Prev. Nutr. Food Sci. 2022;27(1):45-49
https://doi.org/10.3746/pnf.2022.27.1.45
ISSN 2287-8602

Impact of Dietary Intake and Physical Activity on Metabolic Syndrome in Saudi Adults: An Exploratory Pilot Study

Dina M. Qahwaji

Clinical Nutrition Department, Faculty of Applied Medical Sciences, King Abdulaziz University, Jeddah 21589, Saudi Arabia

ABSTRACT: Metabolic syndrome (MetSyn) is characterized by the clustering of commonly observed multiple metabolic abnormalities, such as abdominal obesity, hyperinsulinemia, dyslipidemia, high blood pressure (BP), impaired fasting glucose level, and occasionally a meager amount of high-density lipoprotein cholesterol (HDL-C). The present case-control pilot study was designed to examine and compare the different dietary habits of specific food groups (meat, dairy, fats, and carbohydrates) in 85 male and female participants (age: 20 to 80 years) between MetSyn patients (n=54), based on World Health Organization criteria and non-MetSyn patients (n=31) at King Abdulaziz University Hospital, Jeddah, Kingdom of Saudi Arabia. Patients were studied based on a dietary questionnaire with clear validity that included personal and diet related habit queries, body mass index (BMI), HDL-C, low density lipoprotein cholesterol, total cholesterol, triglycerides, and BP. Results showed significantly increased values for BMI (kg/m^2), systolic BP, diastolic BP, HDL-C, and blood calcium concentration among the MetSyn group compared to non-MetSyn group. Substantial differences were obtained for fasting glucose distribution between MetSyn and non-MetSyn groups ($P<0.002$). The study analysis revealed that consumption of dairy and fats was relatively higher in MetSyn patients. Also, the frequency of eating meat and derivatives showed no significant statistical difference. between the two groups. The study found that the MetSyn group consumed a significantly more proportion of dairy products, though there were no changes in dietary patterns between the MetSyn and non-MetSyn groups in terms of the intake of meats, dairy, fat, and carbohydrate.

Keywords: dietary intake, dietary pattern, metabolic syndrome, physical activity, Saudi Arabia

INTRODUCTION

Metabolic syndrome (MetSyn) is characterized by various established cardiovascular risk factors, such as insulin resistance, obesity, atherogenic dyslipidemia, and hypertension. MetSyn has been defined multiple times using various scientific standards such as the International Diabetes Federation (IDF), Adult Treatment Panel (ATP) III, and World Health Organization (WHO) criteria. The IDF criteria emphasize the presence of central obesity as a component of MetSyn. When three or more of the risk factors are present, MetSyn is restricted using the ATP III criteria (Ranasinghe et al., 2017; Al-Rubeaan et al., 2018; Garralda-Del-Villar et al., 2018).

Behavioral factors also play many roles, which is why MetSyn can be induced by various factors such as dietary habits and a lazy lifestyle. It has been noted that due to a sedentary lifestyle and consumption of energy-dense/high-fat diets, MetSyn is becoming a common worldwide problem that increasing with time (Ramic et al., 2016). Even medications (used for the management of depression and other mental disorders, inflammation, allergies, human immunodeficiency virus, etc.) can be the reason for increasing weight, blood pressure (BP), blood glucose level, and high cholesterol, which may be risk factors of MetSyn and can affect it severely.

Healthy middle-aged men show MetSyn related heart disease and a higher death rate, and a connection between MetSyn and other disorders has also been established (Garralda-Del-Villar et al., 2018). MetSyn has been linked to an increased risk of cardiovascular diseases, type 2 diabetes mellitus (T2DM), atherosclerosis, and a higher mortality rate in a meta-analysis of long-term studies that have previously been published, and MetSyn is expected to become more common as one's body mass index (BMI) and age increase (Garralda-Del-Villar et al., 2018).

According to the IDF, approximately one-quarter of adults worldwide have MetSyn (Al-Rubeaan et al., 2018).

Received 20 December 2021; Accepted 11 January 2022; Published online 31 March 2022

Correspondence to Dina M. Qahwaji, E-mail: dqahweji@kau.edu.sa
Author information: Dina M. Qahwaji (Professor)

The Middle East, for example, is well-known for having a greater prevalence of MetSyn. According to the ATP III and IDF standards, the occurrence rate of MetSyn in several Middle Eastern nations, including Gulf countries, ranges from 17% in Oman (Al Dhaheri et al., 2016; Al Mansour et al., 2016; Ramic et al., 2016; Gosadi et al., 2017; Ostovar et al., 2017; Hoyas and Leon-Sanz, 2019; Shin and Jee, 2020; Wang et al., 2020) to 40.5% in the United Arab Emirates (Al-Nozha et al., 2005; Al Dhaheri et al., 2016; Al Mansour et al., 2016; Gosadi et al., 2017; Ostovar et al., 2017; Hoyas and Leon-Sanz, 2019; Shin and Jee, 2020; Wang et al., 2020).

Moreover, additional variables that can lead to metabolic disorders are numerous and reach new heights in the Kingdom of Saudi Arabia (KSA) (Al-Nozha et al., 2005). The analysis finds that, given the prevalence of the rate of MetSyn, the incidence rate in Saudi Arabia is likely to surpass the limit observed in many other nations. The incidence of MetSyn was 39.8% according to National Cholesterol Education Program ATP III criteria and 31.6% according to IDF criteria in a 2018 descriptive study of 12,126 individuals in KSA (Al-Rubeaan et al., 2018).

While KSA has the highest rates of diabetes globally, it also has a high incidence of obesity, which directly impacts more than one-third of the population, the majority of whom are adults. Other symptoms of MetSyn are also becoming more common in KSA. According to IDF criteria, MetSyn was found in 31.6% of the Saudi population, affecting 34.4% of the male population being male and 29.2% of the female population. The ATP III criteria found the prevalence of MetSyn at 39.9%. Precisely, 45.0% men and 35.4% of women, its prevalence is increasing since it's been documented in several other nations (Al-Rubeaan et al., 2018).

As a result, the current descriptive study was intended to investigate the differences in patterns of dietary consumption of specific food groups (meat, dairy, fats, bread, and grains) between patients with and without MetSyn based on WHO criteria among adult male and female out-patients at King Abdul-Aziz University Hospital (KAUH) in Jeddah, Saudi Arabia.

MATERIALS AND METHODS

Subjects

The present case-control study was carried out at the KAUH in Jeddah, KSA, from January 2019 to May 2019. The research outlines the inclusion criteria for patients with MetSyn (diabetes mellitus which encompasses T2DM, high BP, and obesity) and non-MetSyn individuals aged 20 to 80 years. Exclusion criteria include all people suffering from various ailments such as cancer, renal disease, etc. Ninety-one patients (males and females) were consulted at the KAUH for this research. Six participants, however, were eliminated from the analysis, four of whom did not meet the WHO criteria and two participants who did not have laboratory results in the KAUH system. The remaining (n=85) patients were separated into two groups: those who had been diagnosed with MetSyn based on WHO criteria (n=54) and those who did not (n=31).

Data collection

Each participant was told about the research goal and the consent form and questionnaire at the outset. Following that, participants were asked to complete the questionnaire under the controlled supervision of clinical student dietitians, which included personal information that the person would fill accurately, such as sex, age, income, level of education, past/present medical history, and occupational status, as well as nutritional habits. Usual food intake and dietary behaviors were measured using an established, validated dietary questionnaire from King Saud University (Ramic et al., 2016). This questionnaire primarily included questions about consuming meat and fish, sandwiches and burgers, fats, and dairy products (skimmed, low, and whole), bread, and cereals. Following the interview, the participant's body weight (kg) and height (cm), specific biochemical values of high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol, triglyceride (TG), vitamin D, hemoglobin A1c, fasting glucose, calcium, potassium, sodium, magnesium, uric acid, and vital signs [mainly BP: systolic (SBP) and diastolic (DBP)], were obtained from the KAUH system. BMI was calculated as weight in kilograms (kg) divided by height in meters squared (m^2). Ethical approval for this study was approved by the KAUH research ethics committee (Reference No. 47-19). Furthermore, each participant signed a consent form before starting the clinical screening.

Statistical analysis

The acquired data was entered, coded, and checked to be error-free before being analyzed using IBM SPSS (version 22, IBM Corp., Armonk, NY, USA). The population sample size at KAUH in Jeddah was 85 adults. According to WHO criteria, 54 (63.53%) of the subjects had MetSyn, whereas 31 (36.5%) were non-MetSyn subjects (not suffering from MetSyn).

The analysis of the study was done by keeping in mind the other significant differences in medical tests and biochemical measurements (BMI, HDL-C, LDL-C, TG, SBP, and DBP) among study groups (WHO-based MetSyn and non-MetSyn patients) by using the *t*-test for the single independent variables after specifying that the data follows the normal distribution that depends on a normal curve. A non-parametric test (the Mann-Whitney U-test) was used to see whether there was a difference in distribution between the two study groups.

The chi-squared test was used to evaluate the relationship between nominal variables such as the correlation between the frequency of possessing the food categories and study groups. The average difference in body measurements and medical tests with the frequency of having or eating food categories was tested using a one-way ANOVA. The proportions for qualitative variables, which comprise the frequencies and percentages of demographic characteristics among research groups, are given using elementary descriptive statistics. Furthermore, statistics are provided as the mean and standard deviation for quantitative variables [mean±standard deviation (SD)]. The P-value less than or equal to 0.05 was used to determine if the findings were significant.

RESULTS

The results (Table 1) demonstrate the characteristics of the 85 patients who participated in the study: 54 with MetSyn based on WHO criteria (63.5%) and 31 with non-WHO standards (36.5%) The mean±SD values of the age for the MetSyn group and non-MetSyn group were 58.97±8.23 and 57.42±11.90, respectively. MetSyn affected 10 males and 44 females, whereas non-MetSyn affected 4 males and 27 females.

Table 2 shows substantial differences in BMI, weight, SBP, DBP, HDL-C, and calcium concentration between the MetSyn group and the non-MetSyn group. The fasting glucose distribution differs significantly between MetSyn and non-MetSyn groups (P<0.002).

Table 1. Descriptive statistics of demographic variables

Demographic variables	MetSyn (WHO based)	Non-MetSyn
Sample size	54 (63.5)	31 (36.5)
Age (yr)	58.97±8.23	57.42±11.90
Sex		
Male	10	4
Female	44	27

Values are presented as number (%) or mean±SD.
MetSyn, metabolic syndrome; WHO, World Health Organization.

Table 3 indicates the daily recommended intake of dairy and fats (2∼4 times every day). The findings revealed that the consumption of dairy and fats was relatively higher in MetSyn patients than non-MetSyn patients, with 25.9% of the MetSyn and 35.5% of the non-MetSyn group consuming less than two times per day (low), 48.1% of MetSyn, and 48.4% of non-MetSyn consuming 2∼4 times/d (within the recommendation), and 25.9% of MetSyn and 16.1% of non-MetSyn more than the recommended intake (high).

There is, however, no statistically significant difference in the frequency of consuming dairy and fat between the MetSyn group (WHO) and the non-MetSyn group.

Table 4 shows that 59.3% of MetSyn participants and 61.3% of non-MetSyn participants consumed less than two servings per day (low). In comparison, 31.5% of the MetSyn group and 29.0% of the non-MetSyn group consumed 2∼3 servings/d (within the recommendation), 9.3% of the MetSyn group, and 9.7% of non-MetSyn group finished more than three servings/d (high).

Table 5 shows that most participants (96.3% of the MetSyn group and 93.5% of the non-MetSyn group) ate

Table 2. Body measurements and biochemical analysis among MetSyn and non-MetSyn

Body measurements and biochemical analysis	MetSyn (WHO based)	Non-MetSyn	P-value
Body mass index (kg/m^2)	34.1±6.7	29.51±6.2	0.004*
Weight (kg)	85.4±18.5	70.5±15.6	0.001*
Systolic BP (mmHg)	145.72±17.94	130.21±14.6	0.0001*
Diastolic BP (mmHg)	76.1±11.9	69.3±12.7	0.021*
HDL-C (mmol/L)	1.2±0.32	1.5±0.43	0.021*
LDL-C (mmol/L)	2.95±0.98	2.73±0.9	0.388
Triglycerides (mmol/L)	1.6±0.64	1.4±0.6	0.268
Vitamin D (ng/mL)	58.4±22.6	58.7±26.3	0.958
Total cholesterol (mmol/L)	4.7±1.1	4.2±0.9	0.055
Fasting glucose (mmol/L)	33.52	17.97	0.002*
Calcium (mmol/L)	2.3±0.1	2.2±0.14	0.045*
Magnesium (mmol/L)	0.82±0.14	0.8±0.2	0.868
Potassium (mmol/L)	4.1±0.43	4.01±0.4	0.502
Sodium (mmol/L)	139.8±2.9	139.4±2.4	0.637
Uric acid (mg/dL)	307.9±94.1	328.2±64.6	0.625

Values are presented as mean±SD or mean rank.
*P<0.05.
MetSyn, metabolic syndrome; WHO, World Health Organization; BP, blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol.

Table 3. Consumption of dairy and fat in the MetSyn and non-MetSyn groups

Consumption per day	MetSyn (WHO based) (n=54)	Non-MetSyn (n=31)	*P*-value
Low (<2 times)	14 (25.9)	11 (35.5)	0.482
Recommended (2∼4 times)	26 (48.1)	15 (48.4)	
High (>4 times)	14 (25.9)	5 (16.1)	

Values are presented as number (%).
MetSyn, metabolic syndrome; WHO, World Health Organization.

Table 4. Consumption of meat and derivatives in the MetSyn and non-MetSyn groups

Consumption per day	MetSyn (WHO based) (n=54)	Non-MetSyn (n=31)	*P*-value
Low (<2 times)	32 (59.3)	19 (61.3)	0.972
Recommended (2∼3 times)	17 (31.5)	9 (29.0)	
High (>3 times)	5 (9.3)	3 (9.7)	

Values are presented as number (%).
MetSyn, metabolic syndrome; WHO, World Health Organization.

Table 5. Consumption of bread and grains (crabs) in the MetSyn and non-MetSyn groups

Consumption per day	MetSyn (WHO based) (n=54)	Non-MetSyn (n=31)	*P*-value
Low (<6 times)	52 (96.3)	29 (93.5)	0.565
Normal (6∼11)	2 (3.7)	2 (6.5)	

Values are presented as number (%).
MetSyn, metabolic syndrome; WHO, World Health Organization.

Table 6. Score mean rank of fast-food consumption (per week) in the MetSyn and non-MetSyn groups

Score	MetSyn (WHO based)	Non-MetSyn	*P*-value
Mean rank	41.6	45.5	0.472

MetSyn, metabolic syndrome; WHO, World Health Organization.

fewer than six servings of bread and grains per day (low). In contrast, only 3.7% of the MetSyn group and 6.5% of the non-MetSyn group consumed 6∼11 servings/d (within the recommended level). There was no statistically significant link between the frequency of eating bread and grains in either group.

Table 6 shows the difference in fast-food consumption/week scores distribution between the two groups. This number indicates that the MetSyn and non-MetSyn groups ranked 41.6 and 45.5 times each week, respectively. However, there is no statistically significant difference in the weekly distribution of fast-food ratings between the two groups.

DISCUSSION

The present study shows that the MetSyn individuals ingested more fat than non-MetSyn participants. A prior study by Al Mansour et al. (2016) found that the subjects who ate high-fat/high-carbohydrate diets had a greater prevalence of MetSyn, but the results were not statistically significant. Obesity and diabetes are more evident in those who eat a lot of fat and carbs.

The current investigation discovered a link between dairy intake and MetSyn. The MetSyn group consumed more dairy than the non-MetSyn group. In contrast, Azadbakht and colleagues' (2005) cross-sectional study of 827 subjects showed that dairy consumption has an inverse association with increased hypertension, which may be responsible for lowering the risk of MetSyn. This study agreed with another study (Lutsey et al., 2008) that found that dairy consumption provides some protection. The disparity between our results and results of other investigators (Azadbakht et al., 2005; Lutsey et al., 2008) might be explained by a distinct difference in sample size, research methodology, and cultural differences (Ostovar et al., 2017; Hoyas and Leon-Sanz, 2019).

The cohort study of Lutsey et al. (2008), which had data from 9,514 participants, concurred with our findings concerning bread and grains, finding no link between incidence of MetSyn and the consumption of whole grains or processed grains (Wang et al., 2020). It found that whole-grain diets had both a high cereal fiber content and a reduced glycemic index, which may minimize the risk of developing MetSyn. This conclusion contradicts our findings since we found no significant association between the frequency of eating bread and grains in both groups. These disparities might be attributed to various sample sizes since McKeown's findings included 2,834 patients in a cross-sectional design (McKeown et al., 2010). Furthermore, the work of Lutsey et al. (2008) found that eating meat and fried meals (fast food) increases the risk of MetSyn, which contradicts our findings for meats and fast food, since we found no significant difference in the weekly fast-food scores between the two groups ($P>0.05$).

The biggest issues influencing our research outcomes were a lack of time and the small sample-size and limited regional pool of participants on which the analysis was conducted.

Our results showed no change in dietary patterns between the MetSyn group and the non-MetSyn group regarding meats, dairy, fat bread, and cereals. However, the MetSyn group consumed significantly more dairy products compared to the non-MetSyn group. Additional research needs to be done with a bigger sample size and a more precise questionnaire. A legitimate conclusion is that dietary items are linked to metabolism and may influence us in various ways, including the development of cardiovascular disease and MetSyn, in addition to affecting each other. More research work is required to clarify the present results and to understand how it might lead to a variety of changes and the total amount of food we consume.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank Ms. Dana Bamieh, and Ms. Jory Naji, my graduating students from the Department of Clinical Nutrition, Faculty of Applied Medical Sciences, at the King Abdulaziz University for their role in collecting samples. I also express sincere gratitude to the participants who were involved in the study.

FUNDING

The present work was funded by the Deanship of Scientific Research at King Abdulaziz University, Jeddah, Saudi Arabia (grant no. G-1537-290-1440-41623).

AUTHOR DISCLOSURE STATEMENT

The author declares no conflict of interest.

REFERENCES

Al Dhaheri AS, Mohamad MN, Jarrar AH, Ohuma EO, Ismail LC, Al Meqbaali FT, et al. A cross-sectional study of the prevalence of metabolic syndrome among young female Emirati adults. PLoS One. 2016. 11:e0159378. https://doi.org/10.1371/journal.pone.0159378

Al Mansour MA, Abdalla SM, Mohamed EY, Mahmoud WS, Alzahrani MK, Medani KE, et al. Prevalence and risk factors of metabolic syndrome (MetS) in primary health care centers' attendants in Majmaah, Saudi Arabia. Majmaah J Health Sci. 2016. 4:14-24.

Al-Nozha M, Al-Khadra A, Arafah MR, Al-Maatouq MA, Khalil MZ, Khan NB, et al. Metabolic syndrome in Saudi Arabia. Saudi Med J. 2005. 26:1918-1925.

Al-Rubeaan K, Bawazeer N, Al Farsi Y, Youssef AM, Al-Yahya AA, AlQumaidi H, et al. Prevalence of metabolic syndrome in Saudi Arabia—a cross sectional study. BMC Endocr Disord. 2018. 18:16. https://doi.org/10.1186/s12902-018-0244-4

Azadbakht L, Mirmiran P, Esmaillzadeh A, Azizi F. Dairy consumption is inversely associated with the prevalence of the metabolic syndrome in Tehranian adults. Am J Clin Nutr. 2005. 82:523-530.

Garralda-Del-Villar M, Carlos-Chillerón S, Diaz-Gutierrez J, Ruiz-Canela M, Gea A, Martínez-González MA, et al. Healthy lifestyle and incidence of metabolic syndrome in the SUN cohort. Nutrients. 2018. 11:65. https://doi.org/10.3390/nu11010065

Gosadi IM, Alatar AA, Otayf MM, AlJahani DM, Ghabbani HM, AlRajban WA, et al. Development of a Saudi food frequency questionnaire and testing its reliability and validity. Saudi Med J. 2017. 38:636-641.

Hoyas I, Leon-Sanz M. Nutritional challenges in metabolic syndrome. J Clin Med. 2019. 8:1301. https://doi.org/10.3390/jcm8091301

Lutsey PL, Steffen LM, Stevens J. Dietary intake and the development of the metabolic syndrome: the atherosclerosis risk in communities study. Circulation. 2008. 117:754-761.

McKeown NM, Troy LM, Jacques PF, Hoffmann U, O'Donnell CJ, Fox CS. Whole- and refined-grain intakes are differentially associated with abdominal visceral and subcutaneous adiposity in healthy adults: the Framingham heart study. Am J Clin Nutr. 2010. 92:1165-1171.

Ostovar R, Kiani F, Sayehmiri F, Yasemi M, Mohsenzadeh Y, Mohsenzadeh Y. Prevalence of metabolic syndrome in Iran: a meta-analysis. Electron Physician. 2017. 9:5402-5418.

Ramic E, Prasko S, Mujanovic OB, Gavran L. Metabolic syndrome—theory and practice. Mater Sociomed. 2016. 28:71-73.

Ranasinghe P, Mathangasinghe Y, Jayawardena R, Hills AP, Misra A. Prevalence and trends of metabolic syndrome among adults in the Asia-Pacific region: a systematic review. BMC Public Health. 2017. 17:101. https://doi.org/10.1186/s12889-017-4041-1

Shin S, Jee H. Prevalence of metabolic syndrome in the Gulf Cooperation Council countries: meta-analysis of cross-sectional studies. J Exerc Rehabil. 2020. 16:27-35.

Wang HH, Lee DK, Liu M, Portincasa P, Wang DQ. Novel insights into the pathogenesis and management of the metabolic syndrome. Pediatr Gastroenterol Hepatol Nutr. 2020. 23:189-230.