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# Obesity Grade and Duration: Impact on Blood Glucose and High Blood Pressure among Jordanian Adults

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ABSTRACT

**Background:** Obesity is a major public health problem and an important risk factor for cardiometabolic disorders, including elevated blood pressure (BP) and type 2 diabetes. Limited evidence is available regarding the role of obesity type, degree, and duration in relation to cardiometabolic risk among Middle Eastern men. This study investigated their association with elevated fasting blood glucose (FBG) and BP among Jordanian adult males.

**Methods**: A cross-sectional study was conducted among 360 Jordanian men aged 30–50 years. Participants were classified according to body mass index (BMI) as normal weight (25.0%), overweight (25.0%), and obese (50.0%). Central obesity was assessed using waist circumference (WC). FBG and BP were measured using standardized procedures. Sociodemographic, lifestyle, dietary, and family history data were collected using a structured questionnaire. Chi-square tests and multivariable logistic regression analyses adjusted for potential confounders were performed.

**Results:** Obese individuals had significantly higher BP and FBG levels than normal-weight individuals ($P < 0.001$). Central obesity associated with elevated BP (OR = 3.10; 95% CI: 2.50–5.80; $P < 0.001$) and FBG (OR = 3.30; 95% CI: 2.60–6.40; $P < 0.001$). Obesity duration (≥10 years) associated with increased odds of elevated FBG (OR = 2.80; 95% CI :2.60–6.00; $P < 0.001$) and BP (OR = 3.10; 95% CI: 2.20–4.10; $P < 0.001$). The interaction between BMI and WC was significant ($P < 0.001$).

**Conclusions:** Central obesity and prolonged obesity duration were strongly associated with elevated BP and elevated FBG among Jordanian adult males. Incorporating WC and obesity duration into routine clinical assessment may improve early identification of cardiometabolic risk. Further longitudinal studies are needed to confirm these findings.

**Keywords**: Obesity; Central obesity; Elevated blood pressure; Elevated blood glucose; Obesity duration; Jordan.

## Introduction

Obesity has emerged as a major global public health challenge and is a leading modifiable risk factor for non-communicable diseases, including type 2 diabetes mellitus and elevated blood pressure (BP) (1–3). The World Health Organization (WHO) has reported that since 1975, the prevalence of obesity has nearly tripled worldwide, with Middle Eastern nations having disproportionately high rates because of fast urbanization, sedentary lifestyles, and dietary changes (2,4,5). Alongside this epidemiological change, there has been a substantial increase in premature mortality and cardiometabolic morbidity.

Body mass index (BMI) has long been traditionally used in routine screenings as a primary indicator of obesity in epidemiological and clinical research. Despite its ease of use and widespread adoption, BMI does not adequately and convincingly reflect the risk of cardio-metabolic diseases, particularly in individuals with visceral obesity, as evidenced by a growing body of research (6). This is demonstrated by the fact that individuals with similar BMI values exhibited significant variations in their metabolic characteristics, highlighting the limitations of BMI as a sole and accurate measure of obesity related health risks. Central obesity, generally tested by waist circumference (WC), has been consistently demonstrated as a

strong associated factor of elevated BP, insulin sensitivity, and elevated fasting blood glucose (FBG) than BMI alone (7).

Visceral adipose tissue is metabolically active and has been associated with insulin resistance, persistent, low-grade systemic inflammation, dysregulation of adipokine secretions, and activation of neurohormonal pathways such as the renin-angiotensin-aldosterone system, all of which are associated with elevated BP and poor glucose metabolism (8).

Furthermore, the type, severity, and duration of obesity play a pivotal role in determining and shaping cardiometabolic risks. Individuals with higher rates of systolic and diastolic BP, increased insulin resistance, and elevated FBG levels are more likely to experience these symptoms, particularly in those with higher WC and BMI compared to normal levels (9). Current longitudinal studies indicate that the duration of obesity is independently associated with type 2 diabetes and elevated BP more than BMI, highlighting the cumulative metabolic effects of chronic obesity (10).

The persistence of chronically elevated FBG and progressive beta-cell dysfunction, persistent increase in vascular resistance, and irreversible vascular remodeling are all consequences of long-term exposure to excess fat accumulation, which may be associated with progressive metabolic dysfunction and elevated BP (7). The temporal dynamics highlight the pivotal role of obesity duration and the emphasis on early intervention for obesity management, which is typically measured in years of elevated BMI, into account as a cumulative risk factor for elevated BP and FBG.

North Africa and many parts of the Middle East have some of the highest rates of cardiovascular and metabolic diseases associated with obesity worldwide. National and regional studies have shown a very high prevalence of general and central obesity, particularly among adult males. (11,12).

Jordan has the highest prevalence of adult obesity in the Middle East and North Africa region (MENA). Recent and previous national surveys have shown a rapid and alarming increase in the prevalence of overweight, obesity, elevated BP, and diabetes among both men and women (13,14). According to regional estimates, the prevalence of diabetes may rise significantly, and over half of Jordan's adult population might be diagnosed with obesity by 2050 (14,15). Furthermore, non-communicable diseases account for about 78% of deaths in Jordan, and obesity is one of the main modifiable risk factors (16,17). However, most local studies have relied primarily on BMI and have rarely incorporated WC or obesity duration into risk assessment models (13,14). Consequently, a crucial study vacuum exists in the thorough evaluation of obesity as a multidimensional exposure spanning type, degree, and duration within the Jordanian setting. Addressing this gap is critical for improving cardio metabolic risk categorization and guiding culturally relevant preventative intervention.

Therefore, while controlling for sociodemographic, lifestyle, nutritional, and familial confounding variables, the objective of the current study was to investigate the independent and combined effects of obesity type (central versus generalized), degree, and duration with elevated BP and FBG in Jordanian adult males. To our knowledge, this is among the first Jordanian studies evaluating obesity type, degree, and duration simultaneously in relation to cardiometabolic risk among adult males.

## Methods

### Study Design and Participants

A cross-sectional study using a multistage stratified sampling technique was conducted to evaluate the potential association between fatness type, degree, and duration with elevated FBG and elevated BP among obese Jordanian adult males aged 30-49.9. The Al-Sareeh area in Irbid Governorate, northern Jordan, was selected as the study site. This area is characterized as a semi-urban community with a homogeneous lifestyle and socioeconomic and cultural background. The study was conducted between September 2024 and July 2025 in accordance with the principles of the Declaration of Helsinki, ensuring ethical treatment of all participants.

Verbal informed consent was obtained from all participants before data collection, as approved by the Institutional Review Board due to the minimal-risk nature of the study. Due to the varying levels of education and literacy of some of the participants, verbal informed consent was obtained after a full explanation of the study procedures, which consisted of collecting data via questionnaires, interviews, and anthropometric measurements. The Institutional Review Board, in the process of ethical approval, approved this consent procedure. The Institutional Review Board of Jerash University approved the study (No. O/1/2025/2026) according to the Declaration of Helsinki.

Based on their BMI, Participants were categorized into three BMI groups: normal weight state (n=90). Group (2): 90 people who were overweight and 180 people who were obese. Should specify clearly both the inclusion and exclusion criteria used in the study. Participants had to be citizens of Jordan and free from severe chronic conditions, acute illnesses, and aged 30-≤50 years. Participants were excluded if they had any disabilities, were taking medications that could affect energy metabolism or body composition, were engaged in strenuous physical activity, had weight fluctuations of more than 5 kg during the two months before testing, were underweight, or had a chronic disease for at least two years.

The primary sampling unit considered the division of each study area into five clusters. Systematic sampling of households (every 30th house) was done. One resident, if available, was selected from each BMI-C (normal weight, overweight, and obese), and each household was informed to contribute if they achieved the study criteria. Whenever there was more than one individual from each BMI-C, one participant was randomly recruited. If the selected household had no volunteers and/or if they were not fulfilling the study criteria, the next household was used.

### Anthropometric and Clinical Measurements

Trained nutritionists conducted anthropometric measurements using defined methods (Centers for Disease Control and Prevention) (18). Measurements were taken in Al-Sareeh Medical Consulting Center.

The height and weight of the participants were determined to determine their BMI, which was used to classify weight status according to WHO (1997) guidelines. To assess central obesity, we measured WC and categorized it as low (< 94 cm), moderate (94–102 cm), or high (≥ 102 cm) (19). Following a 15-minute rest period, BP was measured using a professional electronic sphygmomanometer. BP was measured two times, and the average was recorded. Elevated BP was defined as a systolic BP of ≥ 120 mmHg or a diastolic BP of ≥ 80

mmHg (20). Using a Roche Cobas c311 analyzer, FBG was measured following an overnight fast (8–12 h). Values FBG ≥100 mg/dL were classified as elevated FBG (21).

**Lifestyle Assessment**

Using a structured, valid, and reliable questionnaire, and for clarification of the main elements of the questionnaire, we documented demographics (age, education, income, and employment) as well as the history of obesity and cardio metabolic disorders in the parents. We used a modified instrument (Al-Hazzaa, 2014) to measure physical activity, classifying the results as low, moderate, or high (22).

To ensure the accuracy of participant recall, all questionnaires were structured, standardized, and interviewer-administered. Participants were provided with clear instructions and reference periods to minimize memory bias. Where possible, information was cross-checked with available records or multiple questionnaire items to verify consistency. These procedures were designed to enhance data reliability and reproducibility. In addition to that, Cronbach's alpha was used to assess the internal consistency of the questionnaire, yielding coefficients ranging from 0.83 to 0.86. To ensure conciseness, only the overall reliability results are reported without a detailed tabular presentation.

Based on the number of years since weight gain started, we utilized body shape charts (23) to calculate the duration of obesity. Short (< 5 years), medium (5–10 years), and long (> 10 years) were the three categories into which this was separated (24). Additionally, we analyzed 24-hour dietary recalls over three non-consecutive days using the Jordanian recipe book and ESHA software (25).

**Statistical Analysis**

The data analysis was computerized and coded using SPSS version 25. Continuous variables are presented as mean ± standard deviation (SD), while categorical variables are summarized as frequencies and percentages. Relationships between categorical variables were initially assessed using chi-square tests. Mean dietary energy intakes were compared using one-way ANOVA. An internal consistency factor was calculated to assess reliability, with a value between 0.83 and 0.86; for simplicity, only the overall reliability coefficient is reported.

To assess the independent relationships between obesity characteristics and cardiometabolic outcome indices, a bivariate logistic regression analysis was used, specifically for elevated FBG and elevated BP. Obesity characteristics included BMI, WC, and duration of obesity. Confounder variables consisted of age, educational level, monthly income, smoking status, physical activity, total energy intake, energy derived from fat, and family history of obesity and cardiovascular disease. BMI and WC showed a moderate correlation (r = 0.84), and to explain their combined relationship and to account for their combined associations, a statistically significant interaction term was included in the model ($P < 0.001$). All other covariates had correlation coefficients ≤ 0.5, indicating a significant association with elevated BP and elevated FBG.

Model calibration was evaluated using goodness-of-fit indices, such as the Hosmer–Lemeshow test, and model assumptions were confirmed. Normal WC (< 94 cm), normal BMI (< 25 kg/m$^2$), and duration of obesity (< 5 years) were the reference categories. There were reported odds ratios (ORs) and 95% confidence intervals (CIs). An interaction term between BMI and WC was used to assess the combined association of general and central obesity. This allowed for the evaluation of both independent and joint effects on cardiometabolic outcomes while accounting for potential confounding variables. The threshold for statistical significance was set at $P < 0.05$.

## Results

**Baseline characteristics**

Table 1 presents the baseline characteristics of the study population according to BMI categories. A clear and statistically significant gradient was observed across BMI groups for most cardiometabolic variables.

The study results show that body weight increased markedly from 72.51 ± 4.72 kg in normal-weight participants to 97.42 ± 6.11 kg in obese individuals ($P < 0.001$). Similarly, WC showed a substantial increase (86.22 ± 2.24 cm vs. 117.48 ± 2.14 cm; $P < 0.001$). Both systolic and diastolic BP increased significantly with BMI. Systolic BP rose from 114.81 ± 9.33 mmHg to 138.30 ± 12.92 mmHg ($P < 0.001$) while diastolic BP increased from 73.91 ± 7.61 mmHg to 91.30 ± 11.83 mmHg ($P < 0.001$). FBG levels were significantly higher in obese participants (151.31 ± 65.30 mg/dL) compared to those with normal weight (104.62 ± 18.12 mg/dL) ($P < 0.001$), indicating early metabolic disturbances.

**Table 1.** General characteristics of the study sample according to BMI categories (Continuous variables), N = 360.

| Variable | BMI Category | | | *P* value [b] |
|---|---|---|---|---|
| | Normal (n = 90) [a] | Overweight (n = 90) [a] | Obese (n = 180) [a] | |
| Age (years) | 38.58 ± 6.23 | 38.95 ± 6.60 | 39.53 ± 6.54 | $P = 0.060$ |
| Body weight (kg) | 72.51 ± 4.72 | 81.92 ± 5.83 | 97.42 ± 6.11 | $P < 0.001$ |
| Waist circumference (cm) | 86.22 ± 2.24 | 103.23 ± 5.11 | 117.48 ± 2.14 | $P < 0.001$ |
| Diastolic blood pressure (mmHg) | 73.91 ± 7.61 | 81.10 ± 9.22 | 91.30 ± 11.83 | $P < 0.001$ |
| Systolic blood pressure (mmHg) | 114.81 ± 9.33 | 125.10 ± 12.11 | 138.30 ± 12.92 | $P < 0.001$ |
| Fasting blood glucose (mg/dL) | 104.62 ± 18.12 | 113.12 ± 33.13 | 151.31 ± 65.30 | $P < 0.001$ |
| Total energy intake (kcal/day) | 2550.58 ± 230.58 | 2681.11 ± 180.49 | 3189.20 ± 270.39 | $P < 0.001$ |
| Energy from fat (%) | 32.30 ± 1.60 | 35.10 ± 1.99 | 36.76 ± 2.40 | $P < 0.001$ |

[a] Data are presented as mean ± (SD).

[b] *P* values were calculated using one-way ANOVA.

Total energy intake also increased significantly across BMI categories (2550.58 ± 230.58 vs. 3189.20 ± 270.39 kcal/day; $P < 0.001$), along with the percentage of energy derived from fat (32.30% vs. 36.76%; $P < 0.001$).

Table 2 presents significant associations between obesity-related measures and elevated BP and elevated FBG. Significant association was observed between higher BMI and family history of obesity, elevated BP and diabetes (all $P < 0.001$). There was no significant difference in current smoking status across BMI groups ($P = 0.210$). Longer duration of obesity (≥10 years) was substantially more prevalent among obese individuals (65.00%) compared to other groups ($P < 0.001$). Additionally, low physical activity levels were significantly more common in the obese group (58.40%) compared to normal-weight individuals (24.40%) ($P < 0.001$). Age did not differ significantly between groups ($P < 0.050$).

Table 3 presents the bivariate analysis; several sociodemographic, familial, dietary, and obesity-related factors were significantly associated with elevated BP and elevated FBG. Participants aged ≥ 40 years had a higher prevalence of elevated BP (56.3%, $P = 0.006$) and elevated glucose (58.9%, $P < 0.001$). Higher education (≥ 12 years) and a monthly income of ≥ 500 JD were also associated with both outcomes ($P < 0.050$). Current smoking had modest but significant associations with elevated BP (55.10%, $P = 0.032$) and glucose (42.60%, $P = 0.040$). Family history of obesity, elevated BP, or diabetes significantly increased the risk of elevated BP (55–66%, $P < 0.010$) and glucose (53–71%, $P < 0.010$). Similar associations were observed for increased prevalence of both outcomes with dietary factors, including total energy intake of ≥ 2550 kcal/day and fat intake exceeding 32%. These factors were also associated with an increased prevalence of both outcomes ($P < 0.05$).

**Table 2.** General characteristics of the study sample according to BMI categories (Categorical variables), N = 360.

| Variable | | BMI Category | | | *P* value [b] |
|---|---|---|---|---|---|
| | | Normal (n = 90) [a] | Overweight (n = 90) [a] | Obese (n = 180) [a] | |
| Parental obesity | Yes | 13 (0.14) | 45 (0.50) | 135 (0.75) | $P < 0.001$ |
| | No | 77 (0.85) | 45 (0.50) | 45 (0.25) | |
| Parental elevated BP | Yes | 22 (0.24) | 31 (0.34) | 101 (0.56) | $P < 0.001$ |
| | No | 68 (0.75) | 59 (0.66) | 79 (0.44) | |
| Parental diabetes mellitus | Yes | 24 (0.26) | 34 (0.38) | 107 (0.59) | $P < 0.001$ |
| | No | 66 (0.73) | 56 (0.62) | 73 (0.41) | |
| Education level ≥ 12 years | Yes | 58 (0.64) | 29 (0.32) | 63 (0.35) | $P < 0.001$ |
| | No | 32 (0.35) | 61 (0.68) | 117 (0.65) | |
| Monthly income ≥ 500 JD | Yes | 77 (0.85) | 33 (0.37) | 57 (0.32) | $P < 0.001$ |
| | No | 13 (0.14) | 57 (0.63) | 123 (0.68) | |
| Current smoking | Yes | 48 (0.53) | 52 (0.58) | 116 (0.64) | $P = 0.210$ |
| | No | 42 (0.46) | 38 (0.42) | 64 (0.36) | |
| Duration of obesity [c] | < 5 years | 12 (10.98) | 19 (17.01) | 17 (15.03) | $P < 0.001$ |
| | 5–<10 years | 3 (2.97) | 14 (12.78) | 18 (16.47) | |
| | ≥ 10 years | 2 (1.98) | 10 (9.00) | 65 (58.50) | |
| Physical activity | Low | 22 (24.40) | 39 (43.30) | 105 (58.40) | $P < 0.001$ |
| | Moderate | 33 (36.70) | 45 (50.00) | 62 (34.40) | |
| | Active | 35 (38.90) | 6 (6.70) | 13 (7.20) | |

[a] Data are presented as counts and percentages (n(%)).

[b] *P* values were calculated using the Chi-square test.

[c] Duration of obesity: this variable contains missing data.

**Table 3.** Bivariate analysis of categorical and lifestyle factors associated with elevated BP and elevated FBG.

| Variable | Elevated BP [a] | *P* value [b] | Elevated FBG [a] | *P* value [b] |
|---|---|---|---|---|
| Age ≥40 years | 111 (56.30) | $P = 0.006$ | 116 (58.90) | $P < 0.001$ |
| Education level ≥12 years | 65 (40.60) | $P = 0.021$ | 73 (43.70) | $P = 0.021$ |
| Monthly income ≥500 JD | 71 (42.50) | $P = 0.041$ | 74 (44.30) | $P = 0.010$ |
| Current smoking | 119 (55.10) | $P = 0.032$ | 92 (42.60) | $P = 0.040$ |

**Cont. Table 2.** General characteristics of the study sample according to BMI categories (Categorical variables).

| Variable | Elevated BP [a] | *P* value [b] | Elevated FBG [a] | *P* value [b] |
|---|---|---|---|---|
| Parental obesity | 112 (54.90) | $P = 0.008$ | 109 (53.40) | $P = 0.007$ |
| Parental elevated BP | 102 (66.20) | $P < 0.001$ | 87 (56.50) | $P = 0.009$ |
| Parental diabetes mellitus | 96 (58.20) | $P = 0.008$ | 117 (70.90) | $P < 0.001$ |
| Total energy intake ≥2550 kcal/day | 134 (56.50) | $P = 0.021$ | 131 (55.30) | $P = 0.031$ |
| Energy from fat >32% | 69 (52.50) | $P = 0.022$ | 70 (59.20) | $P = 0.007$ |

[a] Data are presented as counts and percentages (n (%)).

[b] *P* values were calculated using the Chi-square test. Statistical significance was set at $P < 0.05$.

Table 4: The study results showed that Obesity measures had a clear gradient; overweight and obese subjects had progressively higher rates of elevated BP (36.70% and 67.20%) and elevated glucose (32.20% and 56.10%, $P < 0.001$). WC ≥ 102 cm and duration of obesity ≥ 10 years were also strongly associated with both increased BP and glucose ($P < 0.001$).

Table 5 presents the multivariate binary logistic regression analysis of obesity-related factors associated with elevated FBG and elevated BP. Jordan is among the top three countries in the region with a high prevalence of obesity and related cardiometabolic disorders. The analysis showed that obesity-related factors were independently associated with both outcomes. Compared with normal-weight participants, overweight individuals had higher odds of elevated FBG (OR: 1.90, 95% CI 1.60–3.70, $P = 0.004$) and elevated BP (OR: 2.80, 95% CI 1.90–3.00, $P = 0.006$), while obese participants had even greater odds (FBG (OR: 2.60, 95% CI 2.00–5.40, $P < 0.001$; elevated BP (OR 3.3, 95% CI 2.10–5.8, $P < 0.001$). Moderate and high WC were also significantly associated with both outcomes, with ORs ranging from 2.80 to 3.30 *(*$P < 0.001$). Duration of obesity showed a graded effect: participants with 5–<10 years of obesity had elevated risk (elevated FBG (OR: 1.70, 95% CI 1.10–3.10; elevated BP (OR: 1.40, 95% CI 1.20–1.90, $P = 0.006$), whereas those with ≥ 10 years had the highest odds (elevated FBG (OR: 2.80, 95% CI: 2.60–6.00; elevated BP OR: 3.10, 95% CI 2.20–4.10, $P < 0.001$). The interaction between BMI and WC was also significant for both elevated FBG (OR: 1.70, 95% CI 1.50–2.30) and elevated BP (OR: 1.80, 95% CI 1.50–2.20, $P < 0.001$), indicating a combined association of general and central obesity.

**Table 4.** Bivariate analysis of obesity-related variables associated with elevated BP and elevated FBG.

| Variable | | Elevated BP [a] | *P* value [b] | Elevated FBG [a] | *P* value [b] |
|---|---|---|---|---|---|
| BMI category (kg/m²) | 18.5–<25 | 10 (12.20) | $P < 0.001$ | 8 (8.80) | $P < 0.001$ |
| | 25–<30 | 33 (36.70) | | 29 (32.20) | |
| | ≥ 30 | 121 (67.20) | | 101 (56.10) | |
| WC (cm) | < 94 | 6 (7.10) | $P < 0.001$ | 5 (5.90) | $P < 0.001$ |
| | 94–<102 | 44 (38.30) | | 41 (35.70) | |
| | ≥ 102 | 114 (71.30) | | 92 (57.50) | |
| Duration of obesity (years) | < 5 | 25 (15.30) | $P < 0.001$ | 18 (13.00) | $P < 0.001$ |
| | 5–<10 | 35 (21.30) | | 31 (22.50) | |
| | ≥ 10 | 104 (63.40) | | 89 (64.50) | |

[a] Data are presented as counts and percentages (n(%)).

[b] *P* values were calculated using the Chi-square test. Statistical significance was set at $P < 0.05$ .

**Table 5.** Multivariate binary logistic regression analysis of obesity-related factors associated with elevated FBG and elevated BP.

| Independent variable | | Elevated Fasting blood glucose [a] | | Elevated blood pressure [a] | |
|---|---|---|---|---|---|
| | | OR (95% CI) [b] | P-value [c] | OR (95% CI) [b] | P-value [c] |
| BMI category (kg/m²) | Normal (reference) | 1.00 | — | 1.00 | — |
| | Overweight | 1.9 (1.6–3.7) | 0.004 | 2.8 (1.9–3.0) | $P = 0.006$ |
| | Obese | 2.6 (2.0–5.4) | <0.001 | 3.3 (2.1–5.8) | $P < 0.001$ |
| WC (cm) | Normal (reference) | 1.00 | — | 1.00 | — |
| | Moderate | 3.1 (2.5–6.1) | <0.001 | 2.8 (2.5–5.4) | $P < 0.001$ |
| | High | 3.3(2.6-6.4) | <0.001 | 3.1 (2.5–5.8) | $P < 0.001$ |

**Cont. Table 5.** Multivariate binary logistic regression analysis of obesity-related factors associated with elevated FBG and elevated BP.

| Independent variable | Elevated blood glucose [a] | | Elevated blood pressure [a] | |
|---|---|---|---|---|
| | OR (95% CI) [b] | P-value [c] | OR (95% CI) [b] | P-value [c] |
| Duration of obesity (years) | < 5 (reference) | 1.00 | — | — |
| | 5–<10 | 1.7 (1.1–3.1) | 0.006 | $P = 0.005$ |
| | ≥ 10 | 2.8 (2.6–6.0) | <0.001 | $P < 0.001$ |
| BMI × WC (interaction) | 1.7 (1.5–2.3) | <0.001 | 1.8 (1.5–2.2) | $P < 0.001$ |

[a] All models were adjusted for age, education level, monthly income, smoking status, total energy intake, energy from fat, physical activity, parental obesity, parental elevated blood pressure, and parental diabetes mellitus. Reference categories were: normal BMI (<25 kg/m$^2$), normal waist circumference (<94 cm), and duration of obesity <5 years.

[b] OR: Odds ratio; CI: Confidence interval.

[c] Statistical significance was set at $P < 0.05$.

## Discussion

The findings of the current study demonstrated that the type, severity, and duration of obesity were associated with elevated BP and FBG levels among adult male Jordanians. The findings of this study demonstrated that the type, severity, and duration of obesity among adult Jordanian males could be considered a strong indicator associated with both elevated BP and FBG levels, as well as metabolic dysfunction. Specifically, obese individuals had significantly higher mean systolic and diastolic BP pressure and FBG levels compared to individuals of normal weight. This finding reflects a clinically significant metabolic dysfunction in obese and overweight individuals, even without a formal diagnosis. Central obesity, as measured by WC, was a strong indicator associated with both elevated BP and elevated FBG.

After accounting for other confounding factors, individuals with a WC of 102 cm or more were more than three times more likely to have elevated FBG, elevated BP, or both. This underscores the importance of visceral fat in cardiovascular and metabolic disease risk, as the study results showed a greater and stronger association between WC and cardiometabolic risk than BMI. Adipokines, free fatty acids, and pro-inflammatory cytokines are released by metabolically active visceral fat. Visceral fat has been associated with impaired insulin signalling and vascular dysfunction (26,27).

Furthermore, we observed a cumulative effect with increasing duration of obesity. Those with obesity lasting over ten years were almost three times more likely to experience elevated FBG and elevated BP. This supports the idea that chronic obesity is associated with long-term changes in blood vessels, increasing insulin resistance and impairing β-cell function (27,28).

We also discovered a significant interaction between BMI and WC, indicating a combined effect where the coexistence of general and central obesity was associated with greater cardiometabolic risk compared with either condition alone. These findings align well with global evidence showing that central obesity has been more strongly associated with cardiometabolic risk than BMI alone (2,9). Research has pointed out the limitations of BMI-based classifications, especially in populations with high rates of metabolic diseases among normal-BMI adults who have higher WC (29,30). In the Middle East, abdominal obesity often occurs at lower BMI thresholds than in Western populations (12,31).

The results of this study may add important independent information to scientific literature by demonstrating that the amount and location of fat accumulation and the duration of obesity play a pivotal and predictive role in cardiometabolic risk. Clinically, these results underscore the necessity of incorporating WC as an indicator of central obesity and the duration of obesity into routine assessments in Jordan and the MENA region in general. Relying solely on BMI for generalized obesity may underestimate the risk in individuals with visceral obesity. However, this study suffers from limitations in its cross-sectional design, which prevents drawing conclusions about causality. It also relies on self-reported data regarding the duration of obesity and physical activity. Furthermore, the sample focused only on men aged 30–50 years, so the results may not be generalizable to male or other age groups, highlighting the need for further studies.

Our results are consistent with recent regional data regarding the high prevalence of elevated FBG and its correlation with abdominal obesity. For example, a large-scale study conducted in Jordan by Ajlouni found that central obesity was strongly associated with high prevalence of metabolic syndrome and its components, such as elevated FBG and elevated BP, among Jordanian adults (14). Similar patterns have been noted in nearby nations like Saudi Arabia and the United Arab Emirates, where extended exposure to obesity has been repeatedly associated with a marked deterioration in metabolic health (32). To reduce the long-term risk of type 2 diabetes and cardiovascular diseases in the Middle Eastern context, localized public health interventions that emphasize early weight management are desperately needed (33).

### Strengths, Limitations, and Clinical Implications

This study's strength lies in its focus on adult males from Jordan, a demographic that is often overlooked in regional metabolic studies. However, the reliance on self-reported obesity duration may be linked to recall bias, and the cross-sectional design limits our ability to draw causal inferences. As a result, the associations observed in this study should not be interpreted as indicative of cause-and-effect relationships. Furthermore, results might not apply to women or other ethnic groups.

Clinically, these findings highlight that WC must be included in routine screenings to detect central obesity and related metabolic risks; BMI alone may be insufficient for comprehensive cardiometabolic risk assessment. In Jordan, early intervention strategies are crucial to preventing long-term metabolic complications due to the substantial impact of obesity duration. Targeted public health initiatives aimed at preventing early-onset obesity can benefit from these insights.

## Conclusion

Based on our findings, we provide further evidence that central obesity and longer obesity duration were more strongly associated with elevated BP and elevated FBG than generalized obesity alone. This multidimensional approach to obesity assessment may offer a more comprehensive framework for cardiometabolic risk stratification among Jordanians and possibly the broader Middle Eastern population. Further population-based studies are warranted to generalize the findings of the current study.

## Ethical Considerations

The Institutional Review Board of Jerash University approved the study (Approval No. O/1/2025/2026) according to the Declaration of Helsinki.

## Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Author Contributions

**Conceptualization;** O.A. **Methodology;** N.A, M.I, S.K. **Formal Analysis;** M.E, N.B, S.T. **Investigation;** M.E, N.B, B.A. **Writing – Original Draft Preparation;** O.A, B.A. **Writing – Review & Editing;** O.A, B.A.

## Data Availability Statement

Not applicable.

## Supplemental Material

Not applicable.

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