Breakfast consumption is inversely associated with metabolic syndrome in a sample of Iranian adults

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Abstract

Background: Central obesity, insulin resistance, dyslipidemia and hypertension are the core components of metabolic syndrome (MetS) which is coincident with unhealthy dietary habits in the Middle-Eastern countries. The aim of this study was to explore the association between dietary habits and metabolic syndrome of adult population living in Yazd Greater Area, Iran.

Methods: This is a cross-sectional study which uses the data of a population-based cohort study on Iranian adults, known as Yazd Health Study (YaHS). The relationship between dietary habits and metabolic syndrome among adults (n= 2896) were analyzed using multiple logistic regression method.

Results: Outcomes from logistic regression examining show that breakfast consumption has a significant inverse effect on the occurrence of metabolic syndrome after adjustment for age, education level, physical activity statue, history of chronic diseases and smoking (odds ratio (OR)= 0.38, 95% confidence interval (CI)= 0.14, 0.97). This effect remains significant even after adjustment for body mass index (BMI) and reveals that odds of having MetS is 69 % lower in breakfast consumers in contrast to non-consumers (OR=0.31, 95% CI= 0.11, 0.87). However, no significant relationship was observed between other dietary habits and MetS after adjustment for all potential confounders

Conclusions: This study revealed that eating breakfast has an inverse relationship with metabolic syndrome. Finding out stronger evidence in relation between dietary habits and metabolic syndrome, more researches especially population-based cohort studies are needed to be conducted.

Introduction

With increased risk of diabetes mellitus (DM) and cardiovascular disease (CVD), which are mostly derived from metabolic syndrome (MetS) [1], urgent strategies to prevent its global epidemic are demanded [2]. Central obesity, insulin resistance, dyslipidemia and hypertension are the core components of metabolic syndrome [3]. According to the international diabetes federation (IDF), the rapid increase of MetS has been estimated to be 20-25% globally [4] which is parallel to the growing rate of DM, hypertension, cardiovascular disease and obesity [2]. The prevalence of MetS in different studies varies, depending majorly on the used criteria of different definitions and their compositions (such as sex, age, race and ethnicity) [5]. For example results of recent systematic review and meta-analysis of studies revealed the overall estimation of MetS prevalence in Iran to be 36.9% based on the Adult Treatment Panel guidelines III (ATP III) criteria and 34.6 % according to IDF [6, 7]. However, regardless of the criteria used, it has been reported that the prevalence of metabolic syndrome around the world is rising drastically [8, 9].

Unhealthy diet and lifestyle are some of the risk factors contributed to MetS [10, 11]. Several studies have been conducted to explore the relationship between dietary habits and MetS [12-19]. It has been reported that dietary habits that are more westernized can increase the chances of MetS [19], whereas diets rich in fruits and vegetables [14] might have a reduction effect.

Considering what has been mentioned above, emerging evidence reveals that higher consumption of sugar sweetened beverages consist of energy-containing sweeteners such as sucrose, high fructose corn syrup or fruit-juice concentrates [20] is associated with increasing risks of MetS [21] not only in the US diet [22] but also, in developing countries such as India and China [23]. These findings also have been confirmed by a meta-analyses of cohort studies [24].

Moreover, studies suggests that consumption of out-of-home meals and energy dense fast foods [25] and snacks which contain highly processed meat, total fat (saturated and trans fatty acids) and refined carbohydrates [26] as well as sodium, can cause postprandial metabolic disorders such as dyslipidemia, subclinical inflammatory and oxidative stress and thereby increase occurrence of MetS [27] [28]. All of which lead to elevated fasting insulin levels and metabolic syndrome in adults [27]. In regard to breakfast habits and MetS, there are some controversial results. Skipping breakfast plays a key role in obesity and those who habitually do not consume breakfast are at higher risk for skipping other meals, snacking, having a sedentary lifestyle and being obese or overweight [29, 30]. Eating breakfast is associated with higher overall diet quality [31] and since it is satiating, it can reduce the total energy intake of the day and cause beneficial impact on improving metabolic parameters [32, 33]. On the contrary, a study suggested that skipping breakfast alone did not have any significant association with MetS prevalence [34].

In despite previous studies that have investigated metabolic syndrome's association with dietary habits, there are only a limited number of them conducted in the Middle-eastern countries where nutritional transition to westernized eating habits has caused an increase in the prevalence of overweight and obesity. This study aims to explore the dietary habits of adult population living in Yazd Greater Area in Iran.

Materials And Methods

Study population and data collection

Yazd Health Study (YaHS) recruitment phase data was used for this cross-sectional study. YaHS was initiated among the adult population living in Yazd Greater Area, with 10000 participants between the ages of 20-70 years old). Established in November 2014 and containing two phases, YaHS at first, randomly selected 200 clusters according to the city post codes. Then, the interviewers set up a meeting time with the residences at each of their assigned addresses. At last, as the interviewers visited the neighborhood of the first addressee based on the study protocol to fill in the questionnaire forms [35].In the present research, out of 3748 available cases with data on dietary intakes and main variables associated with metabolic syndrome, 2896 participants were considered according to exclusion criteria (including having a history of cardiovascular disease, diabetes and cancer).

Demographics data, anthropometrics (weight, height and waist circumference), socioeconomic status, education, physical activity, tobacco smoking and dietary habits in addition to biochemical assessments including; fasting blood glucose, triglyceride and HDL cholesterol levels were also carried out.

The present study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Science (IR.SSU.MEDICINE.REC.1395.287). Written informed consents were obtained from all the participants.

In general, all the required information on participants' dietary habits, anthropometric indices measurements, blood test results, blood pressure measurement and confounding factors consisting of socioeconomic status, history of chronic diseases and physical activity status, were extracted and merged from YaHS database [36].

Dietary Assessment

We aimed at obtaining accurate information on some dietary habits noted by participants via a questionnaire [36]. These items were as follows; i) sweetened drinks (fruit juices, artificially or homemade sweetened beverages) with frequency consumption of not at all, less than once per week, once or more per week, ii) fast foods consumption with frequency of not at all or few times per year, 1-3 times per months, once or more per week, iii) breakfast consumption as not at all in frequency, once per week or more than once per week , iv) sugar cubes with the serving intake of not at all, 1-2 cubes per day and more than 2 cubes per day.

Diagnosis of metabolic syndrome

National Cholesterol Education Program and Adult Treatment Panel III criteria (NCEP) present the definition of MetS in the current study [37-39]. To be diagnosed with at least 3 risk factors out of the five following cases, means a participant has metabolic syndrome if: i) Triglyceride (TG) above 150 mg/dl or consuming triglyceride lowering agents (hyperglyceride); ii) high density lipoprotein-cholesterol (HDL-C) level of less than 40 mg/dl in men and less than 50 mg/dl in women or any kind of pharmacological treatment; iii) Systolic blood pressure above 130 mmHg and diastolic blood pressure above 85 mmHg (hypertension); iv) Fasting blood glucose above 100 mg/dl or usage of pharmacological treatment as a control from blood sugar; and v) and waist circumference (WC) above 91.5 cm in men and 85.5 cm in women (adopted for only Iranian population) [40].

Evaluation of anthropometric indices

Weight was recorded with participants wearing lightweight clothing and no shoes using a digital scale (Model BF511, Omron Co. Karada Body Scan, Osaka, Japan) with the precision of 0.1 kg. A non-stretchable tape meter with the precision of 0.5 cm was used to measure height with lightweight clothing and no shoes and with their heels, hip, shoulder and head touching the wall. Body mass index (BMI; weight (kg) / height (m^2)) was calculated from measuring height and weight. Waist circumference was also measured by a tape in the horizontal plane midway between the iliac crest and the rib cage with the precision of 0.1 cm.

Blood pressure measurement

Systolic and diastolic blood pressures were measured in the sitting position by an automatic digital blood pressure monitor (Reister Germany). Each measurement was repeated for two times after every 5-minute interval.

Laboratory data

Data on serum level of fasting blood glucose (FBG) (mg / dl), total cholesterol, triglycerides, low density lipoprotein-cholesterol (LDL-C) and high density lipoprotein-cholesterol (HDL-C) were measured and collected. The equipment used in this study included a calibrated Ciba Corning auto-analyzer device (Ciba Corp., Basle, Switzerland (and Pars Azmoon company kits to asses fasting blood glucose and triglyceride after centrifuging and bionic kits as an analyzer for HDL cholesterol.

Physical activity assessment

For ascertainment physical activities the Iranian Short Version of International Physical Activity Questionnaire (IPAQ) was given to the participants [41, 42]. Physical activity levels of each participant were categorized as active and inactive based on the guideline of short form of IPAQ [43].

Statistical analysis

All statistical analyses were performed using SPSS version 24 (SPSS Inc., Chicago, IL, USA) and to show the qualitative variables, they went under a frequency and percentage discretionary. Multiple-logistic regression was used to examine the association between dietary habits and MetS. The lowest frequency or serving indicates a reference for all the models and adjustments of the confounding factors which are as follows: Age (20-29, 30-39, 40-49, 50-59, 60-69 years), educational level (secondary school and lower, high school, diploma and graduate diploma, bachelors, masters and PhD), history of chronic diseases (yes/no, including : hypertension, diabetes, cardiovascular disease, cancer, depression, dyslipidemia), smoking history (yes/no), physical activity level (inactive and active), and BMI (continuous).

Results

Table 1 shows the general characteristics of study population. A majority of participants (53.2%) as illustrated were females. Furthermore, a high percent of the participants (24.7%) were between ages of 40-49 years old and had secondary school or lower education (53.5%). The smoking status also demonstrates that a high percent of the volunteers did not smoke (90.0%) and were married (86.9%). Moreover, 51.8% of the participants were active on their physical activity statue.

The prevalence of the metabolic syndrome among the participants was 32.2% as demonstrated in table 2. Additionally, the plurality of the participants (38.6%) were overweight (BMI= 25-29.9). Moreover, 38.8 % met the criterion for hypertriglyceridemia (plasma TG higher than 150 mg/dl) and 29.3% had FBG higher that 100 mg/dl, while 65.8% had low levels of HDL-C (≤40 mg/dl in men and ≤50 mg/dl in women). Furthermore, abdominal obesity which is considered as waist circumference > 91.5 cm for men and 85.5

cm for women afflicted 65.1% of the study population. It was also found that 45.5% of the subjects suffered from high blood pressure (130/85).

Dietary habits among the participants have been presented in table 3. According to our findings, consumptions of sweetened drinks in 77.8% and sugar cubes in 88.5% of participants were as once or more than once per week. 60.6% of the subjects did not consume fast foods at all or few times per year. 93.8% of participants were also breakfast consumers.

Furthermore, after adjusting the confounders, results of the logistic regression examining the association among those who consume breakfast for once per week compared to those who completely skip breakfast shows a significant relationship with odds of metabolic syndrome, which means that these subjects have 62% lesser chance of MetS (odds ratio (OR)= 0.38, 95% confidence interval (CI)= 0.14 to 0.97). This effect remains significant even after adjustment for BMI and reveals that odds of MetS is 69 % lower in breakfast consumption as once per week in contrast to non-consumption (OR=0.31, 95 % CI= 0.11 to 0.87).

Nevertheless, no significant association has been witnessed between other dietary habits including consumption of sweetened drinks, sugar cubes, and fast foods with MetS after adjusting for potential confounders.

Discussion

In the current study, consumption of breakfast can significantly contribute to low chance of MetS. Conversely, consumptions of sweetened beverages, fast foods and sugar cubes have been shown to have non-significant impact on the occurrence of MetS. These relations between dietary habits and MetS were maintained after adjusting for potential cofounders such as age, education level; and physical activity level; history of chronic diseases; smoking and BMI.

Many studies suggest that eating breakfast can associate with an overall better diet quality and healthy lifestyle [44-46]. It has been also reported that individuals who eat breakfast frequently have a lower risk of an array of metabolic outcomes comparing to their peers who infrequently or never eat breakfast [47].

Furthermore, consistent to our outcomes, a few studies suggest no significant association between sweetened beverages consumption and higher risk of metabolic syndrome and its components [48-50]. A prospective study also, showed that sweetened drinks consumption was not associated with incident of metabolic syndrome in a middle-aged population [51]. This, however, is in contrast with several other studies that report sugar-sweetened drinks intake has significant effect on metabolic syndrome [52-54]. Sweetened beverages that were included in this study consist of artificially or homemade beverages. Sweetened beverages in Iran are usually of plant origin which contain beneficial compounds such as polyphenols which are inversely associate with MetS and its components [55]. This issue could be a source of contradiction in this study and others.

Additionally and following the same reasons we could not find any significant association between fast foods intake and metabolic syndrome however many studies suggest that regular fast foods consumption has irreparable effect on general health and can increase the risk of obesity, insulin resistance and other metabolic abnormalities [56-58]. There is not a definitive agreement on ‘fast foods’ definition [59]and differences in ingredients of the fast foods in the different studies could have caused discrepancies in the outcomes. Moreover, fast foods consumption in our study was generally low (most of the study population (60.6%) did not consume fast foods at all or the intakes were only few times per year.

Many studies suggest that breakfast intake is beneficial to metabolic health which is in the same line as our findings [60, 61]. This, as provided by a spectrum of research evidence could be for the reason that eating breakfast plays an important role in factors related to appetite and glucose, insulin and lipid metabolism [61-63]. It has been discussed in some studies that poor breakfast habits can be a part of unhealthy lifestyle which predicts metabolic syndrome [64].

On the contrary, controversial outcomes report that a recommendation to eat or skip breakfast may have no effect on body weight [65].

It has been reported that breakfast intake can potentially improve energy balance along with insulin and glucose level thus leading to satiety and lesser weight [66]. Breakfast consumers are also more likely to have better overall dietary quality along with following dietary recommendations more than non-consumers [67]. Obesity and high fasting glucose, the components of the metabolic syndrome and higher levels of total cholesterol (TC) and LDL-C are also evident after skipping breakfast completely compared to regular breakfast eaters [68]. According to a population-based cohort study, MetS prevalence grows with the continuation of omitting breakfast or poor breakfast habits [64].

This study contains a few limitations. First of all, the design of this study is cross-sectional which does not provide a liable source of causality. Second, the data on dietary assessments were based on self-reported questionnaires. And third, the impact of confounders could not be fully controlled due to unknown or unmeasured factors. Strength points suggest that this study investigates the impact of dietary habits on metabolic syndrome among a relatively large sample in a Middle Eastern country. A large extent of confounders that might affect the metabolic syndrome or its components have been also considered and controlled.

Conclusions

As a conclusion, this study provides evidence that there is in fact an inverse relationship between breakfast intake and metabolic syndrome. No significant association has been seen between other dietary habits and MetS. However, to find out stronger evidence in relation between dietary habits and metabolic syndrome, more studies especially population-based cohort researches need to be conducted.

List Of Abbreviations

MetS: metabolic syndrome; YaHS: Yazd Health Study; OR: odds ratio; CI: confidence interval; DM: diabetes mellitus; CVD: cardiovascular disease; IDF: international diabetes federation; ATP III: Adult Treatment Panel guidelines III; NCEP: National Cholesterol Education Program and Adult Treatment Panel III; HDL-C: high density lipoprotein-cholesterol; TG: Triglyceride; WC: waist circumference; BMI: Body mass index; FBG: fasting blood glucose; LDL-C: low density lipoprotein-cholesterol; IPAQ: International Physical Activity Questionnaire; TC: total cholesterol

Declarations

Ethics approval and consent to participate

The present research was approved by the Ethics Committee of Shahid Sadoughi University of Medical Science (IR.SSU.MEDICINE.REC.1395.287). Written informed consents were obtained from all the participants.

Consent for publication

Not applicable

Availability of data and material

None

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

1. M and M. H designed the study.

2. S. S and M. H conducted the statistical analysis.
3. S. S and E. L wrote the draft of manuscript.
4. M and M. H critically revised the manuscript and confirmed the final version of it to submit.

All authors read and approved the final version of manuscript.

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Tables

Table 1. Distribution of all participants according to general characteristics.

Variables	Total (n=2896) N (%)
Sex	
Male	1352 (46.8%)
Female	1534 (53.2%)
Age (years)	
20-29	541 (18.8%)
30-39	639 (22.2%)
40-49	713 (24.7%)
50-59	560 (19.4%)
60-69	429 (14.9%)
Education level	
Secondary school and lower	1534 (53.5%)
Diploma and Graduate diploma	877 (30.6%)
Bachelors	389 (13.6%)
Masters and PhD	66 (2.3%)
Smoking	
Yes	185 (6.6%)
Sometimes	55 (2.0%)
Quit	43 (1.5%)
No	2533 (90.0%)
Marital status	
Married	2505 (86.9%)
Single	274 (9.5%)
Widowed	89 (3.1%)
Divorced	15 (0.5%)
Physical activity	1396 (48.2%)
Inactive	1500 (51.8%)
Active	

Table 2. Distribution of participants according to metabolic syndrome (MetS) and its components.

Variables	Total (n=2896) N (%)
BMI (kg/m^2)	
Low weight (<18.5)	80 (2.9%)
Normal (18.5-24.9)	863 (31.3%)
Overweight (25-29.9)	1062 (38.6%)
Obesity (30-39.9)	671 (24.4%)
Extreme Obesity (≥40)	77 (2.8%)
Triglyceride status (mg/dl)	
Lower than 150	1768 (61.2%)
Equal to or higher than 150	1119 (38.8%)
Fasting Plasma glucose status (mg/dl)	
Lower than 100	2044 (70.7%)
Equal to or higher than 100	849 (29.3%)
Waist Circumference status (cm)	
91.5 for men and 85.5 for women	1001 (34.9.%)
91.5 for men and 85.5 for women	1870 (65.1%)
HDL status (mg/dl)	
40 for men and 50 for women	1900 (65.8%)
40 for men and 50 for women	986 (34.2%)
Hypertension status (mmHg)	
No	1571 (54.5%)
Yes	1312 (45.5%)
MetS	
No	1940 (67.8%)
Yes	920 (32.2%)

Table 3. Distribution of participants according to dietary habits.

*Dietary habits	Total (n=2896) N (%)
Sweetened drinks	
Not at all	632 (22.1%)
Lower than once per week	970 (33.9%)
Once or more per week	1256 (43.9%)
Fast foods	
Not at all or few times per year	1746 (60.6%)
1-3 times per month	867 (30.1%)
Once or more per week	268 (9.3%)
Breakfast	
Not at all	94 (3.3%)
Once per week	84 (2.9%)
More than once per week	2697 (93.8%)
2Sugar cubes	
Not at all	331 (11.5%)
1-2 cubes per day	672 (23.3%)
More than 2 cubes per day	1877 (65.2%)

* Dietary habits for all items were presented as frequency of consumption except for sugar cubes which presented as serving of intake.

Table 4. Multivariable-adjusted odds ratios (95% CI) for metabolic syndrome across different frequencies or servings for various dietary habits in a sample of Iranian adults.

[1] Dietary habits	Metabolic Syndrom			
	[2] Multivariable adjusted		[3] Multivariable + BMI	
	OR	95% CI	OR	95% CI
Sweetened drinks				
Not at all	Reference		Reference	
Lower than once per week	0.93	0.71-1.22	0.97	0.74-1.28
Once or more per week	0.98	0.76-1.27	1.07	0.82-1.40
Fast foods				
Not at all or few times per year	Reference		Reference	
1-3 times per month	1.02	0.81-1.28	0.93	0.73-1.18
Once or more per week	0.92	0.62-1.36	0.88	0.58-1.31
Breakfast				
Not at all	Reference		Reference	
Once per week	0.38*	0.14-0.97*	0.31*	0.11-0.87*
More than once per week	0.74	0.40-1.37	0.36	0.36-1.32
Sugar cubes				
Not at all	Reference		Reference	
1-2 cubes per day	1.01	0.71-1.45	1.03	0.71-1.49
More than 2 cubes per day	1.05	0.76-1.45	1.09	0.78-1.52

[1] Dietary habits for all items were presented as frequency of consumption except for sugar cubes which presented as serving of intake.

[2] Adjusted for age (20-29, 30-39, 40-49, 50-59, 60-69 years), education level (Secondary school and lower, High school, Diploma and Graduate diploma, Bachelors, Masters and PhD), physical activity level (active and inactive), history of chronic diseases (hypertension, diabetes, cardiovascular disease, cancer, depression and dyslipidemia), smoking (yes/no).

[3] Adjusted for age (20-29, 30-39, 40-49, 50-59, 60-69 years), education level (Secondary school and lower, High school, Diploma and Graduate diploma, Bachelors, Masters and PhD), physical activity level (active and inactive), history of chronic diseases (hypertension, diabetes, cardiovascular disease, cancer, depression, and dyslipidemia), smoking (yes/no) and BMI.

*Significance level was considered as $p<0.05$.