

Association of Body Mass Index with Blood Groups, Rh Factor, Obesity and Other Factors among Students of King Khalid University, Abha, KSA: A Cross-Sectional Study

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Abstract

Background: This study delves into the correlation between blood groups, Rh factor, and Body Mass Index (BMI) within the student cohort at King Khalid University. The research aims to uncover whether specific blood groups and Rh factors correlate with variations in BMI, an essential indicator of health status. Preliminary results indicate notable patterns, suggesting a possible link between certain blood types and BMI categories. This association could pave the way for personalized health interventions, emphasizing the importance of integrating genetic and physiological markers in health risk assessments. The findings hold the potential for enhancing targeted preventive strategies, contributing to the broader field of personalized medicine and public health.

Methods: A cross-sectional study was conducted, collecting sociodemographic data and BMI measurements by using questionnaire that contained sociodemographic data including weight, height, types of ABO blood groups and other related factors of the participants. Chi square and other statistical tests included, correlation and multiple linear regression were used.

Results: Total participants were 580, out of which, male were 350 (60.3%) and 230 (39.7%) were females. Most of the participants' age group was between 22 to 25 years. The maximum prevalence of obesity and overweight was found 15.2% and 12.1% in male compared to females. The most common blood group was O (32.6%) followed by the group A (29%), B (22.9%) and AB (15.5%) were found to be highly significant with BMI. In multiple linear regression, gender (coefficient = - 2.89, p = 0.000), residence (coefficient = - 1.80, p = 0.013) and blood group B (coefficient = 1.16, p = 0.039) were associated to BMI.

Conclusion: This study reveals possible genetic implications on obesity risk among King Khalid University's students by examining relationships between certain blood groups, the Rh factor, and BMI.

KEYWORDS: Blood Groups; Rh Factor; Body Mass Index (BMI); Obesity; Genetic Influences

Introduction

Blood groups, determined by the presence or absence of specific antigens on the surface of red blood cells, along with the Rh factor, a separate antigenic system, have traditionally been pivotal in transfusion medicine and genetic studies [1]. However, their potential influence extends beyond these areas, hinting at a complex relationship with metabolic processes, including those governing body weight and fat distribution. BMI, a quantitative measure of body fat derived from an individual's weight relative to their height, serves as a crucial indicator for assessing obesity, a condition with far-reaching health implications [2].

The study of blood groups and the Rh factor has historically been confined to the domains of transfusion medicine and genetic research [3]. However, recent studies have begun to unravel the broader implications of these biological markers, suggesting their influence extends into various aspects of human health, including predispositions to diseases, nutritional metabolism, and even psychological traits. The Body Mass Index (BMI), a widely recognized measure of body fat based on height and weight, has been extensively studied in relation to lifestyle diseases such as diabetes, cardiovascular diseases, and obesity [4]. The intersection of these seemingly disparate domains-blood groups, Rh factor, and BMI-offers a promising avenue for research, particularly in the context of preventive healthcare and personalized medicine [5].

King Khalid University, with its diverse student population, provides an ideal setting for such an investigation. Students, often at the cusp of transitioning into adulthood, present a dynamic cohort where genetic predispositions and environmental influences converge. This period is marked by significant changes in lifestyle, dietary habits, and physical activity levels—all of which are known to influence BMI. Furthermore, the controlled environment of a university, coupled with the accessibility of a relatively homogenous population, facilitates a detailed study of the correlations between these biomarkers.

This research aims to explore the associations between blood groups, Rh factor, and BMI among students at King Khalid University. By elucidating these relationships, the study endeavors to contribute to the growing body of knowledge in the field of biometrics and health informatics. The significance of understanding these correlations lies not only in the academic contribution to genetic and nutritional epidemiology but also in the practical implications for designing targeted health interventions and policies. For instance, if certain blood groups are found to be associated with higher BMIs or specific health risks, this information could be used to tailor dietary recommendations, exercise programs, and even psychological support services to better meet the needs of these groups.

Moreover, this study aligns with the broader objectives of public health and personalized medicine, which seek to move beyond the one-size-fits-all approach to healthcare. By identifying specific biomarkers that may predispose individuals to certain health conditions, healthcare providers can offer more personalized advice, interventions, and treatments. This approach not only enhances the efficacy of healthcare strategies but also empowers individuals to make informed decisions about their health and lifestyle.

The study's approach will include a thorough evaluation of each student's BMI value in addition to a thorough review of the distributions of Rh factors and blood groups throughout the student body. To find any meaningful relationships, statistical methods will be used, accounting for a variety of confounding variables such as age, gender, food preferences, and levels of physical activity. Assuring a representative sample of the student body, considering the multifactorial impacts on BMI, and addressing the ethical issues surrounding genetic and health-related research are some of the expected problems of this study. To sum up, the purpose of this research is to clarify the complex connections that exist between blood types, Rh factor, and BMI among King Khalid University students. The goal of the research is to inform the creation of more sophisticated and successful health therapies by shedding light on the interactions between these biomarkers and environmental and lifestyle variables. This research has the potential to improve our understanding of genetics, nutrition, and public health from an academic standpoint as well as to provide guidance for real-world tactics aimed at improving student wellbeing and creating a healthier society.

Materials and Methods

Study design and participants

A cross-sectional descriptive study was conducted using a structured questionnaire among the students aged 18 years and above from King Khalid University (KKU), Abha, KSA. Abha is the capital of 'Asir Region in Saudi Arabia. It is situated 2,270 meters (7,450 feet) above sea level in the fertile Asir Mountains of south-western Saudi Arabia, near Asir National Park. Abha's mild climate makes it a popular tourist destination for Saudis. Saudis also call the city the Bride of Mountain due to its position above the sea. Abha was the capital city for the Prince of Asir Ibn Ayde under the authority of the Ottoman Empire until World War I. The city of Abha was composed of four quarters, the largest of which contains a fortress. Hilltop fortresses are a characteristic feature of the city [6].

Total bachelor students were reading around 32000 in many disciplines in KKU in 2023. A total of 580 participants in this study were obtained after obtaining informed consent for participation through google form. The participants with incomplete or missing data, or of an age below 18 years were excluded.

Data collection and analysis

The participants were provided with an electronically shared questionnaire that was well-designed. Six questions covering general demographic information are included in it, such as age, height, weight, marital status, type of ABO blood group with Rh factor, course discipline, yearly programme, and general opinions about blood givers, blood recipients, diet, smoking, and diseases linked to ABO blood groups and obesity. BMI was used to evaluate obesity adequately [7]. BMI was computed as the individual's weight in kilograms divided by the square of their height in metres [8, 9]. The weight classification was based on the WHO BMI classification as follows: underweight (BMI < 18.5), normal weight (BMI 18.50-24.99), overweight (BMI 25-

29.99), obese (BMI> 30) [3, 4]. The data were analyzed by using SPSS to determine any association between obesity and different ABO blood groups [10].

Sample Size Calculation

The calculation of sample size was done by using the Cochran formula [11, 12].

$$n = z^2 * p * q / d^2$$

Where n is the sample size, Z (1.96) the statistic corresponding to level of confidence, P is expected prevalence (50%), and d is marginal error 5% and additionally multiply design effect (1.5) in this cohort. The level of confidence used 95%.

Required sample size = $n * 1.5(\text{design effect}) = 576 \approx 580$.

Statistical Analysis

Data were entered in the computer using the IBM Statistical Package for the Social Sciences® (SPSS®) for Windows version 21.0 (SPSS Inc., New York, United States). The proportions were expressed as frequencies with percentage. Association among the variable was calculated by using Chi square and Fisher Exact test. Multiple linear regression was performed with BMI as the dependent variables. Sociodemographic and associated clinic variables were independent variables. Adjusted odds ratios (AORs) and Unadjusted odds ratio (UAORs), 95% confidence intervals (CIs), coefficients, and standard errors were calculated. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Sociodemographic and other related characteristics of students at King Khalid University, Abha

Variables	Subcategories	Total No. (N)	Percentage (%)
Gender	Female	230	39.7
	Male	350	60.3
Age group	18-21	216	37.2
	22-25	320	55.2
	>26	44	7.6
Residence	Other Than Asir Province	46	7.9
	Asir Province	534	92.1
Marital Status	Unmarried	540	93.1
	Married	40	6.9
Course Discipline	Applied Science	322	55.5
	Engineering	64	11.0
	Humanity	32	5.5
	Medicine	78	13.4
	Others	84	14.5
Yearly Program	1 st Year	92	15.9
	2 nd Year	86	14.8
	3 rd Year	174	30.0
	Final Year	228	39.3
Blood Group	A	168	29.0
	B	133	22.9
	AB	90	15.5
	O	189	32.6
Rh Factor	Negative	26	4.5
	Positive	554	95.5
BMI (Body Mass Index)	Underweight	70	12.1
	Healthy	292	50.3
	Overweight	122	21.0
	Obese	96	16.6
Blood Donate	No	408	70.3
	Yes	172	29.7

Blood Received	No	522	90.0
	Yes	58	10.0
Disease	No	354	61.0
	Anxiety/Depression	78	13.4
	Diabetes	42	7.2
	Hypertension	34	5.9
	Obesities/overweight	72	12.4
Smoking	No	476	82.1
	Yes	104	17.9
Diet	Vegetarian/Eggetarian	132	22.8
	Non-Vegetarian	448	77.2
Total		580	100%

Table 1 shows that total participant was 580 out of which, the majority of male students (60.3%) was found compared with females (39.7%), the age group distribution highlights that the majority of students fall into the 22-25 year age category (55.2%), followed by those aged 18-21 (37.2%), and a smaller percentage (7.6%) above the age of 26 years, the residence data shows that a significant majority of students (92.1%) come from the Asir Province, while a smaller portion (7.9%) come from other regions, marital status of participants indicates that the majority was unmarried (93.1%), while a smaller percentage was found to be married (6.9%), in academic disciplines, with Applied Science (55.5%) being the most common, followed by Engineering (11.0%), Medicine (13.4%), and others disciplines, another distribution across different academic years reveals that the final year was the highest representation (39.3%) compare to others, in blood groups and Rh factors provide insights into the blood composition of the student population were found relationship O(32.6%)>A(29%)>B(22.9%)>AB (15.5%) with (95.5%) positive Rh factors. Furthermore, the categorization of students into different BMI categories, including Underweight (12.1%), Healthy (50.3%), Overweight (21.0%), and Obese (16.6%), offers insights into the overall health and prevalence of weight-related issues among students, blood donation (29.7%) and reception (10.0%) behaviors among students is included and also Anxiety/Depression disease was maximum (13.4%) compare to others, majority of nonsmoker (82.1%) and in diet categories highest (77.2%) was found non vegetarian compare to others variables. This data can be significant for research focusing on blood-related health behaviors and their implications.

Table 2: Association between BMI, Sociodemographic and other factors

Variables		Underweight		Healthy		Overweight		Obese		Chi-square / Fisher Exact Test
		Freq uenc y	%	Freque ncy	%	Freque ncy	%	Frequen cy	%	
Gender	Female	20	3.4%	150	25.9%	52	9.0%	8	1.4%	p<.001
	Male	50	8.6%	142	24.5%	70	12.1%	88	15.2%	
age group	18-21	46	7.9%	90	15.5%	40	6.9%	40	6.9%	NA
	22-25	24	4.1%	178	30.7%	62	10.7%	56	9.7%	
	>26	0	0.0%	24	4.1%	20	3.4%	0	0.0%	
Residence	Other Than Asir Province	4	.7%	24	4.1%	18	3.1%	0	0.0%	p<.001
	Asir Province	66	11.4%	268	46.2%	104	17.9%	96	16.6%	
Marital Status	Unmarried	70	12.1%	276	47.6%	106	18.3%	88	15.2%	0.002
	Married	0	0.0%	16	2.8%	16	2.8%	8	1.4%	
Course discipline	Applied Science	40	6.9%	154	26.6%	76	13.1%	52	9.0%	NA
	Engineering	0	0.0%	32	5.5%	8	1.4%	24	4.1%	
	Humanity	0	0.0%	20	3.4%	4	.7%	8	1.4%	
	Medicine	8	1.4%	46	7.9%	16	2.8%	8	1.4%	
	Others	22	3.8%	40	6.9%	18	3.1%	4	.7%	
Yearly	1st Year	8	1.4%	48	8.3%	12	2.1%	24	4.1%	p<.001

Program	2ndYear	18	3.1%	42	7.2%	22	3.8%	4	.7%	
	3rd Year	20	3.4%	74	12.8%	40	6.9%	40	6.9%	
	Final Year	24	4.1%	128	22.1%	48	8.3%	28	4.8%	
ABO System	A	24	4.1%	94	16.2%	34	5.9%	16	2.8%	p<.001
	B	11	1.9%	74	12.8%	8	1.4%	40	6.9%	
	AB	10	1.7%	49	8.4%	18	3.1%	13	2.2%	
	O	25	4.3%	75	12.9%	62	10.7%	27	4.7%	
Rh factor	Negative	4	.7%	8	1.4%	14	2.4%	0	0.0%	p<.001
	Positive	66	11.4%	284	49.0%	108	18.6%	96	16.6%	
Blood Donate	No	62	10.7%	200	34.5%	86	14.8%	60	10.3%	0.002
	Yes	8	1.4%	92	15.9%	36	6.2%	36	6.2%	
Blood Received	No	70	12.1%	254	43.8%	106	18.3%	92	15.9%	p<.001
	Yes	0	0.0%	38	6.6%	16	2.8%	4	.7%	
Types of Disease	No	46	7.9%	202	34.8%	78	13.4%	28	4.8%	NA
	Anxiety/Depression	8	1.4%	62	10.7%	0	0.0%	8	1.4%	
	Diabetes	16	2.8%	8	1.4%	8	1.4%	10	1.7%	
	Hypertension	0	0.0%	8	1.4%	16	2.8%	10	1.7%	
	Obesities/overweight	0	0.0%	12	2.1%	20	3.4%	40	6.9%	
Smoking	No	62	10.7%	240	41.4%	102	17.6%	72	12.4%	0.140
	Yes	8	1.4%	52	9.0%	20	3.4%	24	4.1%	
Diet	Vegetarian	12	2.1%	68	11.7%	24	4.1%	28	4.8%	0.240
	Non-Vegetarian	58	10.0%	224	38.6%	98	16.9%	68	11.7%	

Table 2 presents an analysis of the association between Body Mass Index (BMI) and various sociodemographic and other factors. Starting with gender, the data shows significant differences in BMI distribution between males and females. A higher percentage of males fall into the underweight, overweight and obese categories compared to females; residence is another factor with a significant association with BMI. Students from the Asir Province show higher rates of overweight and obesity compared to those from other regions, with a $p < 0.001$, marital status also reveals a significant association with BMI, in unmarried were higher prevalence of underweight, overweight and obesity compared to married participants, with a p -value of 0.002, ABO blood group was found to be highly significant compared to BMI. Blood type "O" was found to be higher prevalence of overweight compared to other blood groups with Fig 1, Rh factor also shows a highly significant ($p < 0.001$) association with BMI. Participants with a positive Rh factor were higher rates of underweight, overweight and obesity compared to negative Rh factor. Similarly, Blood donation and Blood received behavior was found to be significant ($p < 0.05$, $p < 0.001$) associated with BMI. Participants who had not donated blood and received were found to be higher prevalence of underweight, overweight and obesity, Yearly program was also found to be statistically significant ($p < 0.001$) association with BMI. Third and final years participants were found to be maximum rates of underweight, overweight and obese compared to other years. The rest of the variables were not found to be significantly associated with BMI.

Table 3: Multiple linear regression of the factor associated with Body Mass Index (BMI) in the Students of KKU

Variables		USORs	Std. Error	SORs	P-value	95% C. I	
						Lower Bound	Upper Bound
Gender	Male	Reference					
	Female	-2.893	.486	-.264	.000	-3.848	-1.938
Age Group	22-25	Reference					
	18-21	-1.493	.470	-.135	.002	-2.416	-.569

	>26	-3.672	1.085	-.182	.001	-5.804	-1.541
Residence	Asir region	Reference					
	Non -Asir region	-1.804	.720	-.091	.013	-3.219	-.389
Marital Status	Married	Reference					
	Unmarried	-2.275	1.196	-.108	.058	-4.624	.074
Course Discipline	Applied Science	Reference					
	Engineering	-.843	.693	-.049	.224	-2.204	.518
	Humanity	2.888	.909	.123	.002	1.103	4.673
	Medical	-1.695	.626	-.108	.007	-2.924	-.466
	Others	-1.653	.614	-.109	.007	-2.859	-.446
Yearly Program	4th Year	Reference					
	1st Year	2.843	.622	.194	.000	1.621	4.065
	2nd Year	1.289	.691	.085	.063	-.069	2.646
	3rd Year	1.237	.491	.106	.012	.273	2.202
Blood Group	O	Reference					
	A	-.488	.556	-.041	.381	-1.580	.605
	B	1.160	.561	.091	.039	.057	2.263
	AB	-.869	.605	-.059	.151	-2.058	.319
Rh Factor	Positive	Reference					
	Negative	-1.204	.951	-.047	.206	-3.073	.665
Blood Donate	No	Reference					
	Yes	-.571	.460	-.049	.215	-1.474	.332
Blood Received	No	Reference					
	Yes	-.275	.667	-.015	.680	-1.584	1.035
Disease	No	Reference					
	Anxiety/Depression	-.101	.599	-.006	.867	-1.277	1.076
	Diabetes	-.033	.822	-.002	.968	-1.649	1.582
	Hypertension	5.644	.924	.248	.000	3.829	7.460
	Obesities	7.992	.604	.492	.000	6.806	9.178
Smoking	No	Reference					
	Yes	.941	.566	.067	.097	-.170	2.052
Diet	Non-Vegetarian	Reference					
	Vegetarian/Eggetarian	-.075	.512	-.006	.884	-1.081	.931

Table 3 shows that results of a multiple linear regression analysis that explores the factors associated with Body Mass Index (BMI) in students at King Khalid University (KKU). This analysis provides valuable insights into the various variables that may influence BMI among students. Firstly, the variable "Gender" stands out as a significant predictor of BMI. Female students exhibit a statistically significant negative association with BMI compared to their male counterparts. Another Age Group variable reveals interesting findings. Students aged 18-21 and those aged >26 both have statistically significant negative associations with BMI when compared to students in the 22-25 age group. Next "Residence" variable indicates that students from the Asir region were statistically significant negative association with BMI when compared to students from non-Asir regions. Further, Course discipline also appears to influence BMI. Students in the "Humanity" discipline exhibit a statistically significant positive association with BMI, while in Medical, others were found to be significant negative association. Another one "Yearly Program" variable reveals that students in the 1st and 3rd years had statistically significant positive associations with BMI compared to those in the 4th years while 2nd year was not found statistically significant. Furthermore, Blood group "B" was found to be positively significant compared to other types of blood groups. Certain diseases, such as "Hypertension" and "Obesities," exhibit statistically significant positive associations with BMI. Students with hypertension have a notably higher

positive association, indicating that they tend to have higher BMIs. In contrast, factors like "Rh Factor," "Blood Donation," "Blood Received," "Smoking," and "Diet" were not show statistically significant associations with BMI.

Table 4: Correlation among BMI, Smoking, Diet, Blood Received and Blood Donate

Spearman Correlation		BMI	Smoking	Diet	Blood Received	Blood Donte
All Cate. of BMI	Correlation Coefficient	1.000	.075	-.050	.011	.113**
	p value		.072	.231	.800	.006
Smoking	Correlation Coefficient		1.000	-.004	.144**	.208**
	p value			.932	.001	.000
Diet	Correlation Coefficient			1.000	.071	-.260**
	p value				.086	.000
Blood Received	Correlation Coefficient				1.000	.035
	p value					.397

Table 4 shows that Spearman correlation coefficient among BMI, Smoking, Diet, Blood Received, and Blood Donation, significant correlation was found between BMI with blood donate group, another smoking group were found positively significant correlation, while with diet was found negatively correlated. Furter, diet groups were found negatively significant correlation with blood donate group.

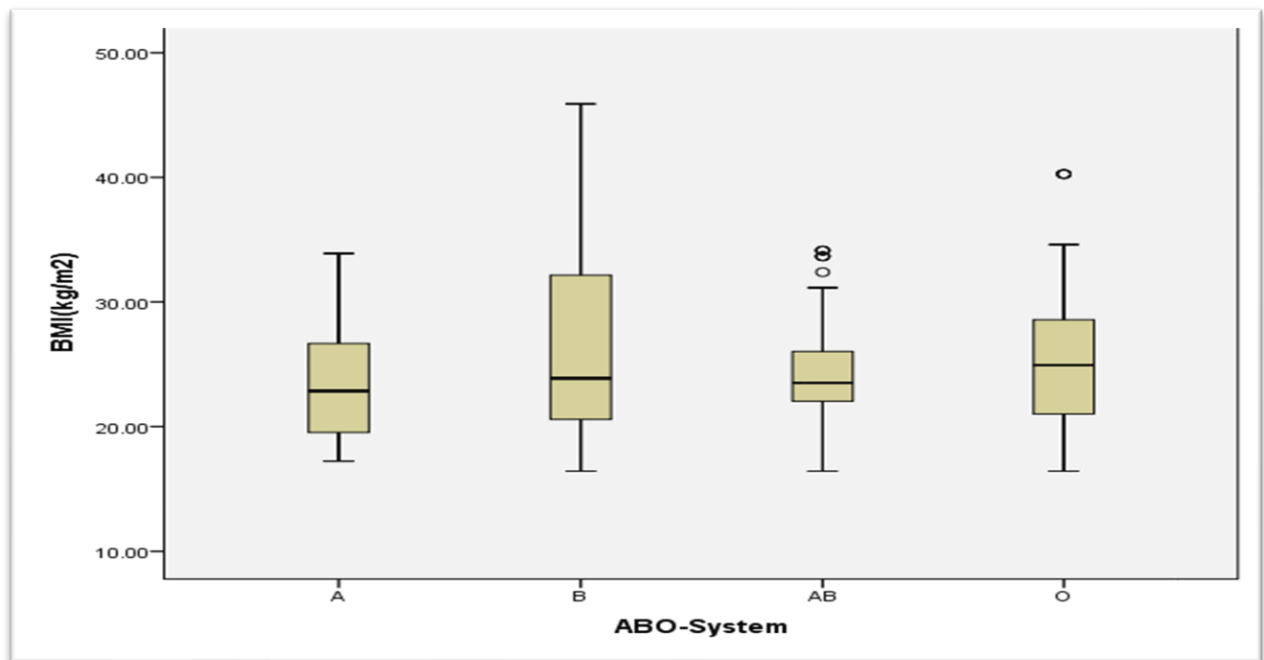


Figure 1: Comparison of body mass index by blood group among KKU Students.

Discussion

We observed that 21% of individuals were overweight and 16.6% were obese. In a concurrent study, Smith S. et al. [13] discovered that 18.7% of participants were overweight and 6.3% of individuals were obese. 35.2% of participants in the 2019 research by Eren C [15] were obese. The fact that we performed our study among students in the (18–25), while they studied the whole population, might account for the discrepancy in the percentage of obese people. The blood types, obesity and overweight were shown to be significantly correlated. In a similar vein, substantial associations were also discovered in the studies conducted by Simth S et al [13], Kadhum SA et al [14], and Eren C et al [15]. Our study also identified a strong correlation between the Rh factor and BMI ($p < .001$). According to a study by Eren C. [15], there is a statistically significant correlation between ABO blood types and obesity in addition to Rh blood kinds. Meanwhile, there was no statistically

significant correlation between the RH group and obesity in the studies conducted by Smith S. et al. [13] and Bashir A. O. [16]. As participants of Bashir O et al. were female may be the cause of the varied outcomes. Results of our investigation showed a substantial correlation between gender, RH group, BMI, and ABO blood group.

However, studies carried out by Aboel Fetoh et al. [15,18] and Chadra et al. [15,17] revealed no statistically significant correlation between the aforementioned variables in BMI, Rh blood group, or gender. Similarly, no statistically significant correlation was found between any of the ABO blood groups and any of the other variables. After using a logistic regression test, a study by Eren C. et al. [15] found a strong correlation between obesity and ABO blood types.

In our study after applying Multiple linear regression analysis, it has revealed a robust relationship between blood group and BMI. Similar results match our results with Eren C et al. [15]. In contrast to the findings analyzed above, we can state that many participants learned about the relationship between blood type and BMI throughout the student data gathering process. However, because the study's participants were drawn from a certain age range, the findings cannot yet be applied to the whole community.

Conclusion

This study provides a comprehensive analysis of the sociodemographic and health-related characteristics of students at King Khalid University in Abha, with a particular emphasis on Body Mass Index (BMI). The study has provided valuable insights into the diverse student population and their health profiles, shedding light on important factors associated with BMI.

One of the primary findings is that BMI varies by gender, with men being more likely than women to be overweight or obese. It was demonstrated that age has an impact on BMI distribution, with the highest percentage of those with healthy BMIs falling within the 22–25 age range. Variations in BMI were linked to variables such marital status, annual program, and academic discipline, emphasizing the need for targeted health interventions based on these factors. Additionally, a relationship between specific blood types, Rh factors, and BMI was discovered. This data could serve as a foundation for developing tailored health promotion programs, formulating regulations, and conducting more studies to improve the overall health and wellness of King Khalid University students.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee).

Informed Consent Statement

Informed consent was obtained from the concerned before data collection.

Conflict of Interest

The authors declare no conflict of interest.

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Data Availability Statement:

All the data generated in the study has been included in the article.

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