged for life style modifications to prevent obesity and its further complications.

Limitations

The study could have been more effective if sample size could have been increased. So that the findings can be applied to the regional population. Small sample size of present study was because of limitation for duration of study.

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