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The Adequacy of Nutrients Intakes among Persons with Metabolic Syndrome, Case-Control Study

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Abstract

The prevalence of metabolic syndrome (MetS) has increased significantly throughout the worldwide. Published literature has focused on nutrient intake along with MetS to identify core reasons behind it. This study aimed to assess the adequacy of nutrients intakes among Egyptian MetS patients. This is a cross-sectional, case-control study and randomly recruited 458 adult subjects (228 MetS and 230 controls) and aged 25 to 60 years. A special form were used for collecting data about socioeconomic status, lifestyle, health history, anthropomorphic measurements biochemical parameters, and nutrients intakes. The majority of control and MetS groups were from urban areas, and about one-third of all subjects were male. Sedentary lifestyles were predominant, as 86.8% and 67.8% of the MetS and control subjects didn't practice any sport. Different degrees of obesity was prevalent among 75.2% of control and 97.8% of MetS subjects. However, morbid obesity was prevalent among 24.6% of the MetS subjects and none of the control subjects. All blood biomarkers among the MetS group exceeded the reference values and were significantly higher than the values of control subjects. Most of the MetS and control subjects failed to satisfy 50% of their requirements from potassium, magnesium, calcium, and vitamin C. Moreover, most MetS subjects failed to satisfy 50% of their requirements from carbohydrates, calories, and protein. Most of MetS and control subjects satisfied more than 100% of requirements from vitamin A, riboflavin, phosphorus, iron, zinc, and copper. In conclusion, MetS subjects had an evident deficiency of essential nutrients especially calories, carbohydrates, protein, calcium, and vitamin C.

Key Words: *Obesity, BMI, Calories, Protein, Vitamin **C**.*

Introduction

Metabolic syndrome (MetS) is defined as a group of risk factors consists of insulin resistance, glucose intolerance, obesity, dyslipidemia, and hypertension [1]. It is also known as a complex medical condition that consists of several interconnected parameters including abdominal obesity, elevated serum triglycerides, decreased levels of high-density lipoprotein cholesterol, elevated blood pressure, and elevated fasting blood glucose level [2].

Recently, the prevalence of metabolic syndrome increased significantly worldwide. Men in Europe have the highest prevalence in the world (41%). The prevalence of MetS in the States of the Gulf Cooperative Council (Kuwait, Oman, Qatar, Bahrain, Saudi Arabia, and the United Arab Emirates) is higher than for US population, at 21% to 37% in men and 32% to 43% in women [3]. According to the statistics of the International Diabetic Federation (IDF), there are seven million six hundred thousand patients in Egypt who have been diagnosed with MetS. In addition to three million, eight hundred thousand are unaware of their disease, and there were 72,327 deaths due to diabetes and its complications in 2014 [4].

Nutrition represents an important modifiable factor affecting MetS risk [5]. Dietary modification helps prevent and manage MetS [6]. However, the optimal dietary pattern for reducing the extent of MetS has not been well established yet [7], but diet modification is an effective way to treat the MetS [8].

Unhealthy dietary pattern was associated with a two-fold increase in MetS risk; thus, reducing the consumption of unhealthy food items including fast foods, sweetened beverages, salty snacks, sweets, and high-fat red meats may reduce the risk of MetS in children and adolescents [7]. Nutritional imbalance due to high energy, fat, and cholesterol intakes are considered to be a risk factor [9].

The intake of some micronutrients has also been associated with the risks of MetS. Vitamin D deficiency increased the risks associated with type 1 diabetes and CVD, such as hypertension, hyperglycemia, and metabolic diseases. When compared to normal individuals, the metabolic syndrome patients had higher carbohydrate and lower fat intake [10]. However, a negative association was observed between plant protein intake and risk of metabolic syndrome [11]. A diet rich in unsaturated fats (Omega 3) and low in saturated fatty acids (SFAs) has been associated with a reduced risk of developing metabolic syndrome. The intake of carbohydrates and proteins is observed to be lower than recommended among MetS patients, and these deficiencies explain the increased prevalence of MetS, especially among females [9].

MetS are positively associated with insufficient calcium intake, vitamin D status, high intake of fiber, and magnesium intake [4]. The patients with MetS mostly experience a

deficiency in micronutrient intake, especially vitamin A, C, E, K, calcium, zinc, and magnesium [9]. Finally, the recent findings by AbuZaid et al, [12], indicated that the majority of the MetS patients failed to satisfy their requirements from essential nutrients, and they concluded that the higher the number of MetS risk factors, the higher was the inadequacy of nutrients intake.
A diversified range of published literature, as cited above, has focused on nutrient intake along with MetS to identify core reasons behind the syndrome. However, there is limited research on the health benefits related to dietary nutrient patterns, specifically in Egypt. At the same time, no study has investigated the relationship between MetS and nutrient intake among Egyptian adults living in Delta governorates. This study was carried out to assess the adequacy of nutrients intakes among Egyptian adults suffering from MetS.

Subjects and Methods

A. Subjects

1. Sample Size

There is no national data for the prevalence of metabolic syndrome among Egyptian populations, so we assumed that the prevalence among adults would not exceed 15% to 25% in the age group 25-60 yr. This study recruited 458 adult subjects (228 MetS and 230 controls), and all of them were Egyptian adults and aged 25 to 60 years randomly chosen.

2. Inclusion criteria

a. Adult Egyptian (males and females)
b. Age: 25 to 60 years
c. For cases; persons who had metabolic syndrome (according to IDF criteria). For control, had no chronic disease, and no metabolic syndrome (according to IDF criteria)
d. Living in Delta governorates
e. Agree to participate

3. Exclusion criteria

a. Had less than three of metabolic syndrome criteria
b. Physically or mentally retarded
c. Subjects who suffered from cancer, psychiatric disorders, and neurological disorders.
d. Refuse to participate

4. Sample Setting

Selection and meeting of participants took place in the obesity and diabetes clinics in hospitals and medical centers in Delta Governorate. B. Methods:

1. Experimental Design

The study is a retrospective, cross-sectional, and case-control study. All eligible subjects enrolled in the study, and they furtherly were divided into two main groups as follows:

A. Case group: in whom 228 patients' adults who have been diagnosed with metabolic syndrome.
B. Control group: in whom 230 adult persons who haven't been suffered from metabolic syndrome or other related diseases.

2. Diagnosis of Metabolic Syndrome

There are several classifications and criteria for diagnoses of metabolic syndrome (Table 1). Because it is the most recent classification, the diagnosis of metabolic syndrome among participants in this study was based on the criteria given by the International Diabetes Foundation [(4)]. Patients, who satisfied three or more of the following criteria, were classified as MetS patients; obesity and 2 of waist circumference ≥ 80 cm, HDL <1.3 mmol/L (<50mg/dL), TG ≥ 1.7mmol/dL (>150 mg/dL), or treated, patients with type 2 diabetes mellitus and fasting blood glucose ≥ 5.6 mmol/L (>100 mg/dL), and SBP ≥ 130 and DBP ≥ 85 or treated for hypertension.

Table 1: Different Classification and Diagnosis of Metabolic Syndrome

Year	**WHO 1999**	**EGIR 1999**	**NCEP/ATPIII 2001**	**IDF 2005**
Number of risk factors	IFG/IGT/T2DM or insulin resistance and 2 of:	Insulin resistance and 3 or more of:	Three or more of:	Obesity and 2 of:
Obesity	Waist/hip ratio >0.9 M, >0.85 F or BMI >30 kg/m2	Waist circumference ≥ 94 cm M ≥ 80 cm F	Waist circumference ≥102 cm M ≥ 88 cm F	Waist circumference ≥ 94 cm M ≥90 (Asian M) ≥ 80 cm F
Dyslipidemia	HDL-C <0.91 mmol/L M (35 mg/dL) <1.0 mmol/L F (39 mg/dL) TG ≥ 1.7 mmol/dL (150mg/dL)	HDL-C <1.0 mmol/L (39 mg/dL) TG ≥ 2.0mmol/dL (177 mg/dL) Or treated	HDL-C <1.0 mmol/L) M (40 mg/dL) <1.3 mmol/L F (50mg/dL) TG ≥ 1.69mmol/dL(150 mg/dL)	HDL-C <1.0 mmol/L M (40 mg/dL) <1.3 mmol/L F (50mg/dL) TG ≥ 1.7mmol/dL (150 mg/dL) Or treated

Year	WHO 1999	EGIR 1999	NCEP/ATPIII 2001	IDF 2005
Hyperglycemia	T2DM FPG >6.1 mmol/L (110 mg/dL) 2 h OGT >7.7 mmol/L (140 mg/dL)	Not T2DM FPG >6.1 mmol/L (110 mg/dL)	T2DM FPG ≥ 110 mg/dL (6.1 mmol/L)	T2DM FPG ≥ 5.6 mmol/L (100 mg/dL)
Hypertension	SBP ≥ 140 DBP ≥ 90	SBP ≥ 140 DBP ≥90 or treated	SBP ≥130 DBP≥ 85	SBP ≥ 130 DBP ≥ 85 or treated
Additional components	Microalbuminuria ≥ 20 mg/min Albumin/creatinine ≥ 30 mg/g	-	-	-

Abbreviations: WHO= World Health Organization; EGIR= European Group for Insulin Resistance; NCEP= National Cholesterol Education Program; AHA= American Heart Association; IDF= International Diabetes Federation; BMI = body mass index; DBP = diastolic blood pressure in mm Hg; M= males, and F = female; FPG = fasting plasma glucose; HDLc = high-density lipoprotein cholesterol; IFG = impaired fasting glucose; IGT = impaired glucose tolerance; M = male; NHLBI = National Heart Lung and Blood Institute;

3. Data Collection

The researcher established a specific form for collecting relevant data. For validation and accuracy, this form has been tested and reviewed by experts in human nutrition, and all feedback was considered and corrections made accordingly. Moreover, this form was tested on 50 MetS patients to make it clear and modify unclear questions as well as simplify the misunderstood statements.

The researcher collected the following data:

3.1 Demographic data: This data including age, marital status, educational level, jobs, family size, monthly income, type of house, etc.

3.2 Lifestyle: Data about daily activity, sports, types and duration of daily activities, screen time (times spent watching television, internet, mobile, and computer), rate of daily sleep, etc. were collected.

3.3 Health History: Data about health status, diseases, family history of illness, medications use, supplements, special regimen, etc. were collected.

3.4 Anthropometric measurements: The anthropometric measurements included weight, height, waist circumference, and body mass index measured.

3.4.1 Bodyweight (WT): Weight was assessed to the nearest 0.1 kg using an electronic balance type, while the subject stood with light clothes and barefooted.

3.4.2 Body Height (HT): Height was measured to the nearest 0.1 cm using flexible non-stretchable tape. The subjects stood on a flat floor with feet parallel and with heels buttocks, shoulders, and back of head touching the upright board and the head in the position of Frankfurt horizontal plane. The head had been held comfortably erect with the lower border of the orbit in the same horizontal plane. The arms were naturally hanging at the sides.

3.4.3 Body mass index (BMI): BMI calculated by dividing the body weight in kg by the square of the height in meters (kg/m2), and then calculated BMI classified as follow: Thinness: less than 16.5 kg/m2, Underweight : 16.5 < 18.5 kg/m2, Normal weight: 18.5 < 25 kg/m2, Grade 1 obesity: 25 < 30 kg/m2, Grade 2 obesity: 30 < 35 kg/m2, Grade 3 obesity: 35 < 40 kg/m2, and Grade 4 Morbid obesity: > 40 kg/m2.

3.4.4 Waist Circumference (WC): Waist circumference is used to define abdominal obesity. It was measured at a horizontal plane midway between the iliac crest and lower rib margin in centimeters to the nearest 0.1 cm. Values ≥ 80 for women and ≥ 90 for men were classified as abdominal obesity [4].

3.5 Biochemical Analysis: Fasting blood samples (12 hr.) were collected from each subject for determination of blood glucose, triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDLc), and low-density lipoproteins cholesterol (LDLc) using the automated analyzer (Architect c8000; Toshiba Inc., Tokyo, Japan). Also, HBA1c, and insulin were determined in the hospital Labs.

3.6 Nutrients Intakes: Using the 24-hour dietary recall for three days (nonconsecutive and including holidays), the interviewers asked the respondents to recall, describe, and quantify the foods and drinks consumed over the previous 24 hours. The obtained dietary intake data were analyzed by food composition tables for Egypt released by National Egyptian Institute [Food Composition Tables for Egypt, 2006].

Sufficiency of Nutrients Intakes: The adequacy of intakes from energy and other nutrients were compared with standard dietary requirements. The requirements were as follow:

a. Energy (kcal/day): Calculated individually by equations (Harries Benedict Equations) given by the Institute of Medicine, Food and Nutrition Board (2002). Those equations were based on sex, age (yr.), physical activity, body weight (kg), body height (m). Based on BMI we used two equations:

1- BMI (18.5 – 25 kg/m2)

EER = 354 - 6.91 x Age (yr.) + PA x (9.36 x Weight {kg} + 726 x Height [m])

2- BMI (> 25 kg/m2)

TEE = 448 - 7.95 x Age (yr.) + PA x (11.4 x Weight [kg] + 619 x Height [m])

The researcher estimated the physical activity factor as 1.13 (Low active) for control subjects and 1.0 (Sedentary) for metabolic syndrome patients.

b. Protein (gram/day) calculated as 1 g/kg/day for all subjects.

c. Fat (gram/day) calculated as 25% of total energy for control subjects and as 20% of total energy for metabolic syndrome subjects.

d. Carbohydrate (gram/day) calculated by differences.

e. Minerals and vitamins, the requirements for minerals and vitamins were calculated by using the adequate intakes (AI) given in DRI standards (2011).

3.7 Statistical Analysis: All obtained data were statistically analyzed using SPSS computer software (version 22), IBM Software, USA. The results presented as mean±SD, and frequency (no), and percentage. Also, the significant differences between normal and patients for numerical variables were calculated by independent sample t-test. While Chi-square test was used to compare categorical variables among normal and patients.

3.8 Ethical considerations: Participation in the study was voluntary, and participants have fully informed about the objectives and procedures of the study. Each participant was given formal consent which clarified the data that will be collected, and subjects who refuse to sign it were excluded. This study has been approved and accredited by the Department of Nutrition and Food Sciences, Faculty of Home Economics, Menoufia University, Egypt.

Results

Table (2) shows the frequency distribution of persons with metabolic syndrome (MetS) and control group according to demographic data. As shown, the majority of control and MetS groups were from urban areas (81.7% and 53.9%, respectively at P= 0.000 ****). As for gender, about one-third of control and MetS subjects were male, and the rest were females, and the statistical analysis didn't reveal any significant differences. Also, 83.8% of the control group and 90.0% of the MetS group were married. The results didn't show any significant differences between control and MetS groups (47.0±9.9 vs. 45.2±10.3 at P=0.057).

Concerning age, there were no significant differences between control and MetS subjects, and the mean±SD for control and MetS subjects was 47.0±9.9 vs. 45.2±10.3 years, respectively, and P= 0.057. The researcher classified the subjects into four age groups (25<=30, 30<=40, 40-<=50, and 50-<=60 years), which almost equaled in the two groups, and there was no significant difference between the control and MetS groups (P= 0.116). Regarding education level, statistical analysis revealed a significant difference (P=0.000) between the two groups, and only 3.9% of MetS subjects had university certificates, while literacy was more prevalent among them (33.8%). On the other, 10.9% of control subjects were illiterate, and 18.7% had university certificates. However, 60.4% of control subjects had secondary certificates compared with 31.1% of MetS subjects. Almost, the same educational trend was observed among subjects' partners.

As for the job, 31.3% and 46.5% of control and MetS groups, respectively had no job/housewife, while 43.9% of control and 32.0% of MetS group were employee, and only 3.9% and 3.9% of control, and MetS groups had specialist jobs (for example engineer, physician, etc.).

The family size of the majority of control and MetS groups was 4 to 6 persons (72.6% and 66.2%, respectively at P=0.008). However, the socioeconomic class of the majority of the control group was moderate (50.4%), while the majority of MetS subjects had low socioeconomic class (45.6%), the statistical analysis revealed a significant difference between the two groups (P=0.000).

Table 2: Frequency distribution of studied subjects according to demographic data

Variable		**Control no (%)**	**MetS no (%)**	**Total no (%)**
Address	*Rural*	42 (18.3%)	105 (46.1%)	165 (36.0%)
	Urban	188 (81.7%)	123 (53.9%)	293 (64.0%)
	Total	230 (100.0%)	228 (100.0%)	458 (100.0%
	Pearson Chi^2:	*Value= 63.3 (P= 0.000 ****)*		
Gender	*Male*	84(36.5%)	80(35.1%)	164 (35.8%)
	Female	146 (63.5%)	148(64.9%)	293(64.2%)
	Total	230 (100.0%)	228 (100.0%)	458(100.0%)
	Pearson Chi^2:	*Value= 0.1 (P= 0.7490)*		
Age (year)	*25<=30*	21 (9.1%)	11 (4.8%)	32 (7.0%)
	30<=40	59 (25.7%)	59 (25.9%)	118 (25.8%)
	40-<=50	84 (36.5%)	74 (32.5%)	158 (34.5%)
	50-<=60	66 (28.7%)	84 (36.8%)	150 (32.8%)

Variable		Control no (%)	MetS no (%)	Total no (%)
	Total	230(100.0%)	228(100.0%)	458(100.0%)
	Pearson Chi²:	*Value= 5.9 (P= 0.116)*		
	mean±SD	47.0±9.9	45.2±10.3	P= 0.057
Marital Status	*Single*	12(5.2%)	12(5.3%)	24 (5.2%)
	Divorced	11(4.8%)	21(9.2%)	32(7.0%)
	Widowed	0(0.0%)	4(1.8%)	4(0.9%)
	Married	207(90.0%)	191(83.8%)	398(86.9%)
	Total	230(100.0%)	228(100.0%)	458(100.0%)
	Pearson Chi²:	*Value= 7.8 (P= 0.051)*		
Education Level	*Illiterate*	25(10.9%)	75(32.9%)	100(21.8%)
	Below Secondary	23(10.0%)	73(32.0%)	96(21.0%)
	Secondary	139(60.4%)	71(31.1%)	210(45.9%)
	Bachelor	43 (18.7%)	9 (3.9%)	52 (11.4%)
	Total	230(100.0%)	228(100.0%)	458(100.0%)
	Pearson Chi²:	*Value= 95.3 (P= 0.000 ***)*		
Job	*No job/housewife*	72(31.3%)	106 (46.5%)	178 (38.9%)
	Worker or technician	14(6.1%)	40(17.5%)	54(11.8%)
	Employee	101(43.9%)	73(32%)	174(38.0%)
	Specialist	43(3.9%)	9(3.9%)	52(11.4%)
	Total	230(100.0%)	228(100.0%)	458(100.0%)
	Pearson Chi²:	*Value= 45.7 (P= 0.000 ***)*		
Family Size	*< 4*	45(19.6%)	69(30.3%)	114(24.9%)
	4 to 6	167(72.6%)	151(66.2%)	318(69.4%)
	> 6	18(7.8%)	8(3.5%)	26(5.7%)
	Total	230(100.0%)	228(100.0%)	458(100.0%)
	Pearson Chi²:	*Value= 9.7 (P= 0.008 **)*		
Socioeconomic class	*Low*	38(16.5%)	104(45.6%)	142(31.0%)
	Moderate	116(50.4%)	84(36.9%)	200(43.6%)
	High	76(33.0%)	40(17.5%)	116(25.3%)
	Total	230(100.0%)	228(100.0%)	458(100.0%)
	Pearson Chi²:	*Value= 54.2 (P= 0.000 ***)*		

**P<0.05, ** P<0.01, and *** P<0.001*

Table (3) shows the frequency distribution of MetS and control groups according to lifestyle factors. As shown, 86.8% of MetS subjects didn't practice sports versus 67.8%

of the control group. On the other hand, 21.3% and 8.3%, respectively of control and MetS subjects practiced mild sports, and the results were significant at P<0.001.
The frequency and duration of the sport among the control group (2.6± 1.9 times/ week and 36.2± 26.2 minutes/time) were significantly higher than the corresponding values of the MetS group (1.8± 1.8 times/ week and 27.1 ±22.1 minute/time) at P< 0.05. Finally, the daily hours spent in the screen of the control group was significantly higher than MetS group (2.4±1.9 and 2.1±1.8, respectively at P<0.05), while daily hours spent in sleeping among the Mets group was significantly higher than the control group (8.2± 7.1 and 7.1±1.5, respectively at P<0.001)

Table 3: Frequency distribution of studied subjects according to lifestyle

Variable		**Control no (%)**	**MetS no (%)**	**Total no (%)**
Practice sports	None	156(67.8%)	198(86.8%)	354(77.3%)
	Mild sports	49(21.3%)	19(8.3%)	68(14.8%)
	Moderate sports	22(9.6%)	8(3.5%)	30(6.6%)
	Hard sports	3(1.3%)	3(1.3%t)	6(1.3%)
	Total	230(100.0%)	228(100.0%)	458(100.0%)
	*Pearson Chi^2: Value= 24.7 (P= 0.000 ***)*			
	Control (n=230) mean±SD	**MetS (n=228) mean±SD**	**Independent sample t - test t.value**	**P.value**
Sports frequency (time/wk.)	2.6± 1.9 (n=84)	1.8± 1.8 (n=42)	2.38	0.018*
Sports duration (min/time)	36.2± 26.2 (n=84)	27.1 ±22.1(n=42)	1.92	0.050*
Screen times (hr./day)	2.4±1.9	2.1±1.8	2.22	.027*
Sleeping hours (hr./day)	7.1±1.5	8.2± 7.11	6.83	0.000***

**P<0.05, ** P<0.01, and *** P<0.001*

Table (4) showed the mean and standard deviation of the anthropometric measurements of MetS and control subjects. Initially, there weren't significant differences between the MetS and the control subjects with age (45.2±10.3 vs. 47.0±9.9, respectively at P=0,057). All measured body indices include weight, BMI, and waist circumferences of the MetS subjects were significantly higher than control subjects at P<0.001.
Table (5) showed the frequency distribution of studied subjects according to BMI classes. In comparison to 75.2% of control subjects, 97.8% of MetS subjects had different degrees of obesity. However, morbid obesity was prevalent among 24.6% of the MetS subjects compared with 0.0% of the control subjects. The statistical analysis of data showed very highly significant differences between the two groups (P<0.001).

Table 4: Mean and standard deviation for anthropometric measurements of studied subjects

Variable	Control (n=230) mean±SD	MetS (n=228) mean±SD	Independent sample t - test t.value	P.value
Age (year)	47.0±9.9	45.2±10.3	1.95	0.057
Weight (kg)	77.6±12.2	95.6±16.2	13.440	0.000***
Height (cm)	166.6±9.0	163.7±9.4	-3.326	0.001***
BMI (kg/m2)	28.1±4.5	35.8± 6.1	15.593	0.000***
Waist (cm)	92.80± 10.30	115.64±11.70	22.179	0.000***

**P<0.05, ** P<0.01, and *** P<0.001*

Table (5): Frequency distribution of studied subjects according to BMI classes.

	Control no (%)	MetS no (%)	Total no (%)
Healthy weight (18.5: 25 kg/m^2)	57 (24.8%)	5 (2.2%)	62 (13.5%)
Overweight (25: 30 kg/m^2)	104 (45.2%)	32 (14.0%)	136 (29.7%)
Obesity (30: 40 kg/m^2)	69 (30.0%)	135 (59.2%)	204 (44.5%)
Morbid Obesity (> 40 kg/m^2)	0 (0.0%)	56 (24.6%)	56 (12.2%)
Total	230 (100.0%)	228 (100.0%)	458 (100.0%)
Pearson Chi^2	*Value= 159.1 (P= 0.000 ****)*		

**P<0.05, ** P<0.01, and *** P<0.001*

Table 6 revealed the mean and standard deviation of the blood results of the MetS and control subjects. As shown, the mean values for fasting blood glucose, HBA1c, triglycerides, total cholesterol, LDL, and VLDL among the MetS group were significantly higher than the corresponding values of control subjects and exceeded the reference values. On the other hand, the mean values among control subjects have lied in the reference values range.

Table 7 showed the mean and standard deviation of the macro and micronutrient intakes of MetS and control subjects. As shown, the MetS subjects didn't satisfy their nutritional requirements from energy, total protein, fat, carbohydrate, fiber, vitamin C, thiamin, potassium, calcium, and magnesium. On the other hand, the control group didn't satisfy - to some degree but not like MetS subjects - their nutritional requirements from energy, fat, carbohydrate, fiber, vitamin C, thiamin, potassium, calcium, and magnesium. However, the deficiency was higher among the MetS group. However, the percentage of intakes by the MetS group from all nutrients was significantly lower than the control group at varying degrees of significance.

Although the requirements from fiber ranged from 25 to 30 gram per day, but the intakes among both MetS and control subjects didn't satisfy 20% of that recommendations.

Table 6: Mean and standard deviation of biochemical analysis for MetS and control subjects.

Variable	Reference values	Control (n=230) mean±SD	MetS (n=228) mean±SD	Independent sample t - test Value	P
FBG (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***
TG (mg/dl)	35-135	118.3±60.2	171.6±70.1	6.5	0.000***
TC (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***

*FBG; Fasting Blood Glucose, TG: Triglycerides, TC: Total cholesterol. *P<0.05, ** P<0.01, and *** P<0.001*

Table 7: Mean and standard deviation for nutrients intakes (daily) of MetS and control subjects.

Variable	Control (n=230) mean±SD (%std)	MetS (n=228) mean±SD (%std)	Independent sample t - test Value	P
Energy (Kcal)	2114.6±529.8 (81.3%)	1629.9±575.1 (57.2%)	-9.4	.000***
Protein (g/day)	79.1±24.3(104.8%)	57.0±22.9 (60.9%)	-10.1	.000***
Fat (g/day)	61.4±24.1 (85.4%)	55.8±24.2 (70.3%)	-2.5	.013***
Carbs (g/day)	311.4±87.4 (75.7%)	225.1±93.8 (51.2%)	-10.2	.000***
Fiber (g/day)	6.0±2.3	4.3±2.0	-8.5	.000***
Vitamin A (mcg/day)	1927.0±1206.1 (251.9%)	1142.2±931.9 (150.2%)	-7.8	.000***
Vitamin C (mg/day)	71.1±53.6 (89.7%)	45.2±42.2 (56.5%)	-5.7	.000***
Thiamin (mg /day)	0.84±0.3 (74.0%)	0.70±0.25 (60.9%)	-5.8	.000***
Riboflavin (mg /day)	1.8±0.8 (149.6%)	1.6±0.7 (137.6%)	-2.1	.038**
Sodium (mg /day)	2295.0±897.3	1730.8±886.6	-6.8	.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	.000***
Phosphor (mg /day)	1131.9±297.7 (161.7%)	879.0±297.0 (125.6%)	-9.1	.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	.000***
Zinc (mg /day)	11.30±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	.000***

*%Std: Percentage of standard requirements from the nutrient. FBG; Fasting Blood Glucose, TG: Triglycerides, TC: Total cholesterol. *P<0.05, ** P<0.01, and *** P<0.001*

The table 8 represented the frequency distribution of studied subjects according to the percentage of nutrients intakes. To identify the percentage of persons who had a severe deficiency, the authors distributed the percentage of nutrient intakes into quartiles, the 1st quartile (QI) represent the intakes below 50%, 2nd quartile (QII) represent the intakes from 50% to less than 75%, 3rd quartile (QIII) represent the intakes from 75% to less than 100%, and 4th quartile (QIV) represent the intakes above 100%.

As shown, the majority of both MetS and control subjects have lied in QI (failed to satisfy 50% of their requirements) for the percentage intakes from potassium (86.8% vs. 51.3%, respectively), magnesium (77.6% vs. 41.3%, respectively), calcium (75%), and vitamin C (61.1% vs. 34.3, respectively).

Concerning the percentage of essential macronutrient intakes, it was clear that the majority of MetS subjects have lied in QI for the percentage intakes from carbohydrate (56.1%), calories (41.7%), and protein (41.2%). In contrast, the majority of control subjects were lied in QII (41.7%) and above for calories, QIV for protein (53.5%), and QII for carbohydrates (38.3%).

However, the majority of both MetS and control subjects were lied in QIV (> 100% of requirements) for the percentage intakes from vitamin A (54.4% vs. 85.7%, respectively), riboflavin (68.9% vs. 72.6%, respectively), phosphors (82.1% vs.68.9%, respectively), iron (85.1% vs. 97.4%, respectively), zinc (58.8% vs. 61.7%, respectively), and copper 96.5 vs. 96.5%, respectively).

Table 8: Frequency of studied MetS and control subjects according to percentage of nutrients intakes.

Nutrient		**QI (< 50% of Req)**	**QII (>=50%: <75% of Req)**	**QIII (>=75%: <100% of Req)**	**QIV(>= 100% of Req)**
Energy	Control	11 (4.8%)	96 (41.7%)	67 (29.1%)	56 (24.3%)
	Mets	95 (41.7%)	86 (37.7%)	39 (17.1%)	8 (3.5%)
	Total	106 (23.1%)	182 (39.7%)	106 (23.1%)	64 (14.0%)
Protein	Control	10 (4.3%)	54 (23.5%)	43 (18.7%)	123 (53.5%)
	Mets	94 (41.2%)	80 (35.1%)	39 (17.1%)	15 (6.6%)
	Total	104 (22.7%)	134 (29.3%)	82 (17.9%)	138 (30.1%)
Fat	Control	38 (16.5%)	65 (28.3%)	58 (25.2%)	69 (30.0%)
	Mets	64 (28.1%)	81 (35.5%)	50 (21.9%)	33 (14.5%)
	Total	102 (22.3%)	146 (31.9%)	108 (23.6%)	102 (22.3%)
Carbs	Control	26 (11.3%)	88 (38.3%)	78 (33.9%)	38 (16.5%)
	Mets	128 (56.1%)	64 (28.1%)	32 (14.0%)	4 (1.8%)
	Total	154 (33.6%)	152 (33.2%)	110 (24.0%)	42 (9.2%)
Vitamin A	Control	12 (5.2%)	7 (3.0%)	14 (6.1%)	197 (85.7%)

Nutrient		QI (< 50% of Req)	QII (>=50%: <75% of Req)	QIII (>=75%: <100% of Req)	QIV(>= 100% of Req)
	Mets	50 (21.9%)	25 (11.0%)	28 (12.3%)	125 (54.8%)
	Total	62 (13.5%)	32 (7.0%)	42 (9.2%)	322 (70.3%)
Vitamin C	Control	79 (34.3%)	54 (23.5%)	26 (11.3%)	71 (30.9%)
	Mets	139 (61.0%)	38 (16.7%)	18 (7.9%)	33 (14.5%)
	Total	218 (47.6%)	92 (20.1%)	44 (9.6%)	104 (22.7%)
Thiamin	Control	51 (22.2%)	79 (34.3%)	63 (27.4%)	37 (16.1%)
	Mets	87 (38.2%)	91 (39.9%)	35 (15.4%)	15 (6.6%)
	Total	138 (30.1%)	170 (37.1%)	98 (21.4%)	52 (11.4%)
Riboflavin	Control	11 (4.8%)	30 (13.0%)	22 (9.6%)	167 (72.6%)
	Mets	9 (3.9%)	22 (9.6%)	40 (17.5%)	157 (68.9%)
	Total	20 (4.4%)	52 (11.4%)	62 (13.5%)	324 (70.7%)
Potassium	Control	118 (51.3%)	112 (48.7%)	0	0
	Mets	198 (86.8%)	30 (13.2%)	0	0
	Total	316 (69.0%)	142 (31.0%)	0	0
Calcium	Control	111 (48.3%)	89 (38.7%)	30 (13.0%)	0
	Mets	171 (75.0%)	41 (18.0%)	16 (7.0%)	0
	Total	282 (61.6%)	130 (28.4%)	46 (10.0%)	0
Phosphor	Control	0	2 (0.9%)	9 (3.9%)	219 (95.2%)
	Mets	0	16 (7.0%)	55 (24.1%)	157 (68.9%)
	Total	0	18 (3.9%)	64 (14.0%)	376 (82.1%)
Magnesium	Control	95 (41.3%)	95 (41.3%)	40 (17.4%)	0
	Mets	177 (77.6%)	39 (17.1%)	12 (5.3%)	0
	Total	272 (59.4%)	134 (29.3%)	52 (11.4%)	0
Iron	Control	0	0	6 (2.6%)	224 (97.4%)
	Mets	0	0	34 (14.9%)	194 (85.1%)
	Total	0	0	40 (8.7%)	418 (91.3%)
Zinc	Control	23 (10.0%)	26 (11.3%)	39 (17.0%)	142 (61.7%)
	Mets	25 (11.0%)	22 (9.6%)	47 (20.6%)	134 (58.8%)
	Total	48 (10.5%)	48 (10.5%)	86 (18.8%)	276 (60.3%)
Copper	Control			8 (3.5%)	222 (96.5%)
	Mets			8 (3.5%)	220 (96.5%)
	Total			16 (3.5%)	442 (96.5%)

Q = Quartile, Req= Nutrients Requirements

Discussion

Most of control and MetS subjects were from urban areas, about one-third of them were males, and more than four fifth were married. Regarding education level, literacy was more prevalent among MetS group, and almost, the same educational trend was observed among subjects' partners. Worldwide, it seemed that the majorities of persons with MetS were illiterate or had low educational level [13, 14, 15]. In agreement with several results carried out in Egypt [16], the family size of the majority of control and MetS groups was 4 to 6 persons. Moreover, low socioeconomic status is one of the important factors that may help trigger occurrence of MetS among adults [17] and the socioeconomic class of the majority of the of MetS subjects in this study was low.

As shown, the sedentary lifestyle were predominant among MetS subjects as the results revealed that more than four fifth of MetS subjects and two thirds of control subjects didn't practice any sports (P<0.001). However, the authors agreed that higher adherence to the healthy lifestyle was associated with a lower risk of developing metabolic syndrome as mentioned by Garralda-Del-Villar et al, [18].

All measured body indices include weight, BMI, and waist circumferences of the MetS subjects were significantly higher than control subjects at P<0.001. These findings agreed with three studies [12, 19, 20]; conducted in Saudi Arabia used the same MetS criteria [21], in whom the most common criteria was abdominal obesity.

About 98.0% of MetS subjects in this study had different degrees of obesity and morbid obesity was prevalent among one fourth of the MetS subjects. With respect to these findings and in agreement with findings of Setayeshgar et al, [14], it could be emphasized that obesity and more specifically abdominal obesity is one of the main risk factors for MetS. Moreover, this high prevalence of obesity and its correlation with MetS could explain the higher rate of MetS among adults in Egypt.

Biochemical parameters which include fasting blood glucose, HBA1c, triglycerides, total cholesterol, LDL, and VLDL were considerably higher than references values among the MetS group, which in turn may explain the problem of metabolic syndrome.

The results of this study demonstrated that the MetS subjects didn't satisfy their nutritional requirements from energy, total protein, fat, carbohydrate, fiber, vitamin C, thiamin, potassium, calcium, and magnesium. These results agreed with that obtained by AbuZaied et al, [12] who found that about half of MetS patients with four or more of MetS criteria in their study failed to satisfy 75.0% of their needs from energy, protein, and carbs.

Although the requirements from fiber ranged from 25 to 30 gram per day, but the intakes among both MetS and control subjects didn't satisfy 20% of that recommendations. Wei et al., [22] found a curvilinear relationship between fiber consumption and prevalence of

MetS, the concluded that dietary fiber intake is associated with less likelihood of having MetS.

In accordance with our findings, the majority of studies found that MetS patients had a marked deficiency in intakes of calcium [9, 23, 24]. Animal and human studies indicate that consuming adequate amounts of dietary calcium and dairy products may reduce body weight and prevent obesity that may lead to metabolic syndrome [24, 25, 26]. Therefore, the researchers - in conformity with published findings by other researchers [27,28] postulated that calcium deficiency may be a risk factor for MetS among Saudi females. Generally, calcium intakes were found to be lower than requirements in several regions of Saudi Arabia [29, 30]. Nevertheless, the deficiency among control group may be ascribable to the low consumption of milk and dairy products – major source of calcium - during the past few years as suggested by Shin et al, [24] who confirmed that dairy product consumption in Asia is much lower than in Western countries.

In conclusion: Low socioeconomic may contribute to the occurrence of metabolic syndrome among adults. The most common criterion among MetS patients in this study was obesity, especially abdominal obesity. However, the authors postulated that obesity is the main risk factor for MetS among adults in Egypt. The percentage of intakes by the MetS group from all nutrients was significantly lower than the control group at varying degrees of significance

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مقدار كفاية المأخوذ من العناصر الغذائية بين مرضى المتلازمة الايضية - دراسة مقارنة بين عينة مختبرة وعينة ضابطة

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الملخص العربي

ازداد انتشار المتلازمة الأيضية بشكل ملحوظ في جميع أنحاء العالم. وقد ركزت بعض الدراسات على العلاقة بين المأخوذ من العناصر الغذائية والمتلازمة الأيضية لتحديد الأسباب الغذائية وراء حدوثها. هدفت الدراسة إلى قياس مدى كفاية المأخوذ من العناصر الغذائية بين مرضى المتلازمة الايضية. هذه دراسة مقطعية مقارنه بين عينه مختبرة وعينة ضابطة. وتم اختيار 458 بالغا بطريقة عشوائية (228 مصابين بالمتلازمة الايضية و230 مجموعة ضابطة) تراوحت أعمارهم بين 25 و60 عاما. قام الباحثون بجمع البيانات عن الحالة الاجتماعية والاقتصادية ونمط الحياة والتاريخ الصحي والقياسات الجسمية والمؤشرات الكيموحيوية والمأخوذ من العناصر الغذائية. أظهرت النتائج ان غالبية العينة الضابطة ومرضى المتلازمة كانوا من المناطق الحضرية، وكان حوالي ثلث افراد العينة من الذكور. كان نمط حياة الجلوس هو النمط السائد بين افراد العينة ولم يمارس 86.8٪ من العينة الضابطة و67.8٪ من مرضى المتلازمة أي رياضة. انتشرت السمنة بدرجاتها المختلفة بين 75.2٪ من المجموعة الضابطة و97.8٪ من المرضى وكانت السمنة المفرطة سائدة بين 24.6٪ من المرضى ولا أحد من المجموعة الضابطة. تجاوزت جميع المؤشرات الحيوية للدم بين مجموعة المرضى القيم المرجعية وكانت أعلى معنويا من قيم المجموع الضابطة. فشل معظم المرضى المتلازمة وأفراد المجموعة الضابطة في تلبية 50٪ من احتياجاتهم من البوتاسيوم والمغنيسيوم والكالسيوم وفيتامين ج. وعلاوة على ذلك، فشل معظم المرضي في تلبية 50٪ من احتياجاتهم من الكربوهيدرات والسعرات والبروتين. حصل معظم مرضى المتلازمة وافراد العينة الضابطة على أكثر من 100٪ من الاحتياجات من فيتامين (أ)، الريبوفلافين، الفوسفور والحديد والزنك والنحاس. الخلاصة، عانى مرضى المتلازمة الايضية في هذه الدراسة من نقص واضح في العناصر الغذائية الأساسية وخاصة السعرات والكربوهيدرات والبروتين والكالسيوم وفيتامين ج.

الكلمات الكاشفة: السمنة، كتلة الجسم، السعرات، البروتين، فيتامين ج