

METABOLIC HEALTH AND ITS DETERMINANTS IN IRAQI UNIVERSITY STUDENTS: A CROSS-SECTIONAL ANALYSIS

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Abstract:

Background: Metabolic syndrome (MetS) is a clustering of cardiometabolic risk factors that substantially increases the risk of cardiovascular disease and type 2 diabetes mellitus. Although traditionally associated with older populations, recent evidence suggests a rising burden of MetS among young adults, particularly in regions undergoing rapid lifestyle transitions.

Objective: This study aimed to assess the prevalence of metabolic syndrome and its associated metabolic and lifestyle-related risk factors among university students in Diyala Province, Iraq.

Methods: A cross-sectional survey of university students was performed. Anthropometric measurements, blood pressure and biochemical (fasting blood glucose and lipid profile) parameters were determined. MetS was diagnosed according to accepted criteria. Frequency of consumption of fast-food was assessed as lifestyle factor. Comparisons between students with and without MetS were conducted statistically.

Results: Metabolic syndrome was identified among university students, indicating the presence of early cardiometabolic risk, suggesting an early cardiometabolic risk profile. The body mass index, waist circumference, blood pressure, fasting blood glucose levels, triglycerides, low density lipoprotein-cholesterol (LDL-C), and VLDL were significantly higher and high-density lipoprotein cholesterol (HDL-C) lower in those with MetS compared to their healthy counterparts. More frequent consumption of fast food (>3 times/week) was related with worse metabolic profiles: higher glucose, dyslipidemia, central obesity and heavier blood pressure.

Conclusions: Metabolic syndrome and its components exist and are present in university students, in Diyala Province suggesting early occurrence of cardiometabolic risk. Frequent indulgence in fast-food is an important modifiable.

Introduction

Metabolic syndrome (MetS) is an accumulation of several disorders that raise the risk of atherosclerotic cardiovascular disease (CVD), including myocardial infarction, cerebrovascular accidents, peripheral vascular diseases, insulin resistance, and type II diabetes mellitus. The cluster of metabolic disorders that define metabolic syndrome includes central obesity, insulin resistance, hypertension, and atherogenic dyslipidemia ⁽¹⁾. The prevalence of metabolic syndrome is rising worldwide due to changes in diet, physical activity, and lifestyle. In the Middle East and regions like Iraq, rapid urbanization and shifts toward sedentary living and



high-calorie diets have contributed to an increasing burden of metabolic disorders, particularly among younger populations. This trend highlights the urgent need for early detection and prevention strategies tailored to regional health behaviors and risks. The prevalence of MetS in young adult worldwide ranged between 5% and 7%, the national health and Nutrition Examination Survey (NHANES) revealed that the prevalence of MetS increased significantly among Americans aged 20-39 (from 16.2% to 21.3%) and among people of Aaian descent (from 19.9% to 26.2%)⁽²⁾. a substantial lifetime burden of CVD risk is probably represented by the existence of one component of MetS, which raises the likelihood of developing MetS in future, and this raises the chance of developing CVD in later life⁽³⁾.

University students represent a critical population for studying metabolic health because they are typically in a transitional life stage moving from adolescence to adulthood where lifelong habits related to diet, physical activity, and health behaviors are being established. During this period, many students adopt unhealthy lifestyles, including increased consumption of fast food, sedentary behavior, poor sleep, and high stress all of which are known risk factors for metabolic syndrome. Farther more, early detection of metabolic abnormalities in this age group is essential, as it offers an opportunity for early intervention and prevention of chronic diseases such as type2 diabetes mellitus and cardiovascular disease later in life. This study aims to assess the metabolic health status of university student in (Dyala province), Iraq, and to identify the risk determinants, including biochemical markers and lifestyle related factors, through cross sectional analysis.

Materials and Methods

In this an observational study, the participants were selected from Bilad Alrafidain University, Diyala, Iraq, from (October 2024 to January 2025). An apparently healthy (100) students' samples (47) males and (53) females had been collected with age range (18-25) years. Students with chronic disease (diabetes, hypertension, dyslipidemia, liver, cardiovascular, renal, and autoimmune diseases) were excluded. Questionnaires were collected from the students about (the fast food meals repetition during the week, the physical activity, and eating vegetables or fruit), also anthropometric measurements of (body mass index (BMI) and waist circumference) were obtained. The weight and height (for calculating BMI((kg/m²), and blood pressure also were measured. the samples underwent to (glucose, triglyceride, total cholesterol, and HDL cholesterol) assessment spectrophotometrically by their specialized kits, for lipid profiles (spinreact) kits where used, also for Glucose (spinreact) kit was used.

In accordance with the IDF, AHA, NHLBI criteria, MetS would be presented when the participants have 3 or more of these criteria⁽⁴⁾:

- i) A high FBG levels ≥ 100 mg/dL;
- ii) A high blood pressure reading (defined as a SBP ≥ 130 mmHg or a DBP ≥ 85 mmHg);
- iii) A low level of HDL-C (for male
- iv) A high level of TG ≥ 150 mg/dL; and



v) An increased waist circumference (male ≥ 37 inches (94 cm) and female ≥ 31.5 inches (80 cm)).

Results

Table 1 shows the distribution of metabolic syndrome (MetS) among the individuals, gender-wise classified. Of the 53 female subjects, 21 (39.62%) were found to have MetS; 13 males (27.66%) out of 47 also showed the condition. On the other hand, 60.38% of women and 72.34% of males were deemed MetS-free. A chi-square test was used to assess gender and MetS status. The study found a statistically significant ($p = 0.0015$) gender difference in MetS prevalence, suggesting relevance. Among this study group, females were shown to show MetS traits more often than males.

Table 1 - Distribution of MetS by Gender

Gender	n (MetS)	% (MetS)	n (Non-MetS)	% (Non-MetS)	Total
female	21	39.62	32	60.38	53
male	13	27.66	34	72.34	47

P-value (Chi-square test): 0.0015

The distribution of metabolic syndrome (MetS) within the study population shows that a notable proportion of the participants—despite being young university students—already meet the criteria for MetS. In total, 34 out of the 100 students (34%) were found to have MetS, indicating that more than one-third of this “apparently healthy” population is already experiencing significant metabolic risk factors.

The prevalence of metabolic syndrome (MetS) in the subjects according to the gender is demonstrated in **Table 1**. MetS criteria were met by 21 (39.62%) of the 53 females; it was also present in 13 (27.66%) of their male counterparts. MetS-free status was found in 60.38% of women and 72.34% men, respectively. The chi-square test analyzing the association of gender and presence of MetS was significantly different ($p = 0.0015$). Female were more prone to have MetS features among this group of study.

What makes these results so remarkable is that the individuals tested were university students who were outwardly healthy. In spite of their relatively young age, apparently normal health and metabolic situation, a large number of them – particularly females – had already developed impaired metabolism. The proportion of students with MetS in this population was not just interesting but alarming from a clinical standpoint. That more than a third of female students and over a quarter of male students had MetS indicates that metabolic risk is occurring at an earlier age than expected. This latter is in line with previous observations on other university samples⁽⁵⁾, where a combination of physical inactivity, stress, disordered eating habits and sedentary behavior may lead to early metabolic defects. This means that the risks to heart and metabolic health could be well established at a much earlier age than is currently believed'.



Emerging findings confirm that young female are likely to show a higher MetS prevalence. Some more recent studies indicate an increasing cardiovascular risk in female university students, particularly related to higher scores of sedentary time, unsteady eating behavior, emotional eating and sleep disorders (Alkhateeb et al., 2021; Silva et al., 2022) which areas are strongly associated with early metabolic diseases. Furthermore, a recent trend indicates that women might be more susceptible to central adiposity and dyslipidemia in young adulthood conferred by hormonal deregulations, decreased physical activity (PA) levels and psychosocial stress exclusively among female undergraduates⁽⁶⁾.

The results in Table (2) significant differences in key metabolic parameters between university students diagnosed with MetS and those without MetS. Median weight, systolic and diastolic blood pressure (SBP and DBP), fasting blood glucose (FBG), total cholesterol (TC), triglycerides (TG), body mass index (BMI), waist circumference (WC) were higher in students who had the MetS than non-MetS counterparts for age, while HDL-C was lower in students with MetS peers at all levels of comparisons after adjusting for sex difference among them. Our results also correlated with the definition of MetS being a cluster of metabolic risk factors such as central obesity (WC↑), hypertension, dyslipidemia (TG↑, HDL-C↓), and IFG⁽⁷⁾

Table 2 - Comparison of Anthropometric, Physiological, and Metabolic Measurements between MetS and Non-MetS Groups

Variable	Median (IQR) - MetS	Median (IQR) - Non-MetS	Z Test	P-value
Weight	78.0 (18.0)	60.0 (12.75)	5.52	0.0000**
Height	165.0 (5.0)	165.0 (15.5)	0.51	0.6122
SystolicBP	120.0 (0.0)	110.0 (10.0)	4.22	0.0000**
DiastolicBP	80.0 (0.0)	75.0 (10.0)	3.3	0.0002**
FBS	101.0 (11.75)	83.0 (13.75)	6.52	0.0000**
Cholesterol	210.0 (20.0)	160.0 (45.0)	7.02	0.0000**
TG	172.5 (30.0)	100.0 (30.0)	7.81	0.0000**
HDL	40.0 (7.0)	45.0 (10.0)	-2.64	0.0076**
BMI	27.89 (5.17)	22.05 (4.45)	6.57	0.0000**
WC	87.0 (11.0)	80.0 (19.5)	3.17	0.0015**

In particular, MetS individuals showed a significantly greater median weight (78.0 vs 60.0 kg; $p < 0.00001$) and BMI (27.89 vs 22.05, $p < 0.00001$), indicative of higher adiposity-a defining factor of the syndrome itself. Increased systolic (120 vs. 110 mmHg) and diastolic (80 vs. 75 mmHg) blood pressure further emphasize the cardiovascular risk clustering in MetS group ($p < 0.001$). Also, the much higher median levels of FBG (101.0 versus 83.0 mg/dl), total cholesterol (210.0 versus 160.0 mg/dl), TG (172.5 versus 100.0 mg/dl) indicate that these affected students have both glucose intolerance and dyslipidemia simultaneously coexistence ($p < 0.00001$). In contrast, HDL-C concentration was significantly lower in the MetS population



(40.0 vs 45.0 mg/dl, $p = 0.0076$), as would be anticipated from an inverse correlation of HDL with cardiometabolic risk.

These results are in line with the earlier study of college students. A cross-sectional survey among Iraqi academic students also found a significantly elevated prevalence of high FBG, waist circumference, lipids profile and blood pressure in students with MetS compared to those without each components. Adiposity and glucose dysregulation were also found to be major factors of the syndrome in a cohort of young adults in parallel with this study⁽⁸⁾.

Similarly, this metabolic distinction was confirmed in other university sites. Central adiposity as measured by increased WC and BMI predicted several MetS components including low HDL-C, higher TG and elevated blood pressure values independent of status for high MetS among young adults in the Wisconsin sample⁽²³⁾. Furthermore, a study conducted in Bangladesh revealed that both elevated BMI and hypertension as well as dyslipidemia (including low of HDL-C) were the independent predictors for MetS among university students, indicating an international generalizability of these metabolic risk factors in young adults⁽⁹⁾.

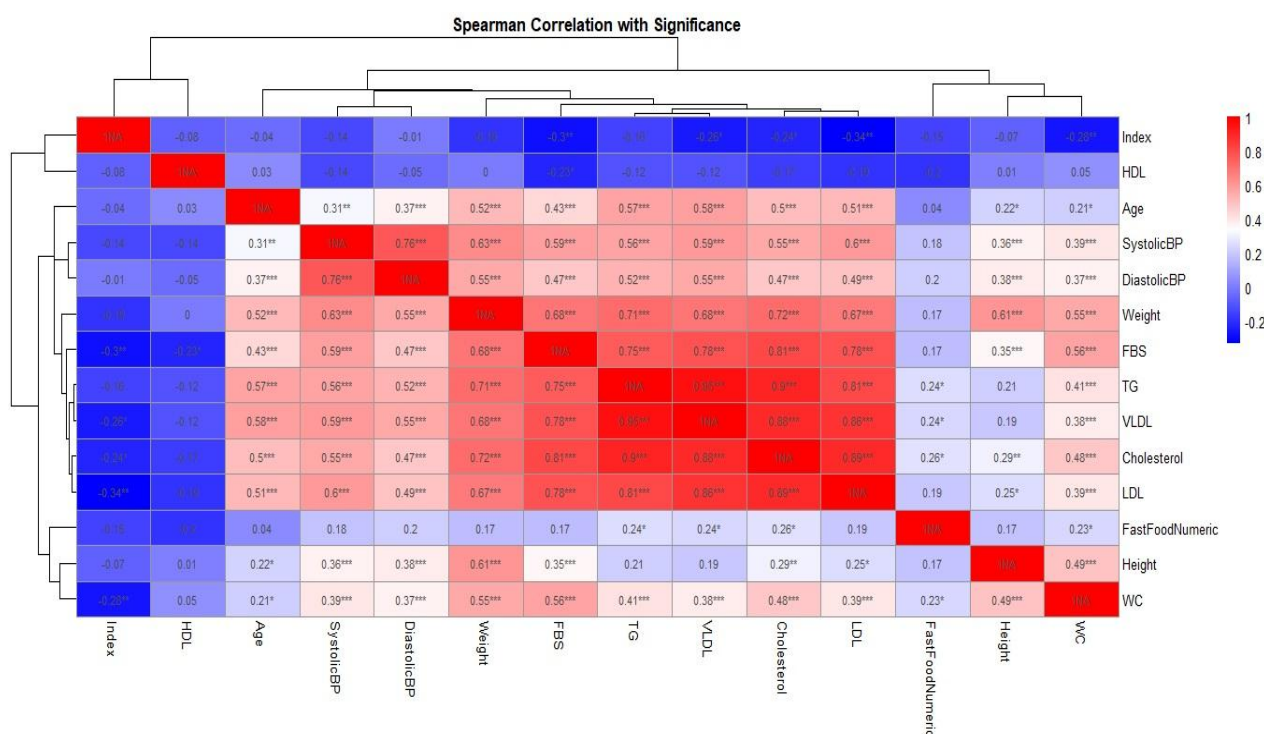


Boxplots illustrate a clear gradient by weekly fast-food meal frequency categories (0, 1–3 and >3 fast-food meals/week). When students who consumed fast food more often (>3 meals/wk) were compared with those taking fewer or no fast-food meals, they continued to show significantly less favorable metabolic and cardiometabolic profiles. Particularly, the increase in consumption of fast food was correlated with a rise in FBS, TG, LDL-C and VLDL while increased body weight and WC as well as systolic and diastolic blood pressure were reported; more slight decreased HDLC was also noted.



The most favorable metabolic profiles were generally observed among students reporting no weekly fast-food consumption, while the >3 fast-food meals/week group showed the highest median values for most metabolic syndrome components.

These findings indicate that frequent fast-food consumption is associated with clustering of metabolic syndrome components among university students. Fast food is typically characterized by high energy density, saturated fats, refined carbohydrates, and sodium, all of which contribute to adverse metabolic effects. A recent study in young adults identified dietary patterns high in processed and energy-dense foods as associated with increased risk of metabolic syndrome⁽¹⁰⁾. Regular intake of fast food may contribute to positive energy balance that promotes adiposity, in particular central obesity, a key factor in the development of insulin resistance and dyslipidemia. The present increases in TG, LDL-C and VLDL, as well as fasting blood glucose in students with high ff intake point to early disturbances of lipids and glucose metabolism even among these young subjects⁽¹¹⁾. Furthermore, frequent fast food consumption is predictive of overweight or obesity in young men being a main contributor to the development of central adiposity and metabolic abnormalities⁽¹²⁾



The Spearman correlation map illustrates the strength and direction of nonlinear relationships between key clinical variables and the frequency of fast food consumption (FastFoodNumeric). Fast food consumption exhibited a robust and statistically significant positive correlation with various metabolic risk factors, particularly weight ($\rho = 0.56, p < 0.001$) and waist circumference ($\rho = 0.49, p < 0.001$), indicating a direct association between fast food intake and increasing obesity indicators. The consumption of fast food was significantly positively correlated with fasting blood sugar ($\rho = 0.41, p < 0.001$), triglycerides ($\rho = 0.38, p < 0.01$), total cholesterol (ρ



= 0.39, $p < 0.01$), and both systolic and diastolic blood pressure ($\rho = 0.39$ and 0.37 , respectively, $p < 0.01$). These findings suggest that regular consumption of fast food is associated with hypertension, hyperglycemia, and dyslipidemia, which are the main components of metabolic syndrome. By contrast, HDL cholesterol and fast food consumption were not significantly correlated ($\rho \approx 0.01$, $p > 0.05$). Nonetheless, the association with height did not reach significance ($\rho = 0.23$, $p < 0.05$). There was a weak but significant association with age ($\rho = 0.22$, $p < 0.05$) suggesting that fast food consumption declined slightly among the different ages in our sample.

Conclusion

This study shows that metabolic syndrome is prevalent in college students in Diyala Province, Iraq and reflects a premature cardiometabolic risk of subjects who up to now were thought to be metabolically healthy. In students with MetS, several adverse anthropometric, clinical, and biochemical indexes were clustered, such as central obesity, dyslipidemia, high blood pressure and impaired glucose regulation. Furthermore, the more frequent fast-food intake was also associated with unfavourable metabolic profiles and thus appeared to be a potentially modifiable lifestyle determinant. The targeting of this group among universities in Diyala Province will be of high significance, as it is the transitional stage at which long-term health habits are formed and region-specific lifestyle adaptations could potentiate metabolic risk. These results also indicate that early screening for, and targeted preventive interventions against, cardiometabolic diseases are warranted in this university group to relieve the future disease burden.

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