



## Original Article

# The correlation between obesity and metabolic syndrome in young female university students in the Kingdom of Saudi Arabia



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## ABSTRACT

**Objective:** To examine the association between increased body mass index (BMI) values and the risk of metabolic syndrome (MetS) in young female science students.

**Methodology:** The study population was 174 female students aged 18–25 years attending King Abdulaziz University (KAU) in the Kingdom of Saudi Arabia (KSA). Anthropometric measurements obtained included weight, height, waist, and hips circumferences. Blood pressure was also measured, and blood samples were collected for measurements of total cholesterol, triglyceride (TG), high-density lipoprotein (HDL), fasting blood glucose (FBG), and other biochemical parameters.

**Results:** Around 17.7% of the students were at risk of developing MetS, with three or more risk factors detected, and 45% of the students had one or two risk factors. Increased BMI values were associated with an elevated risk of developing MetS, as 41.4% of the overweight students and 44.8% of the obese students had three or more risk factors.

**Conclusion:** The prevalence of MetS is increasing in Young female university in the KSA as a result of an unhealthy lifestyle, including a lack of physical activity, leading to increased weight and the possible development of chronic diseases.

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## 1. Introduction

Metabolic syndrome (MetS) is a major health issue worldwide, and its prevalence is increasing rapidly in accordance with rapid lifestyle-related changes. Increased energy intake, increased obesity, and decreased physical activity all contribute to the development of MetS [1]. MetS is characterized by interconnections between metabolic, biochemical, and physiological factors, which may lead to the development of atherosclerotic cardiovascular disease and type 2 diabetes mellitus [2,3]. The clinical diagnosis of MetS includes hypertension, hyperlipidemia, glucose intolerance, and a prothrombotic and proinflammatory state [4], with increased mortality caused by the development of heart diseases [5].

The prevalence of MetS varies worldwide, depending on the region, environment and genetic background of individuals [6]. According to the International Diabetes Federation, 25% of adults worldwide have MetS [7]. Studies suggest that having at least one risk factor for MetS at a young age increases the risk of developing MetS in later life [8]. According to data on the prevalence of MetS in

the U.S., between 1988 and 2012, the prevalence increased to 35% in 2102 [9].

In 2001, the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) devised a definition for MetS [10], which was updated by the American Heart Association and the National Heart Lung and Blood Institute in 2005 [7]. According to the NCEP ATP III definition, individuals can be considered to have MetS if three or more of the following five criteria are met: waist circumference over 35 in or 88 cm (women), blood pressure over 130/85 mmHg, fasting triglyceride (TG) level over 150 mg/dl, fasting high-density lipoprotein (HDL) cholesterol level less than 50 mg/dl (women), and fasting blood sugar (FBS) over 100 mg/dl. A previous study reported that the prevalence of MetS in the Kingdom of Saudi Arabia (KSA) was 39.8% in men and 29.2% in women, with low HDL the most important component of MetS, followed by abdominal obesity [11].

Given the increased prevalence of obesity in the KSA [12], it is important to determine the risk of developing MetS, especially in young adults, as this will affect their quality of their life and subsequently the development of chronic diseases. The aim of the present study was to estimate the prevalence of MetS and risk factors for the syndrome in female university undergraduates at

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King Abdulaziz University (KAU) in the KSA and its correlation with BMI values.

## 2. Methodology

This cross-sectional study comprised 174 students and was conducted between December 2017 and April 2018 at KAU. The inclusion criteria were female science students aged between 18 and 25 years. The exclusion criteria were pregnancy/lactation.

The General Directorate of Health Affairs of the College of Medicine, KAU and biomedical ethics unit at the Faculty of Medicine, KAU approved this study. Informed verbal and written consent were obtained from all the participants after explaining the objectives and methodology of the study. All the participants completed a questionnaire survey, which included questions on areas related to lifestyle, BMI, and general health issues.

Anthropometric measurements, including weight, height, and waist and hip circumferences, were obtained with the subjects in a standing position, wearing light clothing, without shoes. Systolic blood pressure and diastolic blood pressure were measured.

Based on their BMI values, the students were divided into four groups: BMI  $<18.5$  kg/m<sup>2</sup>: underweight, 18.5–24.9 kg/m<sup>2</sup>: normal weight, 25.0–29.9 kg/m<sup>2</sup>: preobese (overweight), and BMI  $\geq 30$  kg/m<sup>2</sup>: obese [13].

Venous blood samples (approximately 5 ml) were obtained from each participant after fasting overnight for more than 10 h. The samples were used for quantitative determination of total cholesterol, HDL-cholesterol, TG, low-density lipoprotein cholesterol, and uric acid, iron, and glucose concentrations in serum, these were determined using commercial kits (Human Gesellschaft for Biochemica and Diagnostica mbH, Germany).

### 2.1. Statistical analysis

Data were expressed as mean  $\pm$  standard error of mean. The significance differences in the measured MetS risk factors between normal-weight and obese individuals was examined using an unpaired student's *t*-test for parametric parameters and the chi-square test for nonparametric parameters.

## 3. Results

According to the participants' ( $N = 164$  female students) BMI measurements Table 1, 48.8% ( $n = 80$  students) were normal weight, 19.5% ( $n = 32$  students) were underweight, 17.7% ( $n = 29$  students) were overweight, and 14% ( $n = 23$  students) were obese. Thus, most of the participants were within the normal BMI range.

Table 2 provides information on various physical and biochemical measurements and differences in these parameters in students with normal versus high BMI values. The results revealed highly significant differences in the weight, waist circumference, and hip circumference measurements of the normal-weight participants (BMI  $\leq 25$  kg/m<sup>2</sup>) as compared with those of the overweight/obese participants (BMI  $\geq 25$  kg/m<sup>2</sup>) ( $p = 0.001$ ). In addition, there was a significant difference in the diastolic blood pressure measurements, with higher levels found in the

participants with a BMI  $\geq 25$  kg/m<sup>2</sup> ( $p = 0.009$ ).

According to the anthropometric measurements, many of the participants had risk factors for MetS: ( $n = 50,50\%$ ) had elevated levels of triglyceride TG, ( $n = 60,40\%$ ) had high FBS, ( $n = 44,33.6\%$ ) had low levels of HDL, ( $n = 35,22.7\%$ ) had high waist circumferences, and ( $n = 13,8\%$ ) had high diastolic blood pressure. Table 3 provides more descriptive data on these measurements for participants.

Table 4 provides data on the different risk factors associated with MetS in the participants according to their BMI values. Overweight and obese subjects with three risk factors were considered to have MetS. Among the overweight students ( $n = 25$ ) with BMI values of 25.0–29.9 kg/m<sup>2</sup> 13 subjects had a waist circumference of  $88.6 \pm 9.3$  cm, an FBG level of  $104.5 \pm 15$  mg/ml, and a TG level of  $208.9 \pm 80.1$  mg/ml. Among the obese students ( $n = 24$ ), 14 students had a waist circumference of  $98.3 \pm 12$  cm, an FBG level of  $127.8 \pm 38$  mg/ml, and a TG level of  $217.7 \pm 73$  mg/ml. In the entire study group, only 3 of the 174 students had one risk factor for MetS ( $234.9 \pm 153$  mg/ml).

In the comparison of the risk factors for MetS, the following factors were associated with a significant risk: waist circumference ( $P = 0.00$ ), FBG ( $P = 0.002$ ), and TG ( $P = 0.003$ ). Seventy-nine students had one or two risk factors for MetS, and 29 students had three or more risk factors. These students had an elevated risk of developing MetS. Students with a BMI value  $\geq 25$  kg/m<sup>2</sup> had the highest chance of developing MetS (41.4% and 44.8% of overweight and obese students, respectively) (Table 5).

## 4. Discussion

In the present study, students with three or more risk factors were considered to have MetS in accordance with the NCEP ATP III definition (2). According to the findings, 17.7% of female science students had increased BMI values and were at risk of MetS. As increased BMI values are associated with an elevated risk of developing MetS, the results highlight the potential risk of MetS and the development of chronic diseases among this Saudi student population. According to previous studies, the KSA is one of a number of countries where there is an increased risk of obesity and diabetes mellitus [12,14]. The increased prevalence of MetS in the present study is in accordance with the findings of these studies.

In recent studies, the prevalence of MetS was reported to be between 10% and 84% worldwide, depending on the age, sex, and ethnicity of the population [4]. In a study conducted in Saudi in 2018 that included 12,126 subjects, 39.8% of students from different regions had a risk of MetS, with a higher risk among males as compared with that among females (34.4% vs. 29.2%) [10]. In the same study, the authors showed that an increased risk of MetS was associated with several factors, such as age, smoking, a low educational level, and living in an urban area.

Our data showed that KAU female students with a BMI  $\geq 25$  kg/m<sup>2</sup> had an elevated risk of MetS. Around 41.4% and 44.8% of overweight and obese subjects, respectively, had three or more risk factors for MetS. The most common risk factors were TG, FBG, and waist circumferences. The association between BMI and an increased risk of MetS is in agreement with that found in other studies, including a study on Kenyan university students [14]. However, in the Kenyan study, only 1.9% of the students were diagnosed with MetS as compared with 17.7% the present study [14]. A study on university students in Brazil also confirmed the association of increased weight with an elevated risk of MetS [15]. In the Brazilian study, 3.5% of the students had three or more risk factors for MetS. A study on Korean university students reported similar findings [15]. However, the much higher percentage of students found to be at risk of MetS in the present study as

**Table 1**  
Body mass index for female students of KAU participate in the study.

BMI Categories (Kg/m <sup>2</sup> )	Number of participants Total = 164	Percentage %
Underweight	32	19.5
Normal	80	48.8
Overweight	29	17.7
Students with obesity	23	14

**Table 2**  
Physical and biochemical characteristics between subjects with obesity and normal subjects.

Parameters	Normal subjects BMI $\leq 25$ kg/m <sup>2</sup> (n = 80)	Subjects with obesity BMI $\geq 25$ kg/m <sup>2</sup> (n = 52)	P value
Age (years)	22.53 $\pm$ 1.78	20.65 $\pm$ 0.19	0.394
Height (m)	1.59 $\pm$ 0.01	1.59 $\pm$ 0.01	0.999
Weight (kg)	53.32 $\pm$ 0.64	77.33 $\pm$ 0.206	0.001
BMI (kg/m <sup>2</sup> )	21.18 $\pm$ 0.19	30.80 $\pm$ 0.83	0.001
Waist (cm)	70.66 $\pm$ 1.01	89.33 $\pm$ 1.98	0.001
Hips (cm)	93.74 $\pm$ 1.18	112.55 $\pm$ 2.43	0.001
Waist/hip ratio	0.76 $\pm$ 0.02	0.81 $\pm$ 0.03	0.143
SBP (mmHg)	104.89 $\pm$ 1.10	109.22 $\pm$ 1.53	0.020
DBP (mmHg)	70.53 $\pm$ 0.95	74.80 $\pm$ 1.39	0.009
Number of exercise	1.94 $\pm$ 0.23	1.14 $\pm$ 0.24	0.025
WBC (X 10 <sup>3</sup> / $\mu$ L)	6.06 $\pm$ 0.20	7.18 $\pm$ 0.28	0.001

Data were expressed as mean  $\pm$  standard error of mean. Significance between normal and obese individuals was made using unpaired student “t” test for parametric parameters and Chi-Square test for non-parametric parameters.

**Table 3**  
Measurements of waist, blood pressure, glucose, triglycerides and high density lipoprotein.

Parameters		Number of Students	Percentages %
Waist Circumferences (Total = 154 students)	$\leq 88$ cm	119	77.3
	$\geq 88$ cm	35	22.7
Blood Pressure (Total = 162 students)	Systolic	$\leq 130$ mmHg	158
		$\geq 130$ mmHg	4
	Diastolic	$\leq 85$ mmHg	149
		$\geq 85$ mmHg	13
Triglyceride (TG) (Total = 100 students)	$\leq 150$ mg/dl	50	
	$\geq 150$ mg/dl	50	
High Density Lipoprotein HDL (Total = 131 students)	$\leq 50$ mg/dl	44	
	$\geq 50$ mg/dl	87	
	$\geq 100$ mg/dl	90	
Fasting Blood Sugar FBS (Total = 150 students)	$\leq 100$ mg/dl	90	
	$\geq 100$ mg/dl	60	

**Table 4**  
Metabolic risk factors in different BMI/metabolic syndrome categories.

Whole sample (n = 170)	Normal weight		Overweight		Obese		All BMI Categories		P
	Without MetS	With MetS	Without MetS	With MetS	Without MetS	With MetS	Without MetS	With MetS	
BMI (kg/m <sup>2</sup> )	70 (22.1 $\pm$ 2.04)	4 (21.1 $\pm$ 1.8)	12 (27.2 $\pm$ 1.2)	13 (27.2 $\pm$ 1.3)	10 (32.7 $\pm$ 2.5)	14 (36.4 $\pm$ 8.4)	122 (21.8 $\pm$ 4.5)	32 (30.3 $\pm$ 8)	.000*
Waist Circumferences (cm)	70 (69.7 $\pm$ 7.6)	4 (87.7 $\pm$ 9.4)	11 (79 $\pm$ 13.5)	13 (88.6 $\pm$ 9.3)	10 (90.1 $\pm$ 15)	14 (98.3 $\pm$ 12)	122 (70.8 $\pm$ 11)	31 (92.8 $\pm$ 11)	.000*
Systolic blood pressure (mmHg)	69 (105 $\pm$ 9.7)	3 (99.3 $\pm$ 2.9)	12 (108.4 $\pm$ 8.6)	13 (111.6 $\pm$ 11.7)	10 (110 $\pm$ 12.3)	14 (106.9 $\pm$ 12)	120 (105.7 $\pm$ 12)	30 (108 $\pm$ 11.7)	0.32
Diastolic blood pressure (mmHg)	69 (70.4 $\pm$ 8.3)	3 (67.7 $\pm$ 13.6)	12 (70.6 $\pm$ 9.1)	13 (75.2 $\pm$ 11.8)	10 (79.8 $\pm$ 11)	14 (74.6 $\pm$ 7.8)	120 (72.3 $\pm$ 13)	30 (74.2 $\pm$ 10)	0.47
Fasting blood glucose (mg/dl)	63 (92.8 $\pm$ 18.3)	4 (88.9 $\pm$ 10.8)	11 (99.8 $\pm$ 17.2)	12 (104.5 $\pm$ 15)	10 (103 $\pm$ 30.6)	14 (127.8 $\pm$ 38)	110 (96 $\pm$ 24.8)	30 (113.3 $\pm$ 31)	.002*
Serum HDL cholesterol (mg/dl)	56 (79.4 $\pm$ 51.8)	4 (51.5 $\pm$ 27.6)	8 (55.8 $\pm$ 20)	12 (77.6 $\pm$ 50)	9 (42.1 $\pm$ 25)	10 (59.4 $\pm$ 43)	90 (86 $\pm$ 81.9)	29 (96.3 $\pm$ 101)	0.17
Serum triglycerides (mg/dl)	43 (147.5 $\pm$ 80.5)	3 (234.9 $\pm$ 153)	11 (182.9 $\pm$ 124)	12 (208.9 $\pm$ 80.1)	8 (152 $\pm$ 100)	13 (217.7 $\pm$ 73)	68 (155.3 $\pm$ 90)	28 (215.7 $\pm$ 82)	.003*
Uric Acid (mg/dl)	43 (5.6 $\pm$ 2.5)	3 (5.9 $\pm$ 1.5)	11 (7.3 $\pm$ 3.2)	12 (7.4 $\pm$ 2.3)	8 (8.2 $\pm$ 2.8)	13 (9.9 $\pm$ 4.1)	68 (6.3 $\pm$ 2.7)	28 (8.4 $\pm$ 3.5)	.003*
White Blood Cells (X 10 <sup>3</sup> / $\mu$ L)	51 (6.04 $\pm$ 1.6)	4 (6.3 $\pm$ 1.8)	10 (6.7 $\pm$ 1.8)	11 (7.3 $\pm$ 1.2)	7 (7.4 $\pm$ 2.6)	14 (7.5 $\pm$ 2.2)	86 (6.1 $\pm$ 1.7)	29 (7.3 $\pm$ 1.8)	.003*

Data were expressed as mean  $\pm$  standard error of mean.

**Table 5**  
Students with metabolic syndrome (presented 3 or more factors outside the allowed range).

Body Mass Index	1-2 Risk Factors	3 or more Risk Factors
Underweight	13 (16.5%)	1 (3.5%)
Normal	45 (56.9%)	3 (10.3%)
Overweight	12 (15.2%)	12 (41.4%)
Obese	9 (11.4%)	13 (44.8%)
Total (164)	79 (48.2%)	29 (17.7%)

compared with that reported in the other studies may be explained by differences in the socioeconomic levels of the students in the other studies [16]. Previous research performed in other gulf

countries with comparable socioeconomic conditions also reported a high percentage of students at risk of MetS [11]. A study on university students in the U.S. found a significant difference in the prevalence of MetS, depending on the study region, with 3.7% of students in the Midwest region having a risk of MetS in contrast with 15.1% in Virginia [17]. These findings emphasize the effect of factors other than an inactive lifestyle (i.e., ethnicity and socioeconomic status) on the development of MetS.

Many previous studies highlighted the role of a low education level in an increased risk of MetS. Reasons other than educational levels may account for the elevated risk of MetS among university students [18]. These include an unhealthy lifestyle, with high fast food consumption, inadequate physical activity, and smoking, all of

which contribute to increased weight gain and therefore the risk of MetS [16].

The present study has several limitations, including the small sample size, time limit and financial support however, future studies can be conducted on a larger sample size and may include both male and female students to look at the effect of gender on prevalence of MetS. We recommend routine screening for university students for MetS-related risk factors. Information gained from screening could be used by researchers, physicians, and educators in the design of educational programs for students This could help prevent the development of chronic diseases, which affect quality of life and have economic consequences in terms of health care.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dsx.2019.06.015>.

### Conflicts of interest

All contributing authors declare no conflicts of interest.

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