The Adequacy of Nutrient Intake Among Saudi Employees with Metabolic Syndrome, Comparative Study

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ABSTRACT

This study aimed to assess nutrient intake and their adequacy in Saudi adults with metabolic syndrome (MetS); participants were randomly recruited from Ministry of Health clinics in Riyadh; the sample included 350 adults aged 30 to 60 years (150 and 200 without MetS) socioeconomic and lifestyle data were collected, anthropometric indices measured, and fasting blood samples obtained for biochemical assays; dietary intake was assessed using three nonconsecutive 24-hour recalls; there were no significant differences between groups in age, marital status, education, or family size; compared with controls, MetS participants were more physically inactive (86.7%) did not practice sports compared to (68.0%) for control groups ($p < 0.001$) and reported lower sports frequency and duration (1.8 ± 1.8 vs 2.6 ± 1.9 times per week, $t = 2.38$, $p = 0.018$; 27.1 ± 22.1 vs 36.2 ± 26.2 minutes per session, $t = 1.92$, $p = 0.050$); MetS subjects had higher weight (95.62 ± 16.21 vs 77.60 ± 12.18 kg), BMI (35.80 ± 6.10 vs 28.10 ± 4.50 kg/m²), and waist circumference (115.64 ± 11.70 vs 92.80 ± 10.30 cm); they also had higher fasting blood glucose (154.2 ± 52.7 vs 100.3 ± 14.2 mg/dL), HbA1c (7.34 ± 2.24 vs 5.40 ± 0.50%), triglycerides (171.6 ± 70.1 vs 118.3 ± 60.2 mg/dL), and LDL-C (137.3 ± 41.5 vs 108.1 ± 34.2 mg/dL), while HDL-C was lower (47.8 ± 12.8 vs 54.6 ± 11.7 mg/dL); energy intake (1629.9 ± 575.1 vs 2114.6 ± 529.8 kcal), protein (57.0 ± 22.9 vs 79.1 ± 24.3 g), carbohydrates (225.1 ± 93.8 vs 311.4 ± 87.4 g), fiber (4.3 ± 2.0 vs 6.0 ± 2.3 g), vitamins A and C, calcium, magnesium, and other micronutrients were all lower in MetS participants; total fat intake was also significantly lower in MetS participants than controls (55.8 ± 24.2 vs 61.4 ± 24.1 g/day; 70.3% vs 85.4% of requirements; $p = 0.013$); in conclusion, Saudi adults with MetS reported lower intakes of essential nutrients and exhibited an unhealthy lifestyle.

Keywords: Metabolic Syndrome, Diet, Glucose, Blood Lipids, Obesity, BMI, Calories, Protein, Vitamin C.

INTRODUCTION

Metabolic Syndrome (MetS), also known as insulin resistance syndrome or "Syndrome X," is a cluster of metabolic and physiological abnormalities that can occur simultaneously in an individual. These abnormalities increase the risk of developing cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), obesity, atherogenic dyslipidemia, and hypertension. MetS had been defined using various criteria, including the International Diabetes Federation (IDF), Adult Treatment Panel (ATP) III, and World Health Organization (WHO). IDF emphasizes central obesity as a fundamental component. According to ATP III, three or more risk factors determine MetS (Ranasinghe *et al.,* 2017 and Al-Rubeaan *et al.,* 2018). Metabolic syndrome is strongly associated with an increased risk of stroke and cardiovascular events (Hayden, 2023). Dietary imbalances, especially high energy intake, fats, and cholesterol, play a critical role in its development (Zhang *et al.,* 2025). Early detection of MetS is crucial for effective management and prevention of its associated conditions. Lifestyle modifications, including dietary improvements and increased physical activity, have been shown to reduce and manage MetS risk factors (Deng *et al.,* 2025). In recent decades, Saudi Arabia has undergone rapid economic and social development, leading to significant shifts in dietary intake patterns. There has been a notable increase in the consumption of energy-dense, processed foods high in fat, sugar, and salt. This lifestyle shift contributes substantially to increase epidemic of non-communicable diseases in the region, particularly metabolic syndrome (Alyousef *et al.,* 2025). National data indicate that approximately 40% of Saudi adults aged 30 to 70 years suffer from MetS. Key contributing factors include hypertension, elevated blood glucose, high triglycerides, low HDL cholesterol, and especially abdominal obesity. The risk of MetS increases with age, sedentary behavior, and high-fat, high-sugar diets (Alhajri *et al.,* 2025). Meta-analyses also link MetS to greater mortality, with its prevalence rising alongside increases in body mass index (BMI) and aging (Garralda-Del-Villar *et al.,* 2018). Approximately one in four adults globally has MetS, with higher prevalence rates reported in the Middle East. For example, rates vary from 17% in Oman to over 40% in the United Arab Emirates, depending on the criteria used (Al-Rubeaan *et al.,* 2018). Behavioral factors such as physical inactivity and unhealthy diets significantly contribute to the escalating prevalence of MetS worldwide. Certain medications may exacerbate

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MetS components by influencing weight, blood pressure, and metabolic parameters (Deng *et al.,* 2025). Recent studies in Saudi Arabia highlight gender differences in MetS characteristics: women tend to have higher rates of obesity and elevated blood sugar, while men show higher triglycerides and lower HDL cholesterol levels, influenced by biological and lifestyle factors (Alyousef *et al.,* 2025). Socioeconomic factors such as income and education also impact MetS risk, with higher income and education levels associated with reduced risk of MetS (Eldakhakhny *et al.,* 2023).

Therefore, the present study was conducted to assess nutrient intake and their adequacy in Saudi adults with metabolic syndrome (MetS).

SUBJECTS AND METHODS

Subjects

Study Population

The study population consisted of Saudi employees working at the Ministry of Health (MOH) in Riyadh region.

Sample Selection

Only Male Saudi Ministry of Health (MOH) employees aged 30 to 60 years who provided informed consent and had at least three risk factors for metabolic syndrome (MetS) were enrolled. Employees without MetS served as control group.

Written informed consent was obtained from all the subjects. Also “Exclusion criteria were: non-Saudi nationality; physical or intellectual disability; cancer; pregnancy or lactation; ascites or edema; end-stage liver or renal disease. Participants were selected by cluster sampling from staff at the Ministry of Health headquarters, the Directorate of Health Affairs, and government hospitals in Riyadh.

Methods

Metabolic Syndrome Diagnosis

Metabolic Syndrome (MetS) was diagnosed based on the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria, which requires at least three of the following abnormalities:

•Increased waist circumference (≥102 cm for men).

•Elevated triglycerides (≥1.7 mmol/L).

•Low HDL cholesterol (men ≤1.03 mmol/L).

•Elevated fasting glucose (≥5.6 mmol/L or diagnosed diabetes).

•Hypertension (SBP ≥130 mmHg or DBP ≥85 mmHg or on antihypertensive treatment).

Study Design

Cases were patients with metabolic syndrome (MetS) and control groups were without MetS, all identified from clinic records.

Data Collection

Data were obtained using a validated questionnaire covering demographics (age, marital status, education, employment, household size); medical and family history (e.g., hypertension, diabetes), medication and supplement use, and special regimens; lifestyle (types and duration of physical activity and sports; screen time for television, internet, mobile, and computer; and daily sleep duration); anthropometric and biochemical history; and dietary intake including a 24-hour dietary recall.

“Body weight was measured using a calibrated digital scale to the nearest 0.1 kg with participants in light clothing and without shoes. Standing height was measured without shoes using a wall-mounted stadiometer to the nearest 0.1 cm. Each measurement was taken twice and the average was recorded”.

Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). Waist circumference (WC) was measured on a horizontal plane midway between the iliac crest and the lower rib margin to the nearest 0.1 cm using a non‑ stretchable measuring tape.

An automated sphygmomanometer measured blood pressure (BP) after an adequate rest period.

Fasting blood samples were collected from each subject to determine fasting blood glucose, HbA1c, and lipid profiles (triglycerides [TG], total cholesterol [TC], HDL cholesterol [HDL‑ C], and LDL cholesterol [LDL‑ C]). Analyses were performed after at least 12 hours of fasting using an automated analyzer (ARCHITECT c8000; Abbott Diagnostics).

Nutrient intakes were estimated using three non-consecutive 24-hour dietary recalls (Subar *et al.,* 2020). Nutrient data were demined using food composition tables for Arab Gulf countries (Gulf Health Council, YEAR) and compared with standard dietary requirements.

Requirements for minerals and vitamins were based on Requirements for vitamins and minerals were based on Dietary Reference Intakes (DRIs) (Otten *et al.,* 2006). Sodium and potassium based on the updated DRIs (National Academies of Sciences, Engineering, and Medicine, 2019). Percentages of nutrient intake were computed as the ratio of observed intake to the respective standard requirement.

All data were statistically using SPSS version 22. Results are presented as frequency and percentage or as mean ± standard deviation (SD). Independent‑ samples t-tests were used to assess differences between groups, and chi-square tests were used to compare categorical variables between patients and controls.

Ethical considerations

Participants took part voluntarily and were fully informed about the study objectives and procedures. Each participant received a written consent form explaining the questionnaire content; individuals who refused to sign the consent were excluded from the study. The study was approved by the Department of Home Economics, Faculty of Agriculture, Alexandria University.

RESULTS AND DISCUSSION

Table 1 compares demographic and socioeconomic variables between the control group (n=200) and the MetS group (n=150). All participants were government employees residing in Riyadh, minimizing site-related variability. No statistically significant differences were observed in age, marital status, education, or family size between groups, supporting sample comparability and reducing potential confounding.

This suggests that these basic demographic factors are similarly distributed across groups, providing a solid foundation for our comparative analysis.

The socioeconomic class was found to differ significantly (χ^2=24.73, p<0.001). A larger proportion of individuals with MetS belong to the low socioeconomic class (45.3% vs. 19.0% in Control), while fewer MetS participants are in the high class (17.3% vs. 25.1%).

The lower socioeconomic characteristics was strongly associated with the presence of metabolic syndrome in this population. Such associations are consistent with broader research suggesting that socioeconomic disadvantages increase metabolic syndrome risk through pathways involving lifestyle, stress, diet, and access to healthcare. In contrast, demographic characteristics like age, and education level alone do not show significant differences here, highlighting the strong influence of socioeconomic context on metabolic health (Azizi *et al.,* 2019).

Table 2 provides a comparative analysis of lifestyle and physical activity between the control group (n=200) and the MetS patient group (n=150).

The findings revealed a highly significant difference in physical activity levels (p < 0.001), with a markedly larger proportion of MetS patients (86.7%) indicating no engagement in sports compared to the Control group (68.0%). This observation aligns with established research linking physical inactivity to an increased risk of MetS through mechanisms such as obesity and insulin resistance. Additionally, significant differences are observed in the modes of transportation utilized by the two groups (p < 0.001). The control group exhibited a greater frequency of sports participation, averaging 2.6 ± 1.9 sessions per week, in contrast to the MetS group, which averaged 1.8 ± 1.8 sessions per week (t = 2.38, p = 0.018). Furthermore, the duration of sports sessions was longer in the Control group, with an average of 36.2 ± 26.2 minutes per session, compared to 27.1 ± 22.1 minutes in the MetS group (p = 0.050).

Table 1. Frequency distribution of studied subjects according to demographic data.

Variable	Category	(%) Control (n=200)	(%) MetS (n=150)	(%) Total (n=350)	Chi-square (χ^2)	p-value
Age (years)	20–29	(17.5%)	(16.7%)	(17.1%)	0.525	0.913
	30–39	(31.0%)	(30.7%)	(30.9%)		
	40–49	(32.5%)	(36.0%)	(34.0%)		
	50–60	(19.0%)	(16.7%)	(18.0%)		
Marital Status	Single	(7.0%)	(5.3%)	(6.3%)	0.418	0.811
	Married	(87.0%)	(88.0%)	(87.4%)		
	Divorced/Widowed	(6.0%)	(6.7%)	(6.3%)		
Education Level	Secondary	(50.0%)	(53.3%)	(51.4%)	0.378	0.539
	Bachelor’s Degree	(50.0%)	(46.7%)	(48.6%)		
Family Size	Less than 4	(25.0%)	(22.0%)	(23.7%)	0.625	0.732
	4 to 6	(70.0%)	(63.3%)	(67.1%)		
	More than 6	(5.0%)	(14.7%)	(9.1%)		
Socioeconomic Class	Low	(19.0%)	(45.3%)	(30.3%)	24.73	0.000 ***
	Moderate	(50.0%)	(37.3%)	(44.6%)		
	High	(31.0%)	(17.3%)	(25.1%)		

Significance: *** P < 0.001 (highly significant)

Table 2. Lifestyle and physical activity by MetS status: sports participation distribution (%) and continuous measures (mean ± SD).

Category		Control (n=200) mean ± SD (n)	MetS (n=150) mean ± SD (n)	"Test"	p-value
Practice sports (%)	None	136 (68.0%)	130 (86.7%)		0.001
	Mild sports	43 (21.5%)	12 (8.0%)		
	Moderate sports	19 (9.5%)	5 (3.3%)		
	Hard sports	2 (1.0%)	3 (2.0%)		
Overall (χ^2, df = 3)				χ^2 = 24.7	p < 0.001
Sports frequency (times/week)		2.6 ± 1.9	1.8 ± 1.8	t =2.38	0.018 *
Sports duration (minutes/time)		36.2 ± 26.2	27.1 ± 22.1	t =1.92	0.050 *
Screen time (hours/day)		2.4 ± 1.9	2.1 ± 1.8	t =2.22	0.027 *
Sleeping hours (hours/day)		7.1 ± 1.5	8.2 ± 7.11	t =6.83	0.000 ***

* $p < 0.05$, *** $p < 0.001$ indicate levels of statistical significance.

Notably, the average daily screen time was significantly higher in the Control group (2.4 ± 1.9 hours) than in the MetS group (2.1 ± 1.8 hours, p = 0.027). Additionally, there was a significant difference in sleep duration, as the MetS group averaged more sleep hours (8.2 ± 7.1 hours) compared to the Control group (7.1 ± 1.5 hours, p < 0.001).

Physical inactivity is a significant risk factor for the development of Metabolic Syndrome (MetS). Various studies have demonstrated the association between low physical activity levels and increased risk of MetS. A study on Korean adult men found that vigorous physical activity (VPA) significantly reduced the risk of MetS by 64.7% (Yuan and Kim, 2023). A systematic review and meta-analysis revealed that both intermediate and high levels of sedentary time were associated with increased MetS risk (Wu *et al.,* 2022). In a study of Saudi adults, spending over six hours daily in sedentary behavior doubled the odds of having MetS, underscoring the detrimental effects of prolonged inactivity (Alkathem *et al.,* 2024). In an Indian foothill population, physical inactivity was linked to higher triglyceride levels in males and increased blood pressure and glucose levels in females (Goyal *et al.,* 2022).

Table 3 presents a comparative analysis of anthropometric indices between healthy controls and MetS patients. The mean age difference observed is not statistically significant (p = 0.057). However, patients with MetS demonstrate significantly higher mean weight, Body Mass Index (BMI), and waist circumference (WC) compared to the control group (p < 0.001), indicating a greater degree of adiposity and central obesity, which are key characteristics of MetS. Additionally, the control groups is slightly taller than the MetS patients, a difference that is statistically significant (p = 0.001). The elevated BMI and waist circumference in MetS patients underscore their increased metabolic risk associated with abnormal fat distribution.

Research indicates that Body Mass Index (BMI) and Waist Circumference (WC) serve as significant indicators of the risk for Metabolic Syndrome (MetS). Variations in these measurements are correlated with the likelihood of developing the syndrome. Investigations in Saudi Arabia (AbouZaid *et al.,* 2019) and Egypt (Eed *et al.,* 2021) have established a strong correlation between BMI and MetS. Additionally, a recent study involving middle-aged and elderly individuals in China demonstrated that reductions in both BMI and WC were associated with a significantly lower risk of MetS, reflected by a hazard ratio of 0.338 (Zhang *et al.,* 2024).

Table 3. Age and anthropometric characteristics among MetS status (mean ± SD).

Variable	Control (n=200) mean ± SD	MetS (n=150) mean ± SD	t-value	p-value
Age (years)	47.0 ± 9.9	45.2 ± 10.3	1.95	0.057
Weight (kg)	77.60 ± 12.18	95.62 ± 16.21	13.44	<0.001***
Height (cm)	166.58 ± 9.0	163.72 ± 9.42	-3.33	0.001***
BMI (kg/m²)	28.1 ± 4.50	35.80 ± 6.10	15.59	<0.001***
Waist (cm)	92.80 ± 10.30	115.64 ± 11.70	22.18	<0.001***

***$p < 0.001$ indicate levels of statistical significance.

"Table 4 illustrates significant differences in metabolic and lipid profiles between the control group and MetS group. The values observed in the control group predominantly reside within established normal clinical reference ranges. Conversely, the MetS group displays markedly elevated levels of blood glucose, HbA1c, triglycerides, total cholesterol, LDL, and VLDL, which indicate the metabolic and cardiovascular risk factors typically associated with MetS. In contrast, the MetS cohort exhibits significantly lower HDL cholesterol levels and related ratios.

Prior research indicates that lipidomic profiles may function as biomarkers for the early detection and ongoing monitoring of MetS (Jové *et al.,* 2014). Key findings from various studies emphasize the alterations in lipid metabolism related to MetS.

In agreement with our findings, Trivedi *et al.* (2024) reported that individuals with MetS present notably elevated triglyceride levels (up to 214.16 mg/dL) compared to controls (118.55 mg/dL). Additionally, they observed higher total cholesterol levels in MetS patients (203.35 mg/dL) when compared with controls (183.0 mg/dL) (Trivedi *et al.,* 2024). Furthermore, these authors documented a substantial reduction in high-density lipoprotein (HDL) cholesterol among individuals with MetS (38.16 mg/dL) relative to control subjects (46.66 mg/dL).

Moreover, MetS subjects show increased concentrations of glycerolipids alongside decreased levels of ether lipids and sphingolipids, thereby indicating a dysregulation in lipid metabolism (Serna *et al.,* 2024). The lipid profiles characteristic of MetS are associated with an increased risk of cardiovascular diseases. This condition is defined by atherogenic dyslipidemia, which is characterized by elevated triglycerides and diminished HDL levels (Bostan *et al.,* 2021).

Table 5 presents a comparison of the intake of macronutrients (energy, protein, fat, carbohydrates, fiber) and micronutrients (vitamins A, C, thiamin, riboflavin, sodium, potassium, calcium, phosphorus, magnesium, iron, zinc, copper) between a healthy control group and individuals diagnosed with Metabolic Syndrome (MetS) in Saudi Arabia. The analysis reveals significantly lower intake levels across nearly all nutrients among the MetS group, specifically in energy, protein, carbohydrates, fiber, vitamin C, thiamin, sodium, potassium, calcium, and magnesium. The substantial t-values and consistently high significance level (less than 0.001) insure the pronounced differences between the two groups.

The diminished intake of energy and nutrients among patients with MetS may indicate altered dietary habits, metabolic changes, or potential dietary restrictions. Conversely, the control group reflects a higher consumption of vitamins and minerals, suggesting a more balanced and nutrient-dense diet.

These findings are corroborated by studies conducted by Julibert *et al.* (2019), which observed that individuals with MetS exhibited lower intakes of energy, carbohydrates, and fiber than their non-MetS counterparts. Of this study, the dietary assessment indicated significant nutrient inadequacies within the MetS group, including insufficient consumption of calories, protein, carbohydrates, fiber, vitamin C, calcium, magnesium, and other micronutrients. Nearly half of the MetS subjects reported consuming less than 50% of the recommended intake levels for calories, proteins, and carbohydrates. Such nutritional deficiencies may further exacerbate metabolic imbalances through mechanisms involving oxidative stress and impaired glucose metabolism.

Table 4. Biochemical variables among MetS and control groups (mean ± SD).

Variable	Reference values*	Control (n=200)	MetS (n=150)	t-value	p-value
Fasting blood glucose (mg/dL)	70-110	100.3 ± 14.2	154.2 ± 52.7	11.4	0.000 ***
HbA1c (%)	4.2 - 6.5	5.4 ± 0.5	7.34 ± 2.24	8.6	0.000 ***
Triglycerides (mg/dL)	35-135	118.3 ± 60.2	171.6 ± 70.1	6.5	0.000 ***
Total cholesterol (mg/dL)	≤ 200	186.4 ± 42.8	219.4 ± 48.6	5.8	0.000 ***
HDL (mg/dL)	45-65	54.6 ± 11.7	47.8 ± 12.8	-4.5	0.000 ***
LDL (mg/dL)	< 130	108.1 ± 34.2	137.3 ± 41.5	6.1	0.000 ***
VLDL (mg/dL)	25-50	23.7 ± 12.1	34.3 ± 14.0	6.5	0.000 ***
HDL/TC ratio	—	0.30 ± 0.1	0.23 ± 0.1	-8.3	0.000 ***
HDL/LDL ratio	—	0.60 ± 0.3	0.39 ± 0.2	-5.8	0.000 ***
LDL/TC ratio	—	0.60 ± 0.1	0.62 ± 0.1	—	0.000 ***

Significance *** $p < 0.001$.

*Reference values are based on standard clinical ranges and NCEP ATP III.

Table 5. Mean and standard deviation for nutrient intakes (daily) and t – values of Mets and control groups.

Variable	Control (n=200) mean ± SD (% Std.)	MetS (n=150) mean ± SD (% Std.)	t-value	p-value
Energy (kcal)	2114.6 ± 529.8 (81.3%)	1629.9 ± 575.1 (57.2%)	-9.4	0.000 ***
Protein (g/day)	79.1 ± 24.3 (104.8%)	57.0 ± 22.9 (60.9%)	-10.1	0.000 ***
Fat (g/day)	61.4 ± 24.1 (85.4%)	55.8 ± 24.2 (70.3%)	-2.5	0.013 ***
Carbohydrates (g/day)	311.4 ± 87.4 (75.7%)	225.1 ± 93.8 (51.2%)	-10.2	0.000 ***
Fiber (g/day)	6.0 ± 2.3	4.3 ± 2.0	-8.5	0.000 ***
Vitamin A (μg/day)	1927.0 ± 1206.1 (251.9%)	1142.2 ± 931.9 (150.2%)	-7.8	0.000 ***
Vitamin C (mg/day)	71.1 ± 53.6 (89.7%)	45.2 ± 42.2 (56.5%)	-5.7	0.000 ***
Thiamin (mg/day)	0.84 ± 0.3 (74.0%)	0.70 ± 0.25 (60.9%)	-5.8	0.000 ***
Riboflavin (mg/day)	1.8 ± 0.8 (149.6%)	1.6 ± 0.7 (137.6%)	-2.1	0.038 **
Sodium (mg/day)	2295.0 ± 897.3	1730.8 ± 886.6	-6.8	0.000 ***
Potassium (mg/day)	2318.7 ± 637.3 (49.3%)	1669.2 ± 622.6 (35.5%)	-11	0.000 ***
Calcium (mg/day)	540.8 ± 199.7 (52.7%)	406.9 ± 189.4 (39.7%)	-7.3	0.000 ***
Phosphorus (mg/day)	1131.9 ± 297.7 (161.7%)	879.0 ± 297.0 (125.6%)	-9.1	0.000 ***
Magnesium (mg/day)	195.0 ± 55.0 (55.9%)	134.7 ± 62.6 (38.4%)	-11	0.000 ***
Iron (mg/day)	15.2 ± 5.8 (187.7%)	12.2 ± 5.5 (152.2%)	-5.3	0.000 ***
Zinc (mg/day)	11.3 ± 5.3 (126.8%)	10.4 ± 4.5 (117.3%)	-2	0.047 *
Copper (mg/day)	2035.3 ± 619.7 (226.1%)	1728.9 ± 561.2 (192.1%)	-5.5	0.000 ***

%Std.: percentage of the standard requirement for each nutrient. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Reference standards based on Dietary Reference Intakes (DRIs).

These conclusions align with previous studies conducted by Julibert *et al.* (2019), as well as those in Saudi Arabia (AbuZaid *et al.,* 2019) and other populations within the Middle East (Eed *et al.,* 2021), which highlight the suboptimal intake of protective nutrients and the overconsumption of processed foods.

Furthermore, a considerable body of research indicates a pronounced deficiency of calcium intake among patients with MetS (Delavar *et al.,* 2008; Al-Daghri *et al.,* 2013 and Shin *et al.,* 2015). Investigations involving both animal and human subjects have demonstrated that adequate dietary calcium and dairy product consumption may play a role in reducing body weight and preventing obesity, which is linked to the development of Metabolic Syndrome (Olguin *et al.,* 2014; Shin *et al.,* 2015 and Ismail & Al Qahiz, 2016).

Table 6: Distribution of MetS patients and control subjects according to nutrient intake adequacy.

The data indicated that a substantial proportion of individuals with MetS (45.3%) ware categorized in the lowest energy intake quartile (<50%), in contrast to only 4.0% of the Control group. Conversely, the majority of Controls (55%) reside within the higher intake quartiles (75-100% and ≥100%). This observation suggests that individuals with MetS generally exhibit a lower total energy intake despite their health condition.

Nearly half of the MetS participants (48.0%) consume less than 50% of the recommended protein intake, while the majority of Controls (52.0%) meet or exceed 100% of their requirements. This finding points to suboptimal protein consumption within the MetS group.

Concerning carbohydrate intake, it is noteworthy that 64.0% of MetS cases fall into the lowest quartile (<50%), compared to a mere 9.0% among Controls, thereby emphasizing the considerably lower carbohydrate intake among MetS participants.

Regarding Vitamin A, a significant percentage of MetS individuals (25.3%) are in the lowest intake quartile (<50%), whereas only 4.0% of Controls are similarly classified. Most Controls (87.0%) consume ≥100% of the recommended Vitamin A, compared to 41.3% among those in the MetS group.

For Vitamin C, a substantial majority of MetS subjects (68.0%) fall within the lowest quartile (<50%), in contrast to 29.0% of Controls.

Calcium intake reveals a stark disparity, with 85.3% of individuals within the MetS group consuming less than 50% of the recommended amount. Controls exhibit a more uniform distribution, although none reach or exceed the 100% intake threshold.

Most participants from both groups can meet or exceed the recommended iron intake (QIV > 100%), albeit the MetS group demonstrates slightly lower percentages.

Table 6. (%) Distribution of MetS Patients and Control Subjects According to Nutrient Intake Adequacy

Nutrient	Quartile	Control (n=200) (%)	MetS (n=150) (%)	Total (n=350) (%)
Energy	QI (<50%)	8 (4.0%)	68 (45.3%)	76 (21.7%)
	QII (50–75%)	82 (41.0%)	64 (42.7%)	146 (41.7%)
	QIII (75–100%)	74 (37.0%)	15 (10.0%)	89 (25.4%)
	QIV (≥100%)	36 (18.0%)	3 (2.0%)	39 (11.1%)
Protein	QI (<50%)	6 (3.0%)	72 (48.0%)	78 (22.3%)
	QII (50–75%)	42 (21.0%)	58 (38.7%)	100 (28.6%)
	QIII (75–100%)	48 (24.0%)	17 (11.3%)	65 (18.6%)
	QIV (≥100%)	104 (52.0%)	3 (2.0%)	107 (30.6%)
Carbohydrates	QI (<50%)	18 (9.0%)	96 (64.0%)	114 (32.6%)
	QII (50–75%)	76 (38.0%)	42 (28.0%)	118 (33.7%)
	QIII (75–100%)	74 (37.0%)	10 (6.7%)	84 (24.0%)
	QIV (≥100%)	32 (16.0%)	2 (1.3%)	34 (9.7%)
Vitamin A	QI (<50%)	8 (4.0%)	38 (25.3%)	46 (13.1%)
	QII (50–75%)	6 (3.0%)	22 (14.7%)	28 (8.0%)
	QIII (75–100%)	12 (6.0%)	28 (18.7%)	40 (11.4%)
	QIV (≥100%)	174 (87.0%)	62 (41.3%)	236 (67.4%)
Vitamin C	QI (<50%)	58 (29.0%)	102 (68.0%)	160 (45.7%)
	QII (50–75%)	48 (24.0%)	32 (21.3%)	80 (22.9%)
	QIII (75–100%)	36 (18.0%)	12 (8.0%)	48 (13.7%)
	QIV (≥100%)	58 (29.0%)	4 (2.7%)	62 (17.7%)
Calcium	QI (<50%)	84 (42.0%)	128 (85.3%)	212 (60.6%)
	QII (50–75%)	82 (41.0%)	20 (13.3%)	102 (29.1%)
	QIII (75–100%)	34 (17.0%)	2 (1.3%)	36 (10.3%)
	QIV (≥100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Iron	QI (<50%)	4 (2.0%)	8 (5.3%)	12 (3.4%)
	QII (50–75%)	8 (4.0%)	12 (8.0%)	20 (5.7%)
	QIII (75–100%)	18 (9.0%)	24 (16.0%)	42 (12.0%)
	QIV (≥100%)	170 (85.0%)	106 (70.7%)	276 (78.9%)

CONCLUSION

This study revealed that nutrient intake and their adequacy in Saudi adults with metabolic syndrome (MetS) from Ministry of Health clinics in Riyadh. The socioeconomic class was found to differ significantly. A larger proportion of individuals with MetS belong to the low socioeconomic class in Control), while fewer MetS participants are in the high class. A highly significant difference in physical activity levels with a markedly larger proportion of MetS patients indicating no engagement in sports compared to the Control group. Physical inactivity was a significant risk factor for the development of Metabolic Syndrome (MetS). The elevated BMI and waist circumference in MetS patients underscore their increased metabolic risk associated with abnormal fat distribution. The MetS group displays markedly elevated levels of blood glucose, HbA1c, triglycerides, total cholesterol, LDL, and VLDL, which indicate the metabolic and cardiovascular risk factors typically associated with MetS. In contrast, the MetS cohort exhibits significantly lower HDL cholesterol levels and related ratios. The diminished intake of energy and nutrients among patients with MetS may indicate altered dietary habits, metabolic changes, or potential dietary restrictions. Conversely, the control group reflects a higher consumption of vitamins and minerals, suggesting a more balanced and nutrient-dense diet.

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الملخص العربي

مقدار كفاية المأخوذ من المغذيات بين الموظفين السعوديين المصابين بالمتلازمة الأيضية، دراسة مقارنة

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هدفت هذه الدراسة إلى تقييم كمية العناصر الغذائية المستهلكة ومدى كفايتها لدى الموظفين السعوديين المصابين بالمتلازمة الأيضية (MetS) مقارنة بالأصحاء. تم اختيار جميع المشاركين عشوائياً من وزارة الصحة في الرياض، وضمّت الدراسة ٣٥٠ مشاركاً تتراوح أعمارهم بين ٣٠ و٦٠ عامًا (150 حالة MetS و٢٠٠ مجموعة ضابطة)، تم جمع البيانات الاجتماعية والاقتصادية وأنماط الحياة، وأجري تقييم المؤشرات الجسمية، مع تحليل العينات البيوكيميائية. طُبّق استرجاع الغذاء لمدة 24 ساعة على مدى 3 أيام. لم توجد فروق معنوية بين المجموعتين في العمر أو الحالة الاجتماعية أو المستوى التعليمي أو حجم الأسرة. سُجّلت نسبة قلة النشاط البدني الأعلى لدى مرضى MetS (86.7%)مقارنة بالضوابط (68%) (p<0.001) ، وعدد مرات ومدة ممارسة الرياضة أقل عند المصابين (1.8±1.8 مقابل ٢.٦±١.٩ مرة/أسبوع، t=2.38، p=0.018؛ 27.1±22.1 مقابل 36.2±26.2 دقيقة، t=1.92، p=0.050)؛ أما الوزن (95.62±16.21 مقابل 12.18±77.6 كجم)، ومؤشر كتلة الجسم (٣٥.٨٠±٦.١٠ مقابل 28.1 ±4.50 كجم/م^2)، ومحيط الخصر (115.64±11.70 مقابل 92.8±10.30سم) فكانت أعلى عند مرضى MetS. كذلك سجلوا معدلات أعلى في جلوكوز الدم (154.2±52.7 مقابل 100.3 ± 14.2 ملغ/ديسيلتر)، والهيموغلوبين السكري(HbA1c) (7.34 ±2.24 مقابل 5.4± 0.5%)، والدهون الثلاثية (TG) (171.6±70.1 مقابل 118.3±60.2 ملغ/ديسيلتر)، والكولسترول الضار (LDL-c) (137.3±41.5 مقابل 108.1± 34.2 ملغ/ديسيلتر)، مع انخفاض معنوي في الكوليسترول الجيد (HDL-c)(47.8±12.8 مقابل 54.6±11.7 ملغ/ديسيلتر) مقارنة بالمجموعة الضابطة، وكان المدخول الغذائي من الطاقة (1629.9±575.1 مقابل 2114.6±529.8 سعر/يوم)، والبروتين (57.0 ± 22.9 مقابل 79.1 ±24.3جم/يوم)، والكربوهيدرات (225.1±93.8 مقابل 311.4 ± 87.4 جم/يوم)، والألياف (4.3±2.0 مقابل 2.3± 6.0 جم/يوم)، وفيتامين ج، والكالسيوم، والمغنيسيوم، والعناصر الدقيقة أقل معنوياً لدى المجموعة المرضية؛ كما أن إجمالي تناول الدهون لدى المشاركين في متلازمة الأيض أقل معنوياً مقارنةً بالمجموعة الضابطة (24.2 ± 55.8 مقابل 24.1 ± 61.4 جم/يوم؛ ٧٠.٣٪ مقابل ٨٥.٤٪ من الاحتياجات؛ قيمة P=0.013). نستنتج أن مرضى المتلازمة الأيضية يعانون من قلة واضحة في المأخوذ الغذائي لجميع العناصر الأساسية، ويمارسون نمط حياة غير صحي.

الكلمات المفتاحية: متلازمة الأيض، النظام الغذائي، الجلوكوز، دهون الدم، السمنة، مؤشر كتلة الجسم، السعرات الحرارية، البروتين، فيتامين ج.