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The Impact of Obesity Types on Metabolic Syndrome and Associated Factors Among Jordanian Women Aged 20–50 Years: A Cross-Sectional Study

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ABSTRACT: **Background: Obesity and cardiometabolic risk, especially in women, are closely associated with metabolic syndrome (MetS), also referred to as insulin resistance syndrome. This study looked at the relationships among adult females' MetS, obesity patterns, and dietary and lifestyle factors.**

Methods: Adult females (n = 310) who were recruited from Al-Sareeh Medical Consulting Center participated in a cross-sectional study. Internationally recognized standards were used to define MetS. Measurements were made of anthropometric indicators, such as waist circumference (WC), waist-to-height ratio (WHtR), body mass index (BMI), and body fat percentage. Data were gathered on dietary intake (food frequency questionnaires), age, and physical activity (validated questionnaires).

Results: The prevalence of MetS rose considerably with age, peaking in women between the ages of 40 and 50. Women who were overweight or obese and did not engage in physical activity had a significantly higher prevalence of MetS ($p < 0.05$). Women who had MetS had higher BMI, body fat percentage, WC, and WHtR, consumed more total energy and fat, and consumed less dietary fiber. They also had higher rates of hyperglycemia, dyslipidemia, and hypertension.

Conclusions: The main causes of MetS in adult females are central obesity, poor diet, physical inactivity, and aging. Public health initiatives that encourage the reduction of abdominal fat, physical activity, and high-fiber diets are crucial, particularly for middle-aged women.

Key words: **central obesity; dietary patterns; insulin resistance; physical activity; public health; women.**

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1. INTRODUCTION

Because of its strong correlation with non-communicable diseases (NCDs) and rising prevalence, metabolic syndrome (MetS) has become a major global public health concern. Rapid changes in lifestyle and socioeconomic status, especially in developing nations, have increased the prevalence of metabolic disorders, necessitating long-term public health initiatives and preventative measures (1–3). Central obesity, dyslipidemia, high blood pressure, and impaired glucose metabolism are among the metabolic abnormalities that define MetS and significantly raise the risk of type 2 diabetes and cardiovascular disease (4–6). A major contributing factor to the development of metabolic syndrome is obesity, a chronic and complex metabolic disorder. Over the past few decades, it has become much more common worldwide, with women showing higher rates than men in many areas. A complex interplay of biological, genetic, and behavioral factors contributes to this gender gap (7–9). The distribution of body fat has drawn more attention as a crucial factor in determining metabolic risk, in addition to overall obesity. Indicators of central obesity, such as waist circumference and waist-to-height ratio, may offer more information about cardiometabolic risk than body mass index (BMI), according to mounting evidence. The metabolic activity of visceral adipose tissue, which is strongly associated with insulin resistance, dyslipidemia, and systemic inflammation, is primarily responsible for this (10–12). As a result, evaluating both central and general obesity is now crucial to comprehending metabolic health and identifying people who are more likely to develop metabolic syndrome. The prevalence of obesity and metabolic syndrome has significantly increased in the Middle East, including the Hashemite Kingdom of Jordan (13–15). According to recent national estimates, the prevalence of obesity is roughly 43.1% among Jordanian women and 28.2% among men, indicating a significant gender gap. Additionally, the prevalence of metabolic syndrome among adults in Jordan ranges from 36% to 51%, according to a number of regional and national studies, indicating a significant public health challenge (14–16). These patterns highlight the critical need to learn more about the factors that contribute to metabolic syndrome in Jordanians. Few studies in Jordan have concurrently looked at various obesity classifications along with dietary and behavioral factors in relation to metabolic syndrome, especially among women of reproductive and early middle age, despite mounting evidence linking obesity with metabolic abnormalities. Determining high-risk populations and developing focused preventative measures may be made easier with an understanding of these connections. Thus, the current study sought to investigate the relationship between metabolic syndrome and its constituent parts in Jordanian women between the ages of 20 and 50 and general obesity, as measured by body mass index, and central obesity indicators, such as waist circumference and waist-to-hip ratio. In order to better understand metabolic risk patterns in this population and to support future preventive and clinical interventions, the study also investigates specific dietary and behavioral factors that may be linked to the syndrome.

2. METHOD

STUDY DESIGN AND SETTING

Between September 2024 and July 2025, a cross-sectional study was carried out among Jordanian women aged 20 to 50 years to assess metabolic syndrome (MetS) and its components across various types of obesity. The study was conducted in the Al-Sareeh region of northern Jordan's Irbid Governorate. Participants were selected from the target population using a multistage cluster sampling technique. The Institutional Review Board of Jerash University (Approval No. 2955/6/2/9/AB) approved the study protocol, which was carried out in compliance with the Declaration of Helsinki's ethical guidelines. All participants gave their written consent before being enrolled.

PARTICIPANTS AND SAMPLING PROCEDURE

The women who took part were married Jordanian women between the ages of 20 and 50. Women could only take part if they were apparently healthy and had not been diagnosed with metabolic or acute diseases. Pregnant or breastfeeding women were not allowed to take part in the study. Other reasons for exclusion included a recent significant weight change (>5 kg within the previous two months), physical disabilities that could affect anthropometric measurements, chronic diseases, or medications known to affect metabolic status. A multistage cluster sampling strategy was used to make sure that the study population was representative. The Al-Sareeh area was chosen as the study site at first. After that, clusters in the area were found, and community-based contacts and local centers were used to find people who met the criteria until the required sample size was reached.

DATA COLLECTION

Trained dietitians collected data through structured interviews, standardized questionnaires, anthropometric measurements, and biochemical assessments. To protect privacy and keep the data safe, each participant was given a unique identification code.

ANTHROPOMETRIC MEASUREMENTS

Using a calibrated stadiometer, participants stood barefoot and had their height measured to the nearest 0.1 cm. A calibrated electronic scale (Seca, Germany) was used to measure body weight to the nearest 0.1 kg, and the participants were wearing light clothing. We used a non-elastic measuring tape to measure the waist, hips, and neck according to standard procedures. We took each measurement twice and wrote down the average. We figured out body mass index (BMI) by dividing weight in kilograms by height in meters squared (kg/m^2). Standard formulas were used to figure out the waist-to-hip ratio (WHR) and the waist-to-height ratio (WHtR). We used the Deurenberg formula to figure out body fat percentage (BF%), which takes into account BMI, age, and sex to figure out body fat composition (17). An electronic sphygmomanometer was used to measure blood pressure after the participant had been sitting still for at least 15 minutes.

BIOCHEMICAL MEASUREMENTS

A trained laboratory technician took venous blood samples after the person had not eaten for 12 to 16 hours. A Roche Cobas c311 analyzer (Roche Diagnostics, Switzerland) was used to look at the samples. The biochemical parameters assessed comprised: fasting blood glucose, total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C)

DIETARY ASSESSMENT

We used three 24-hour dietary recalls that were not on the same day to figure out what people ate. Two of these recalls were on weekdays and one was on a weekend day. To make sure the memories were accurate, trained dietitians did the interviews. The Jordanian Food Atlas was used to guess the sizes of the portions. We used ESHA Food Processor software to look at nutrient intake. The software had Jordanian recipes built into the database. Daily energy and nutrient intakes were compared to the recommended dietary allowances.

PHYSICAL ACTIVITY ASSESSMENT

We used a validated questionnaire based on Al-Hazzaa (2014) to measure levels of physical activity. This questionnaire has been used before in Arab populations. Based on the total physical activity score, the participants were put into three groups: low activity (0–8), moderate activity (9–17), high activity (18–27) (18).

DEFINITIONS AND CLASSIFICATION CRITERIA

The World Health Organization (WHO) BMI criteria from 1997 were used to classify general obesity. Waist circumference and waist-to-height ratio cut-offs that are commonly used in epidemiological studies were used to measure central obesity. According to the updated National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria, metabolic syndrome is characterized by the presence of three or more of the following components: increased waist circumference, elevated triglycerides, decreased HDL cholesterol, heightened blood pressure, and elevated fasting blood glucose (19). The NCEP-ATP III guidelines (19) were used to make the lipid profile classifications. The American Diabetes Association's (2024) (20), rules were used to define fasting blood glucose categories, and the American Heart Association's (21)American Heart AssociationAmerican Heart Associat(2017) rules were used to define blood pressure categories.

STATISTICAL ANALYSIS

Data were analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Continuous variables are represented by the mean ± standard deviation (SD), whereas categorical variables are conveyed through frequencies and percentages. The Shapiro-Wilk test was used to determine whether continuous variables were normal. The unpaired Student's t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables were used to compare groups. The chi-square test or, when applicable, Fisher's exact test were used to compare categorical variables. After controlling for potential confounders like age, smoking status, and physical activity, logistic regression analysis was used to investigate the relationship between obesity indices and metabolic syndrome components. 95% confidence intervals (CIs) and odds ratios (ORs) were presented. The threshold for statistical significance was set at $p < 0.05$.

3. RESULTS

SOCIODEMOGRAPHIC AND LIFESTYLE CHARACTERISTICS ASSOCIATED WITH METABOLIC SYNDROME

Using the Chi-square test, Table 1 shows the relationship between the 310 participating women's sociodemographic traits and the prevalence of metabolic syndrome. The presence of metabolic syndrome was significantly correlated with age (p =

0.004), with women in the 40–50 age range having a higher prevalence than those in younger age groups. Additionally, there was a statistically significant correlation ($p = 0.021$) between monthly income and metabolic syndrome. Compared to participants with lower income, a larger percentage of those with income ≥500 JOD were categorized as having metabolic syndrome.

The prevalence of metabolic syndrome was significantly correlated with family size ($p < 0.001$). The percentage of metabolic syndrome cases was higher among participants from households with four or more members than among those from smaller households. Conversely, there was no statistically significant correlation found between metabolic syndrome and educational level ($p = 0.525$). Physical activity levels showed a strong association with metabolic syndrome ($p < 0.001$). The prevalence of metabolic syndrome was highest among women reporting low physical activity levels and lowest among those reporting high physical activity.

Table 3.1 Socio-demographic and Lifestyle Profile of Participants Categorized by Metabolic Syndrome Status (N=310)

Variable	Categories	Present (n=181)	Absent (n=129)	p-value
Age (Years)	20–29.9	51 (28.1%)	18 (14.0%)	**0.004**
	30–39.9	60 (33.1%)	42 (32.7%)	
	40–50	70 (38.8%)	69 (53.3%)	
Education	High School	71 (39.2%)	51 (39.4%)	0.525
	≥ High School	110 (60.8%)	78 (60.6%)	
Income (JOD)	< 500	69 (38.1%)	65 (50.3%)	**0.021**
	≥ 500	112 (61.9%)	64 (49.7%)	
Family Size	< 4 members	53 (29.3%)	65 (50.4%)	**0.000**
	≥ 7 members	57 (31.5%)	21 (16.3%)	
Physical Activity	Low	142 (74.7%)	48 (25.3%)	**0.000**
	Moderate/High	68 (56.7%)	52 (43.3%)	

Notes: Values are presented as n (%). Significant p-values (<0.05) are in bold. Abbreviations: JOD: Jordanian Dinar.

Results of this study, as shown in table 3.2, revealed among women with MetS, there is a definite trend of nutritional excess. Compared to the "Absent" group, the "Present" group consumed substantially more fat (101.82 g) and total energy (2389.95 kcal). On the other hand, the MetS group consumed substantially less dietary fiber (14.01 g vs. 17.25 g). In terms of body composition, the MetS group had significantly higher levels of all obesity indices (BMI, Body Fat%, Waist Circumference, and WHtR), indicating that central adiposity is a key feature of the syndrome in this population.

Table 3.2 Comparison of Nutrient Intake and Body Composition between MetS and Non-MetS Groups

Category	Parameter	Present (Mean ± SD)	Absent (Mean ± SD)	p-value
Nutrient Intake	Energy (kcal)	2389.95 ± 286.5	2142.37 ± 275.6	**0.001**
	Fat (g)	101.82 ± 15.08	76.2 ± 21.87	**0.009**
	Carbohydrates (g)	274.95 ± 28.32	251.57 ± 25.90	**0.001**
	Dietary Fiber (g)	14.01 ± 3.81	17.25 ± 6.27	**0.001**
Anthropometry	BMI (kg/m²)	33.48 ± 7.03	25.79 ± 4.98	**0.001**
	Body Fat (%)	42.92 ± 13.24	31.01 ± 11.29	**0.001**
	WC (cm)	95.50 ± 13.24	80.05 ± 11.20	**0.001**
	WHtR	0.59 ± 0.10	0.49 ± 0.08	**0.001**

Notes: BMI: Body Mass Index; WC: Waist Circumference; WHtR: Waist-to-Height Ratio

Trends in Severity and Prevalence (Table 3.3). The findings suggest that obesity indices are reliable indicators of the severity of MetS. In addition to having the highest prevalence of MetS, women categorized as "Obese" by BMI (≥ 30) or "High Risk" by Waist Circumference (≥ 88 cm) and WHtR (≥ 0.55) were also more likely to have four or more syndrome components. It's interesting to note that younger women (20–29.9) still showed a high prevalence of multiple metabolic abnormalities (53.6% having ≥ 4 components), indicating an early onset of metabolic risk, despite older age being a risk factor.

Table 3.3 Distribution of Metabolic Components and Severity across Age and Obesity Indices

Variable	Category	MetS N (%)	≥4 Components	p-value
BMI (kg/m²)	Normal (18.5–<25)	23 (12.7%)	5 (5.7%)	**0.001**
	Obese (≥ 30)	131 (72.4%)	99 (63.9%)	
WC (cm)	High Risk (≥ 88)	142 (78.5%)	110 (66.3%)	**0.001**
WHtR	High Risk (≥ 0.55)	139 (76.8%)	108 (65.8%)	**0.001**
Age (Years)	20–29.9	51 (28.2%)	37 (53.6%)	**0.001**
	40–50	70 (38.7%)	47 (33.8%)	

Abbreviations: MetS: Metabolic Syndrome; BMI: Body Mass Index; WC: Waist Circumference; WHtR: Waist-to-Height Ratio.

Trends in Risk Factor Analysis (Table3. 4) Physical inactivity is the most powerful independent risk factor, according to the logistic regression model, increasing the odds of MetS by more than twofold (Adjusted OR = 2.08). MetS risk was consistently positively correlated with obesity markers (BMI and WC) and fat intake. Conversely, dietary fiber served as a protective factor (OR = 0.94), with each unit increase in fiber intake linked to a lower chance of developing the syndrome.

Table 3.4 Logistic Regression Analysis of Independent Factors Associated with Metabolic Syndrome

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Age (per year)	1.04 (1.02–1.07)	1.03 (1.01–1.06)	**0.003**
BMI (kg/m²)	1.18 (1.12–1.25)	1.14 (1.08–1.21)	**0.001**
WC (cm)	1.09 (1.05–1.13)	1.07 (1.03–1.11)	**0.001**
Fat Intake (g/day)	1.05 (1.02–1.08)	1.03 (1.01–1.06)	**0.021**
Fiber (g/day)	0.92 (0.88–0.97)	0.94 (0.90–0.99)	**0.028**
Physical Inactivity	2.41 (1.35–4.29)	2.08 (1.12–3.87)	**0.020**

Notes: Multivariate model adjusted for age, BMI, WC, body fat, dietary intake, and activity levels. Abbreviations: OR: Odds Ratio; CI: Confidence Interval; BMI: Body Mass Index; WC: Waist Circumference.

4. DISCUSSION

Impact of Age and Socioeconomic Factors on Metabolic Syndrome Prevalence

The outcomes of the current study show that the prevalence of metabolic syndrome and abdominal obesity have a tendency to rise with age, particularly among women aged 40–50 years. This shape has been broadly reported in preceding epidemiological studies and may reproduce age-associated metabolic changes, counting increased visceral adiposity and adaptations in lipid and glucose metabolism (22,23). This reflection may be partly described by hormonal changes that impact fat distribution and metabolic purpose in women.

Estrogen acting a protective part in glucose metabolism and fat distribution during generative years. However, hormonal variations associated with aging may prime to increased visceral adiposity and reduced insulin (22,23). Similar age-associated styles in metabolic syndrome prevalence have been recognized in both local and international studies (14,24–26).

Socioeconomic factors can play a role in shaping metabolic health patterns. This study showed a higher prevalence of metabolic syndrome among women with higher household incomes. This is likely due to lifestyle and dietary changes associated with increased purchasing power, which allows individuals access to energy-rich foods and processed products, as well as urbanization and mechanization, which have contributed to more sedentary lifestyles (10,15). Such lifestyle forms have been concomitant to increased adiposity, chronic low-grade inflammation, and insulin resistance (23,27).

In contrast, the current study did not show a statistically significant association between educational level and metabolic syndrome. This finding is consistent with several regional and local studies, but differs from some universal research that recommends an inverse relationship between education and risk factors for metabolic syndrome (24,28–30). These dissimilarities may reproduce variations in cultural, economic, and behavioral factors crosswise populations.

Impact of Dietary Patterns, Physical Activity, and Lifestyle Changes on Metabolic Status

In the study, dietary patterns appeared to play a significant role in the metabolic characteristics exhibited by participants. Women with metabolic syndrome tended to report dietary patterns characterized by increased energy intake and higher consumption of carbohydrates and fats, coupled with relatively low fiber and protein intake. These dietary patterns have been strongly associated with an increased risk of weight gain, insulin resistance, and metabolic disorders in previous studies (23,31).

Low dietary fiber intake is associated with impaired glycemic control and altered lipid metabolism, while increased energy intake may contribute to fat accumulation (32–35). These mechanisms may partially explain the higher prevalence of metabolic disorders among individuals with less balanced dietary patterns.

The results of this study showed that physical activity is a fundamental and important factor linked to metabolic health. The prevalence of metabolic syndrome was observed to be higher among sedentary participants, while its prevalence was lower among active participants. These findings are consistent with previous studies indicating that regular physical activity can improve insulin sensitivity, lipid metabolism, and overall cardiometabolic health (36,37).

In the Jordanian context, the rapid urbanization and technological changes have contributed to increased sedentary lifestyles and the availability of fast food—a fattening environment. These factors may contribute to increased visceral fat accumulation and metabolic disorders.

Role of General and Central Obesity Indicators in Metabolic Risk

The current study discovered strong correlations between a number of metabolic syndrome components and obesity indicators, such as BMI, body fat percentage, waist circumference, and waist-to-height ratio. Participants with metabolic abnormalities like dyslipidemia, elevated blood glucose, and hypertension typically had higher values of these indices. Additionally, the study's multivariate regression results highlight the complexity of metabolic syndrome in this population, where modifiable lifestyle behaviors—particularly high dietary fat intake and physical inactivity—significantly exacerbate the interaction between aging and central adiposity. This predictive model emphasizes that focusing only on one risk factor may not be enough; instead, a comprehensive strategy that addresses both behavioral and metabolic components is necessary for successful risk reduction.These results are in line with earlier research showing a strong correlation between systemic metabolic dysfunction and excess adiposity, especially abdominal fat accumulation (15,24). Because visceral fat is metabolically active and has been closely linked to insulin resistance, inflammatory pathways, and cardiometabolic risk, central obesity indicators have drawn more attention in epidemiological research (19,38,39). Measures of the distribution of abdominal fat, such as waist circumference and waist-to-height ratio, demonstrated significant correlations with components of the metabolic syndrome in the current study.

Previous studies have shown that waist-to-height ratio can be a useful indicator in clinical assessments for evaluating cardiovascular and metabolic disease risk in various populations (40,41).Furthermore, lifestyle factors such as diet and regular physical activity may mitigate some of the negative metabolic effects associated with increased body fat accumulation (42,43). These findings underscore the importance and necessity of using anthropometric indicators and lifestyle behaviors to assess metabolic health in routine clinical examinations.

5. CONCLUSION

The current study highlights the widespread prevalence of metabolic syndrome and central obesity among participants, particularly with increasing age and socioeconomic status. The results show that increased body mass index (BMI), an indicator of generalized obesity, waist circumference, an indicator of central obesity, and body fat percentage are strongly correlated with metabolic disorders. Furthermore, the study identifies poor diet quality, characterized by high fat and low fiber intake coupled with low levels of physical activity, as independent and critical predictive risk factors for metabolic risk. These findings suggest that lifestyle changes in the Jordanian context are a major driver of cardiovascular and metabolic diseases.

6. RECOMMENDATIONS

Targeted Screening: Instead of depending only on BMI, conduct routine screening for central obesity using waist circumference and waist-to-height ratio, particularly for women over 40. Nutritional Intervention, Create public health initiatives that emphasize consuming more dietary fiber and consuming fewer processed foods that are high in fat and energy. Physical Activity Advocacy, To combat the sedentary nature of contemporary urban lifestyles, support community-based physical activity programs. Socioeconomic Focus, Target high-income populations with health awareness campaigns because they may be more vulnerable to "lifestyle-related" metabolic risks as a result of dietary changes.

7. STRENGTHS AND LIMITATIONS

Using multivariate regression to find independent predictors, this study offers a thorough examination of anthropometric and lifestyle factors. It provides important information about Jordan's unique cultural and socioeconomic context, where metabolic patterns are changing quickly.

The study's cross-sectional design makes it more difficult to prove a direct link between metabolic syndrome and lifestyle factors. Furthermore, recall bias may affect self-reported food and exercise data, which should be taken into account when interpreting the findings.

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