Original Article

Assessment the Relation between the Blood Groups and Body Mass Index According to Gender

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Abstract

Background: According to reports, the ABO blood grouping was linked to the risk for and consequences of a number of illnesses and infections. Obesity, which is among the most prevalent disorders that can beprevented,, is a major public health concern. The causes of obesity are multifaceted and include genetic, environmental, and socio-economic factors. **Aim:** This study aims to discover the association of blood groups with BMI in both genders, which blood group is more likely to developobesity,, and the prevalence of obesity in the sample. **Materials and Methods:** A cross-sectional study was performed on (253) individuals from Mosul City. Weight and height were taken, and BMI was calculated. The blood group was determined by using the slide agglutination test. **Results:** This study included (58.1%) female and (41.9%) male participants, with a mean age (22.024 ± 7.872 years). Obesity and overweight had respective prevalence rates of (24.5%) and (9.1%), mostly in males. The prevalence of blood groups was as follows: O (36.8%), A (29.2%), B (26.1%), and then AB (7.9%). Rh-positive factor was found in (88.9%). No statistical differences were observed among the blood groups regarding mean BMI ($P = 0.513$) and gender ($P = 0.487$), and Rh blood group did not seem to be associated with participants' BMI ($P = 0.915$) or gender ($P = 0.482$). There was no significant association between blood types and BMI. **Conclusion:** There is no association between BMI and blood groups in both genders, although a prevalence of blood group type O and Rh-positive can be seen in the distribution of blood groups, and in contrast to other studies, the obesity and overweight prevalence in this group were lower.

Keywords: ABO blood group, body mass index, obesity, Rh blood group

Introduction

Blood groups

A blood group (BG) system is characterized serologically by a particular antibody and consists of hereditary antigens produced by one gene or a set of ≥ two homologous genes. The "International Society of Blood Transfusion" now recognizes 43 BG systems with 345 antigens for human red blood cells (RBCs) that are genetically defined by 48 genes.[1]

ABO system

The ABO BG, the most significant in transplantation and transfusions of blood, was first identified by Karl Landsteiner in 1900[2] and is divided into types "A, B, AB, and O" depending on the presence of agglutinogens, commonly known as blood group antigens; which are glycoprotein antigens that are expressed on the surface of RBCs. Many glycoprotein antigens exist, but the A and B antigens are the most significant.[1,3,4] The gene on chromosome 9 is responsible for the ABO BG system, which is composed of three alleles: I^A, I^B, and I^O. It is noteworthy that ABO antigens are expressed in a wide range of tissues and cells, including the endothelium of blood vessels, epithelial cells, thrombocytes, and nerve cells, in addition to on the surface of RBCs.[5] People who express a certain A or B antigen are immune to it, while

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people who do not have that antigen create antibodies that naturally identify it.[6]

Rh blood group system

The Rh system holds the highest clinical significance after the ABO system. Although it actually comprises many more antigens, it is predominantly made up of the C, D, and E antigens. Among them, D is the most antigenic one. Rh-positive or Rh-negative status is, therefore, indicated according to the existence or lack of D-antigen, respectively.[2,4]

Body mass index

"Body mass index" (BMI) is a means to determine if a person is overweight or obese. Obesity, which is among the most prevalent diseases that can be prevented, is a major public health concern. The causes of obesity are multifaceted and include genetic, environmental, socio-economic, and psychological or behavioral factors.[7]

ABO blood group and other diseases

According to reports, the ABO blood grouping was linked to the risk for and consequences of a number of illnesses and infections such as cardiovascular and coagulation diseases, tumors, sepsis, and COVID-19 infection severity.[8-10] These studies aid in identifying the disease's susceptibility and in developing preventive strategies to lower the incidence.

Many studies have ascertained whether having a certain ABO and Rh blood antigen would make someone more likely to have a higher BMI. Yet, these research studies came to conflicting conclusions about the relationship between ABO/Rh status with BMI. If we can identify the blood type that is more susceptible to obesity, we can concentrate more effort on preventing obesity in those who have this blood type.

This study aimed to discover the following: blood group associations with BMI in males and females, which blood group is more likely to develop obesity, and the prevalence of obesity within the sample of study.

Materials and Methods

After gaining Institutional Ethics approval and informed consent from each participant, a cross-sectional study was performed on (253) individuals from Mosul City including young and middle-aged groups, who did not have any chronic illnesses, were not on diet restriction, and were non-pregnant women. A short personal, medical, surgical and drug history was taken from each participant by answering questionnaire forms.

Weight and height were taken, and BMI was calculated for each participant by dividing body weight by height (Kg/m^2), and BMI classification according to "World Health Organization" (WHO) was used as shown in Table 1.[11]

Table 1: Classification of BMI

BMI	Classification
Below 18.5	Underweight
18.5 to 24.9	Normal weight
25.0 to 29.9	Overweight
30.0 or more	Obesity

Blood group was determined by the slide agglutination test. By using a clean glass slide divided into three divisions and under aseptic conditions, a blood drop was obtained by a finger-prick, for each part, and then mixed separately with "anti-A, anti-B and anti-D" sera. The BG will be determined within several minutes by checking the agglutination reaction.[12]

Statistical analysis

"Microsoft Excel 2007" sheets were used to summarize the study's data collection, and "IBM-SPSS 26" was used for statistical analysis. These data's normality was determined using the "Shapiro-Wilk test," and we applied parametric tests. Standard deviation and mean were used to express the data. The difference in two groups was calculated using the "*t* test" for independent two means. The difference between the means of ≥ two groups was determined using a "one-way ANOVA test." If any cell has an anticipated value of < 5, the "Freeman-Halton Exact test" was employed in more than 2 by 2 tables. The "Chi-square test" was utilized to evaluate the differences for the nominal data. Age, sex, blood type, and Rh group were employed as independent variables, and "linear regression" was applied to analyze the association and predictability between obesity and these variables. Significant results are those with "$P \leq 0.05$."

Results

Table 2 displays the descriptive data of the participants in the study, in which the mean age for the sample was (22.024 ± 7.872 years). The mean height was (165.958 ± 9.311 cm), and mean weight was (66.362 ± 14.814 kg). Mean BMI for the study sample was (23.981 ± 4.386). There was female predominance, representing 58.1%, while males constituted 41.9% of the sample. The commonest blood group was O, found in 93(36.8%). Rh-positive factors were found in 88.9%.

The percentages of subjects who are underweight, normal, overweight, and obese are shown in Table 3 demonstrating that most of the study sample had normal BMI 155(61.3%), mostly females. Overweight and obesity were found in 24.5 and 9.1%, respectively, participants, mostly in males.

Associations between ABO BG and BMI and the gender of the study participants are demonstrated in Table 4. This table revealed that there were nonstatistically significant variations in mean BMI between the ABO BGs. No sex-related statistically significant difference between the ABO BGs is shown.

Table 5 shows the association between individuals' Rh blood group, BMI, and gender, but does not indicate any significant variations.

Table 6 shows the association between blood types and BMI for all subjects, but nonstatistical significant differences were found.

Association between blood types and BMI for female participants is demonstrated in Table 7 and showed nonstatistical significant differences.

Table 2: Participants' descriptive statistics

Variables	Mean	SD
Age (years)	22.024	7.872
Height (cm)	165.958	9.311
Weight (kg)	66.362	14.814
BMI	23.981	4.386
Sex	No.	(%)
Female	147	58.1
Male	106	41.9
Blood group	No.	(%)
A	74	29.2
B	66	26.1
AB	20	7.9
O	93	36.8
Rh	No.	(%)
Positive	225	88.9
Negative	28	11.1

Table 8 shows the association between individuals' male blood type and BMI; however, nonstatistical significant differences were found.

Linear regression of obesity with age, sex, blood groups, and Rh groups is shown in Table 9 and shows that the predictors explained 29.2%, and the overall significant effect was discovered, $F = 25.51$, $P = 0.000$. Age and sex were the only two individually significant predictors.

Discussion

To our knowledge, this is the first cross-sectional study performed in Mosul City, Iraq, studying the association of BG with BMI and gender with the purpose to take preventive measures, such as diet and lifestyle changes, for those with a blood group highly susceptible to developing obesity, which is linked to progression to many diseases.

Studying BG distribution frequency is significant for healthcare, blood transfusion, and blood group–disease association.[13] This study demonstrated a predominance of blood type O, followed by A, B, and AB groups, a result that is similar to other studies in Iraq[13-16] and in other countries,[17-20] Although Smith *et al.*[21] in Ghana and Agrawal *et al.*[22] in India showed a predominance of blood type O, followed by B, Sari *et al.* GÖK showed a predominance of blood type A in Turkey,[23,24] and Jawed *et al*. in Pakistan[25] showed a predominance of blood type B. Consistently, as in this study, all ethnicities in the mentioned studies showed that the AB blood type was the least common blood type and a greater prevalence of Rh-positive individuals was observed as compared to Rh-negative individuals. The ABO BG system distribution varies among the world population and even within population subgroups, and this was found to be due to

Table 3: Percentage of subjects who are underweight, normal, overweight, and obese

BMI	Female		Male		Total	
	No.	%	No.	%	No.	%
Underweight	10	6.8	3	2.8	13	5.1
Normal	97	66.0	58	54.8	155	61.3
Overweight	28	19.0	34	32.1	62	24.5
Obese	12	8.2	11	10.3	23	9.1
Total	147	100.0	106	100.0	253	100.0

Table 4: Association between participants' gender, BMI, and ABO blood group

Parameter		A ($n = 74$)	B ($n = 66$)	AB ($n = 20$)	O ($n = 93$)	P value*
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Mean BMI		24.138 ± 4.763	24.476 ± 5.603	22.976 ± 2.650	23.720 ± 3.252	0.513
Sex	Female	44 (59.5)	34 (51.5)	14 (70.0)	55 (59.1)	0.487**
	Male	30 (40.5)	32 (48.5)	6 (30.0)	38 (40.9)	

*One-way ANOVA;

**Chi square test

Table 5: Association between participants' gender, BMI, and Rh blood group

Parameter		Rh + (n = 225)	Rh – (n = 28)	P value*
		Mean ± SD	Mean ± SD	
Mean BMI		23.445 ± 4.432	23.565 ± 4.706	0.915
Sex	Female	129 (57.3)	18 (64.3)	0.482**
	Male	96 (42.7)	10 (35.7)	

*t test for independent two means;
**chi square test

Table 6: Blood type and BMI association for all participants

Variable	Mean BMI	Underweight	Normal	Overweight	Obese	Total
A+	24.275 ± 4.769	3 (4.5)	41 (62.2)	15 (22.4)	8 (11.9)	67
A–	22.819 ± 4.842	1 (14.3)	4 (57.1)	1 (14.3)	1 (14.3)	7
B+	24.187 ± 5.562	7 (11.7)	31 (51.6)	15 (25.0)	7 (11.7)	60
B–	27.358 ± 5.667	0 (0.0)	1 (16.7)	4 (66.6)	1 (16.7)	6
AB+	22.807 ± 2.747	0 (0.0)	12 (70.6)	5 (29.4)	0 (0.0)	17
AB–	23.935 ± 2.174	0 (0.0)	2 (66.7)	1 (33.3)	0 (0.0)	3
O+	23.677 ± 3.246	2 (2.5)	56 (70.4)	18 (22.2)	5 (6.2)	81
O–	24.007 ± 3.423	0 (0.0)	8 (66.7)	3 (25.0)	1 (8.3)	12
P value	0.534*	0.180**	Ref.	0.347**	0.345**	253

*One-way ANOVA;
**Freeman–Halton Exact test

Table 7: Blood type and BMI association for female participants

Variable	Mean BMI	Underweight	Normal	Overweight	Obese	Total
A+	23.621 ± 5.180	3 (8.1)	25 (67.6)	5 (13.5)	4 (10.8)	37
A–	22.819 ± 4.842	1 (14.3)	4 (57.1)	1 (14.3)	1 (14.3)	7
B+	23.374 ± 5.174	4 (12.5)	19 (59.4)	7(21.9)	2 (6.2)	32
B–	28.042 ± 12.176	0 (0.0)	1 (50.0)	0 (0.0)	1 (50.0)	2
AB+	22.565 ± 2.824	0 (0.0)	9 (75.0)	3 (25.0)	0 (0.0)	12
AB–	23.557 ± 2.932	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	2
O+	23.576 ± 3.629	2 (4.2)	33 (68.7)	9 (18.8)	4 (8.3)	48
O–	23.033 ± 2.346	0 (0.0)	5 (71.4)	2 (28.6)	0 (0.0)	7
P value	0.899*	0.546**	Ref.	0.959**	0.548**	147

*One-way ANOVA;
**Freeman–Halton exact test

Table 8: Blood type and BMI association for male participants

Variable	Mean BMI	Underweight	Normal	Overweight	Obese	Total
A+	25.081 ± 4.153	0 (0.0)	16 (53.4)	10 (33.3)	4 (13.3)	30
A–	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0
B+	25.117 ± 5.931	3 (10.7)	12 (42.8)	8 (28.6)	5 (17.9)	28
B–	27.016 ± 1.909	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	4
AB+	23.386 ± 2.766	0 (0.0)	3 (60.0)	2 (40.0)	0 (0.0)	5
AB–	24.691 ± 0.0	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1
O+	23.824 ± 2.638	0 (0.0)	23 (69.7)	9 (27.3)	1 (3.0)	33
O–	25.369 ± 4.471	0 (0.0)	3 (60.0)	1 (20.0)	1 (20.0)	5
P value	0.718*	0.102**	Ref.	0.165**	0.334**	106

*One-way ANOVA;
**Freeman–Halton exact test

Table 9: Linear regression of obesity with age, sex, blood groups, and Rh groups

Model	Unstandardized coefficients		Standardized Coefficients	*t* value	*P* value	*F*	*R*	R^2	Adjusted R^2
	B[a]	Std. error	Beta						
Constant)	19.902	1.338		14.879	0.000	25.51	0.540	0.292	0.280
Age	0.290	0.030	0.520	9.666	0.000				
Sex	–1.732	0.477	–0.195	–3.629	0.000				
Blood group	–0.133	0.187	–0.038	–0.712	0.477				
RH	0.698	0.748	0.050	0.934	0.351				

[a]Dependent variable: BMI

genetic factors, invasions, migration, and marriage with other ethnic groups.[13,26,27]

Compared to other research, this study demonstrated a lower prevalence of overweight (24.5%) and obesity (9.1%).[28-33]This may be due to differences in the type of samples collected or due to improved health education or consumption of different diets and physical activities.

Although several studies had been performed on the association between BG and BMI, the results are still conflicting. This research showed a nonsignificant association between blood types with BMI in both males and females. This result was similar to those of research done by Alwasaidi *et al.*[16] and Aboel-Fetoh *et al*[34] in KSA, Siddiqui *et al.* in India,[35] Andalibi *et al.*[19] and Jafari *et al*[36] in Iran, Khan *et al.* in Lahore,[37] and Mascie-Taylor and Lasker in UK.[38]

While other authors showed an increase in BMI associated with the presence of a certain ABO antigen, Kadhum *et al.*[15] found that (O+) people are more vulnerable to increase in BMI, Eren *et al.*[39] concluded a significantly association between BG and obesity with a higher rate of obesity found within the (A+) blood group, and Mashahit *et al.*[40] indicated a significant association with the O type but no significant differences regarding the Rh blood group. Nas *et al.*[41] found the highest BMI in the (AB -) blood group.

The result of this study was not surprising owing to prior knowledge that the obesity-related genes "FTO, FABP2, LEP, LEPR, and MC4R" are not located on the same ABO chromosome.[42] Another point of view is that no scientific evidence supports the effect of a certain diet for each type of ABO "blood-type diet." Physiologically, red blood cells are not engaged in food digestion, intestinal absorption, or metabolism.[43-46]

The different results regarding the association between BG with BMI may be due to local factors or differences in sample type or size rather than real genetic effects.

Conclusion

The study's findings indicate that there is no association between BMI and BG in both genders, and that a prevalence of type O and Rh-positive BG can be seen in the distribution of BG, and in contrast to other studies, the prevalence of obesity and overweight was lower in this group.

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Conflicts of interest

There are no conflicts of interest.

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