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FACTORS ASSOCIATED WITH INCREASED WAIST CIRCUMFERENCE AMONG UNIVERSITY FEMALE STUDENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Obesity is a global health concern, with waist circumference (WC) serving as a primary measure of abdominal obesity, which is a principal risk factor for chronic diseases. This study aimed to investigate the socioeconomic and dietary factors associated with increased WC among young adult Saudi female students. A cross-sectional study included 472 female university students in Makkah City. Socioeconomic status, targeted dietary behaviours, anthropometric measures, and body composition were assessed using standard protocols. Logistic regression analysis was used to identify predictors of increased WC (≥ 80 cm). The prevalence of increased WC was 17.8%. Factors significantly associated with increased WC included breakfast skipping (OR: 5.54, 95% CI: 1.28-24.0, $p=0.022$), regular soft drink consumption (OR: 16.62, 95% CI: 3.42-80.7, $p<0.001$), and regular red meat consumption (OR: 4.44, 95% CI: 1.01-19.4, $p=0.048$). The study reveals that increased WC is prevalent among female university students, and several modifiable faulty dietary behaviours are likely to influence WC. These findings highlight the necessity for public health interventions that target relevant risk factors to prevent obesity and its associated health complications in this population.

KEYWORDS: Dietary Patterns; Lifestyle Behaviours; Abdominal Obesity; Socioeconomic Factors; Health Awareness; Eating Habits; Body Composition; Fast Foods.

1. INTRODUCTION

For The global prevalence of obesity, a chronic condition characterized by excessive fat accumulation, has reached epidemic proportions [24]. Obesity is now widely acknowledged as an epidemic condition deeply entwined in the worldwide burden of overall illness and death, affecting both genders of all ages, and in both industrialized and developing countries [24; 11]. Obesity poses significant health risks, increasing the likelihood of developing chronic diseases such as type 2 diabetes, cardiovascular diseases, and certain types of cancer [10]. Waist circumference (WC) is a simple and reliable anthropometric measure that is strongly associated with visceral adiposity and is a better predictor of cardiometabolic risk than body mass index (BMI) alone [7; 20].

One of the key factors that contribute to an increase in WC is a lack of regular or daily exercise, as well as skipping breakfast, consuming fried foods, drinking soft beverages, and consuming processed meat [17; 1]. Additionally, socioeconomic factors such as lower income and education levels have been associated with increased WC due to limited access to healthy foods and environments that promote physical activity [23].

In Saudi Arabia, the prevalence of obesity and abdominal obesity has been on the rise, particularly among young adults [3]. This trend is a significant public health concern as it increases the burden of chronic diseases and impacts the quality of life of young people. Therefore, understanding the factors associated with increased WC in this population is crucial for developing effective prevention and intervention strategies.

This study aims to investigate the socioeconomic and dietary factors associated with increased WC among young adult Saudi female students in Makkah City, a high-risk group underrepresented in existing literature. By identifying these factors, we can inform targeted interventions that promote healthy lifestyles and reduce the risk of obesity and its associated health complications in this population.

1. MATERIALS AND METHODS

1.1. Study Design and Subjects

This cross-sectional study was conducted at the female university student sections at Umm Al-Qura University, Makkah, Saudi Arabia, utilizing a stratified sampling technique. The inclusion criteria consisted of asymptomatic healthy female students aged 18-24 years. Exclusion criteria included students with chronic or acute illnesses. The response

rate was approximately 97%. The study received ethical approval from the Faculty of Medicine at UQU (approval number AMSEC-01-749-2021). Informed consent was obtained from all participants at the beginning of the study. Participants were assured of confidentiality and their right to withdraw from the study.

1.2. Data Collection

A total of 472 eligible female students were enrolled in this study. Face-to-face interviews were conducted. A closed questionnaire was used to collect data with three sections: socioeconomic factors, anthropometric measurements, and nutritional intake. It captured key modifiable risk factors identified in prior literature [17], rather than exhaustive dietary patterns. The food frequency questionnaire was conducted based on the validated questionnaire from Ibrahim and Ghaith, 2020 investigation [11].

Socioeconomic factors such as income (in Saudi Riyals; SAR), educational level, regular physical exercise, and smoking behavior were examined. Anthropometric measurements were performed and recorded by trained dietitians, including weight (kg), height (cm), BMI (kg/m^2), WC (cm), hip circumference (HC; cm), waist-to-hip ratio (WHR), triceps skin fold thickness (TSFT; mm), and mid-arm circumference (MUAC; cm). The previous anthropometric measurements followed the standard methodology reported in the Azzeh et al. study [4]. WC ≥ 80 cm was considered obese according to the International Diabetes Federation's definition of central obesity [2].

1.3. Statistical Analysis

Data analysis was performed using the Statistical Package for Social Sciences software (SPSS; version 20, IBM, NY). Statistically significant results were considered at $P < 0.05$.

Continuous data were presented as means and standard deviation (mean \pm SD), while categorical data were presented as frequency and percentage. The Chi-squared test (χ^2) and Mann-Whitney test were applied to assess significant differences in categorical and continuous data, respectively.

Logistic regression analysis was conducted to determine the odds ratios (OR) and corresponding 95% confidence intervals (95% CI) to identify independent variables as predictors of increased WC. Logistic regression models were adjusted for body mass index (BMI) to isolate associations between dietary factors and WC independent of overall adiposity.

2. RESULTS

Table 1 shows the characteristics of the study participants. The mean age, weight, and height of the sample was 20.6 ± 1.3 years, 55.2 ± 12.9 kg, and 156.8 ± 4.6 cm, respectively. Study results observed that the mean BMI was 22.4 ± 5.1 kg/m², and most of the sample was within a mean of normal weight (46.6%). On the other hand, obese participants were observed in 48 (10.2%) subjects. The average WC was 71.1 ± 10.1 cm and the frequency of the participants higher than the normal range was 17.8%. While normal WC was observed in 82.2%. The mean values of HC, WHR, MUAC, and TSFT were 96.7 ± 10.4 cm, 0.73 ± 0.06 , and 26.4 ± 5.1 cm, respectively. The mean income of the sample was the highest for the <4000 SAR category (45.4%) and lowest for the 4000-8000 SAR category (9.3%). The majority educational level of the sample was within the high education (89.8%). About half of the participants performing regular physical activity (52.5%), and 94.1% were not smokers.

Table 2 shows the anthropometric and adiposity measurements according to WC groups. Between the two groups, BMI (Kg/m²), WC (cm), HC (cm), WHR, MUAC (cm), TSFT (mm), FAT(g), FAT (%), and BMD all showed significant ($P < 0.05$) results.

Table 3 shows the socioeconomic characteristics and dietary behaviors according to WC groups. It was observed that there was a significant ($P < 0.05$) difference between those who don't exercise in an increased WC and a non-increased WC (57.1% vs 45.4%, respectively). The WC was significantly ($P < 0.05$) higher among females who skipped breakfast and drank >6 cups of water than other groups. For those who drink soft drinks, 61.9% of them had a higher percentage of an increased WC. Furthermore, females who regularly consumed meat exhibited higher percentages of increased WC compared to those who did not consume meat frequently. It was observed that an increase in the percentage of WC in those who skipped breakfast daily. Results indicated a significant ($P < 0.05$) increase in WC in females who do not consume vegetables regularly.

Table 4 shows the potential significant predictors related to increased WC. BMI (OR:1.6, 95% CI:1.464-1.839, $P < 0.001$), breakfast skipping (OR: 5.5, 95% CI: 1.279-23.965, $P = 0.02$), regular consumption of soft drinks (OR:16.6, 95% CI: 3.424-80.691, $P < 0.001$), and regular consumption of meat (OR: 4.4, 95% CI: 1.014-19.42, $P = 0.04$) were positively associated with high WC.

3. DISCUSSION

The primary goal of this study was to examine the

socioeconomic and dietary factors that contribute to an increased WC among young adult Saudi female students. Our study highlights the significant impact of dietary behaviors on WC among young Saudi women. The high prevalence of increased WC (17.8%) in the sample studied underscores the need for targeted interventions to address modifiable risk factors. Our findings align with previous research demonstrating the detrimental effects of breakfast skipping [18; 15], regular soft drink consumption [17; 5], and red meat consumption on WC [19; 13].

The strong relationship between the consumption of soft drinks and red meat and the increased expectation of increasing and raising the WC through the poor energy compensation at subsequent meals caused by the reduced satiety of liquid carbohydrates is the most likely mechanism through which sugar-sweetened beverages can cause weight gain. The high sugar content of soft drinks contributes to excessive calorie intake, promoting fat accumulation and increased WC [12]. Specifically, it has been proposed that the high fructose content of soda corn syrup may contribute specifically to the risk of obesity. The study of Kim and Lee supports the results of our study that the consumption of carbonated drinks has been linked to an increased risk of obesity [14]. Red meat consumption may contribute to an increase in WC because of its high caloric density, especially processed and fatty meats, which can result in consuming more calories overall. WC and weight growth may occur if calorie intake surpasses the body's requirements.

Red meat consumption, particularly processed meat, is often high in saturated fat and calories, which can lead to weight gain and increased WC [8; 22; 27]. These lipids have the potential to cause weight gain and the buildup of belly fat when ingested in excess. Another comparable result has been proposed is the influence of hormones for example certain hormones such as insulin-like growth factor 1 which are naturally present in meat or employed in its manufacturing may have an impact on the composition of the body and the deposition of fat, particularly belly fat we found in the study of Daneshzad *et al.* similar results of our study [6]. These factors indicate the necessity of dietary choices in influencing obesity and increasing the abdominal area. Examining the extent and extent of obesity in the study, as 10.2% of contributors were classified as facing or suffering from the problem of obesity, may shed light on the need for public health initiatives that include weight management in this demographic.

Study results suggested that breakfast skipping

was associated with increased WC. The association between breakfast skipping and increased WC may be due to several mechanisms, including increased hunger and subsequent overeating later in the day, altered hormonal responses, and decreased physical activity [16; 25]. This indicates that mealtimes and regularity may play an important and decisive role in controlling the middle area. This finding may require much exploration and emphasizes the need for integrated lifestyle interventions that are not only concerned with the substance and substance of the diet but may also overlook temporal distribution. A link between breakfast skipping and increased WC is unlikely to be established and may require further research [21]. Although breakfast has traditionally been associated with various health benefits, including weight management and control, our research aims to take a distinct perspective [26]. The effectiveness of breakfast skipping around the waist may vary from person to person. Factors such as metabolism, and general eating habits can affect how breakfast skipping affects your body structure and composition [26]. Any breakfast should be distinguished from a healthy and nutritious breakfast. If people who eat breakfast choose to eat healthy foods throughout the day, this may help achieve the desired result [9]. Factors other than breakfast skipping alone may influence the relationship between mealtimes and WC. The general pattern and frequency of meals throughout the day can play a significant role, especially from breakfast onwards. People with comorbidities may react differently to breakfast skipping [26].

The sample size of 472 participants enhances the statistical power and confidence of the findings. The

study is limited by its cross-sectional design, which precludes the establishment of causality. Additionally, the study sample was limited to female students in Makkah City, limiting the generalizability of the findings to other populations. While our FFQ focused on behaviors linked to abdominal obesity, future studies should include more comprehensive dietary assessments (e.g., 24-hour recalls, expanded FFQs) to capture overall dietary patterns. Moreover, future research should investigate the underlying mechanisms through which the identified factors affect WC and explore the impact of cultural factors on dietary behaviors in this population. Despite these issues, this study is the first of its kind in Makkah City. Additionally, standardized measurements for anthropometric variables were performed, ensuring uniformity in weight, height, and WC data across all participants.

4. CONCLUSION

This study provides valuable insights into the factors associated with increased WC among young Saudi women. The prevalence of elevated WC was 17.8%. Factors markedly correlated with elevated WC included habitual soft drink intake (OR: 16.62) breakfast skipping (OR: 5.54), and frequent red meat consumption (OR: 4.44). Our findings emphasize the need for public health interventions that promote healthy dietary habits, including regular breakfast consumption and reduced consumption of sugary drinks and red meat. Such interventions should be tailored to the cultural context of Saudi Arabia to ensure their effectiveness in preventing obesity and its associated health complications in this population.

Contribution of Authors: Ahmad A. Obeidat, Firas S. Azzeh and Mousa N. Ahmad contributed to conception and design of the work including planning the methodology and framework for the research. Batool S. Alharthi, Areej A. Alzahrani, Raghd B. Alnemri, Fatma K. Bawazeer and Firas S. Azzeh contributed to data acquisition, analysis, and interpretation. Ahmad A. Obeidat, Salam M. Habib, Reema A. Alyamani and Mousa N. Ahmad contributed to drafting and revising the manuscript.

Table 1: Characteristics Of Study Participants (N=472).

Variable	Mean \pm SD or Frequency (%)
Age (years)	20.6 \pm 1.3
Weight (kg)	55.2 \pm 12.9
Height (cm)	156.8 \pm 4.6
Body mass index (Kg/ m ²)	22.4 \pm 5.1
Underweight	124 (26.3%)
Normal weight	220 (46.6 %)
Overweight	80 (16.9%)
Obese	48 (10.2%)
Waist circumference (cm)	71.1 \pm 10.1
Normal	388 (82.2%)
Higher than normal	84 (17.8%)

Hip circumference (cm)	96.7 ± 10.4
Waist-to-hip ratio	0.73 ± 0.06
Normal	456 ± (96.6%)
Higher than normal	16 ± (3.4%)
Mid-upper arm circumference (cm)	26.4 ± 5.1
Triceps skin fold thickness (mm)	15.9 ± 9.4
Income (Saudi Riyals; SAR)	
<4000	176 (45.4%)
4000-8000	36 (9.3%)
8000-15000	92 (23.7%)
>15000	84 (21.6%)
Educational level	
secondary school	48 (10.2%)
high education	424 (89.8%)
Do you do any physical exercise?	
Yes	248 (52.5%)
no	224 (47.5%)
Smoking	
Yes	28 (5.9%)
no	444 (94.1%)

Table 2: Anthropometric And Adiposity Measures According to Waist Circumference Groups

Variable	Mean ± SD or Frequency (%)		P-value
	Increased waist circumference		
	Yes (n= 84) Increased	No (n=388) Normal	
Age (year)	20.5 ± 0.9	20.6 ± 1.3	0.5
Weight (Kg)	73.7 ± 12.5	51.2 ± 8.8	<0.001
Height (cm)	157.6 ± 4.2	156.7 ± 4.7	0.015
BMI (Kg/m ²)	29.7 ± 5.4	20.8 ± 3.4	<0.001
WC (cm)	88.1 ± 6.1	67.5 ± 6.3	<0.001
HC (cm)	110.3 ± 10.4	93.7 ± 7.7	<0.001
WHR	0.8 ± 0.1	0.7 ± 0.0	<0.001
MUAC (cm)	32.2 ± 4.8	25.1 ± 4.3	<0.001
TSFT (mm)	20.1 ± 13.1	15.1 ± 8.1	0.001

Abbreviations: BMI: Body mass index; HC: Hip circumference; TSFT: Triceps skin fold thickness; circumference; MUAC: Mid-upper arm WC: Waist circumference; WHR: Waist-to-hip ratio.

Table 3: Socioeconomic Characteristics According to WC Groups.

Variables	Increased WC		P-value
	Yes (n=84)	No (n=388)	
Income (Saudi Riyals)	<4000	176 (45.4%)	0.230
	4000-8000	8 (9.5%)	
	8000-15000	92 (23.7%)	
	>15000	84 (21.6%)	
Educational level	Secondary school	40 (10.3%)	0.507
	High education	348 (89.7%)	
Physical exercise	Yes	212 (54.6%)	0.033
	No	176 (45.4%)	
Exercise frequency	None	176 (45.4%)	0.003
	Once a week	56 (14.4%)	
	2 - 4 times a week	116 (29.9%)	
	daily	40 (10.3%)	
Smoking	Yes	27 (7.2%)	0.31
	No	360 (92.8%)	
Breakfast consumption	No	56 (14.4%)	0.087
	Sometimes	172 (44.3%)	
	Yes	160 (41.2%)	
Breakfast consumption frequency	Rarely	52 (13.4%)	0.001
	From 2-3 times a week	72 (18.6%)	
	From 4- 5 times a week	120 (30.9%)	

	Daily	24 (28.6%)	144 (37.1%)	
Number of daily water cups consumed	1-3 cups	24 (28.6%)	128 (33.0%)	0.068
	2-4 cups	28 (33.3%)	96 (24.7%)	
	3-5 cups	20 (23.8%)	68 (17.5%)	
	≥6 cups	12 (14.3%)	96 (24.7%)	
Energy drinks consumption	Yes	4 (4.8%)	20 (5.2%)	0.171
	Sometimes	16 (19.0%)	112 (28.9%)	
	No	64 (76.2%)	256 (66%)	
Soft drinks consumption	Yes	52 (61.9%)	104 (26.8%)	<0.001
	Sometimes	28 (33.3%)	164 (42.3%)	
	No	4 (4.8%)	120 (30.9%)	
Meat consumption	Yes	48 (57.1%)	120 (30.9%)	<0.001
	Sometimes	24 (28.6%)	192 (49.5%)	
	No	12 (14.3%)	76 (19.6%)	
Dairy products consumption	Yes	4 (4.8%)	20 (5.2%)	0.830
	Sometimes	20 (23.8%)	104 (26.8%)	
	No	60 (71.4%)	264 (68%)	
Fruits consumption	Yes	28 (33.3%)	132 (34%)	0.962
	Sometimes	48 (57.1%)	216 (55.7%)	
	No	8 (9.5%)	40 (10.3%)	
Vegetables consumption	Yes	12 (14.3%)	80 (20.6%)	0.001
	Sometimes	48 (57.1%)	260 (67.0%)	
	no	24 (28.6%)	48 (12.4%)	
Rice consumption	Yes	12 (14.3%)	44 (11.3%)	0.442
	Sometimes	52 (61.9%)	268 (69.1%)	
	No	20 (23.8%)	76 (19.6%)	
Body mass index categories	Underweight	8 (9.5%)	116 (29.9%)	<0.001
	Normal weight	4 (4.8%)	216 (55.7%)	
	Overweight	24 (28.6%)	56 (14.4%)	
	Obese	48 (57.1%)	0 (0%)	

Values are expressed as frequency (%). P-values were determined by Chi-squared test.

Table 4: Potentially Significant Predictors Related to Increased Waist Circumference.

Variable	OR	95% CI	P-value
Body mass index	1.641	1.464-1.839	<0.001
Exercise frequency			
None	0.808	0.131-4.992	0.819
Once a week	0.794	0.087-7.22	0.838
2 - 4 times a week	0.396	0.061-2.558	0.331
Daily	1		
Breakfast consumption frequency			
Rarely	5.535	1.279-23.965	0.022
From 2-3 times a week	5.435	1.56-18.939	0.008
From 4- 5 times a week	0.755	0.212-2.838	0.7
Daily	1		
Soft drinks consumption			
Yes	16.622	3.424-80.691	<0.001
Sometimes	4.842	1.032-22.719	0.046
No	1		
Meat consumption			
Yes	4.437	1.014-19.42	0.048
Sometimes	0.915	0.229-3.656	0.9
No	1		
Vegetables consumption			
Yes	0.325	0.074-1.428	0.137
Sometimes	0.341	0.092-1.266	0.108
No	1		

Abbreviations: CI: confidence interval, OR: odds ratio

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