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ORIGINAL ARTICLE

The Association between Macronutrient Quality Index and Global Dietary Quality Score with Metabolic Syndrome among Iranian Male Staff Population

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ABSTRACT

Background: Diet quality indices such as Global Dietary Quality Score (GDQS) and Macronutrient Quality Index (MQI) have been suggested to be linked to non-communicable diseases. However, they are rarely studied in relation to metabolic syndrome (MetS). Thus, we aimed to investigate the association between GDQS and MQI with MetS among Iranian male staff.

Methods: Four-hundred male personnels aged ≥18 years old were enrolled in this cross-sectional study. The GDQS and MQI were calculated using the measures of a vlidated 168-item food frequency questionaire (FFQ). In addition, by measuring waist circumference (WC), fasting blood sugar (FBS), blood pressure (BP), high density lipoprotein choldesterol (HDL-C), and triglyceride (TG).

Results: The prevalence of MetS was 20.3%. In addition, the MQI was inversly and significantly associated with the risk of having high TG in the adjusted model. However, no significant correlations were seen between MQI and MetS, FBS, WC, HDL-C, and BP. Moreover, in the adjusted model, the GDQS was negatively and significantly associated with the risk of low HDL-C. No significant association was observed between GDQS and MetS, FBS, WC, TG, and BP.

Conclusion: The GDQS and MQI were not correlated with the risk of MetS. A higher diet quality measured by GDQS and MQI can be inversely associated with the risk of dyslipidemia as a major component of MetS.

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Introduction

Metabolic syndrome (MetS) is defined by having at least three components of impaired glucose metabolism, low level of high-density lipoprotein cholesterol, elevated blood pressure, hypertriglyceridemia and central obesity based on the International Diabetes Federation and the American Heart Association definitions (1, 2). This disorder has attracted the attention of many researchers due to its relationship with diabetes and cardiovascular diseases (3). According to the Framingham study, MetS alone accounts for 25% of new cardiovascular disease (CVD) cases (4). Available evidence has estimated that the prevalence of the MetS is up to 33% in Iran (5).

The effectiveness of dietary modifications in the prevention and treatment of MetS has been described before (6). Modification in proportion of macronutrients and adherence to high-quality diets are recommended in the management of MetS (7). Dietary quality indices are extensively employed to assess the correlation between overall dietary habits and the risk factors associated with chronic diseases. Global dietary quality score (GDQS) is a new diet quality assessment method to evaluate both under and over-nutrition (8)wal. In summary, the GDQS is a nutrition-based measure assessing the quality of diet based on a comprehensive list of healthy and unhealthy food group intakes (9)ÿÿÿ. Previous findings suggest an inverse association between GDQS and diet indicating a higher diet quality with cardio-metabolic outcomes including CVDs, diabetes mellitus (DM), body mass index (BMI), body fat, diastolic blood pressure, abdominal obesity, high density lipoprotein choldesterol (HDL-C) and low density lipoprotein choldesterol (LDL-C) (10, 11).

Macronutrient quality index (MQI) encompasses three sub-indices that each carries equal weight and represents the macronutrient classes of proteins, carbohydrates, and fats (12). To our knowledge, there is no available study on the correlation between MQI and MetS. Limited researches found controversial relationships between MQI sub-indices and the risk of MetS (13-15). Higher diet quality characterized by consuming higher nutrient-dense food groups such as whole grains, fruits, legumes, low-fat dairy products, nuts and vegetables, in addition to a lower intake of saturated fatty acids (SFAs), trans fatty acids (TFAs), sugars, processed and refined carbohydrates was shown to be related to a lower risk of cardio-metabolic diseases; particularly MetS (16-19). However, the effectiveness of some dietary quality indices including the Dietary Approaches to Stop Hypertension (DASH) and the Mediterranean Diet in the management of MetS are widely established (19, 20), but there are inadequate studies to investigate the relationship between MQI and GDQS with the risk of MetS or its components. Hence, we aimed to assess the correlation of MQI and GDQS with the risk of MetS or its components among Iranian male staff.

Materials and Methods

This cross-sectional study was conducted among 400 healthy male staff aged ≥18 years old. The participants were recruited from various office centers between September 2020 and January 2022 using a cluster sampling method in Tehran, Iran. The data was obtained from a previous research to determine the sample size as explained by Parastouei *et al.* (21) utilizing the Peduzzi approach [n=10×k/P]; where the K represents the number of indeoendant variables and P is the prevalence of the outcome. Considering 4 dietary patterns as the independent variables and deprression with the prevalence of 16% as the main outcome in the mentioned study, the minimum sample size was calculated to be 250 participants. Regarding the availibility of target population, a totalof 400 participants were included in the study.

Participants were included if they were a male staff aged 18 years or older. Exclusion criteria were any history of psychological disease, taking psychiatric medication, eating disorders, malignancies, kidney and liver failure, colitis, adrenal diseases, CVDs, and thyroid and parathyroid diseases. Those with daily energy intake lower than 800 or higher than 4,000 Kcal were excluded. An informed consent was obtained from all participants. In addition, characteristics of participants such as age, past medical history, drug history, and smoking status were asked using a demographic questionnaire. Moreover, physical activity was assessed by using the 7-item International Physical Activity Questionnaire (IPAQ) (22). This present study was approved by the the Medical Ethics Committee of the Baqiyatallah University of Medical Science, Tehran, Iran (IR. BMSU.REC.459).

Standard protocols were used to measure anthropometric variables including weight, height, BMI, and waist circumference (WC) (21). A total of 10 mL venous blood sample was collected from each participant and stored at -18°C for further analysis. Serum triglyceride (TG), HDL-C, and fasting blood sugar (FBS) were assessed by using standard commercial kits (Pars Azmoon Inc., Iran). In addition, systolic and diastolic blood pressures were measured using a calibrated sphygmomanometer after a 15-minute sitting position. The participants were diagnosed with MetS according to The National Cholesterol Education Program's Adult Treatment Panel III report (ATP III) (23).

Dietary intakes were collected using a validated semi-quantitive 168-item food frequency questionaire (FFQ) (24). The FFQ was consisted of 9 general food groups of dairy, meat and fish, eggs, fruits, vegetables, legumes and cereals, oils and fats, pastries, beverages, and miscellaneous foods. Standard portion size and frequency of intake from "never or almost never" to "more than 6 times a day" were recorded for each food item. Food ingredients such as food groups, macronutrients, and micronutrients were extracted using NUTRITIONIST IV software (version 7.0; N-Squared Computing, Salem, OR, USA).

MQI consists of 3 variables including Carbohydrate Quality Index (CQI), Healthy Plate Protein source Quality Index (HPPQI), and Fat Quality Index (FQI). The CQI is calculated based on 4 domains of Glycemic Index (GI), ratio of whole grains to total cereals, intake of total dietary fiber, and ratio of solid to total carbohydrate. HPPQI was calculated as the ratio of healthy protein sources including nuts, pulses, poultry, and seafood to unhealthy proteins (red meat, cheese, and processed meat). In addition, FQI was determined using the formula of (monounsaturated fatty acids: MUFAs+polyunsaturated fatty acids: PUFAs)/(SFAs+TFAs). For each index, participants were categorized into quintiles with values ranging from 1 to 5. The MQI score was calculated as the sum of three values of all indices, ranging from 3 (the lowest quality) to 15 (the highest quality) (25).

GDQS as another valid food-based dietary quality measure constisted of 25 food items including 16 healthy food groups, 7 unhealthy food groups, and 2 food groups (high-fat dairy product and red meat) that are considered unhealthy when consumed in excess. A higher intake of healthy food group and a lower intake of unhealthy food group represent a higher quality diet. Up to a particular treshold, increased consumption of red meat and high-fat diary products could increase the GDQS, however, upper quantities could decrease the point of GDQS. Thus, the total GDQS ranged from 0 to 49. The GDQS can also be categorized into GDQS+(costisted of 16 healthy food groups with a possible score from 0 to 32) and GDQS− (included 7 unhealthy food groups, high-fat dairy, and red meat ranging from 0 to 17) (26, 27).

The normality of the variables was assessed using Kolmogrov-Smirnov test. In addition, values were presented as mean±standard deviation (SD), median (interquartile range), or frequency (%). Differences between healthy participants and those with MetS were evaluated using independent sample t-test for normal values, Mann-Whitney for non-normal parameters, and Chi-Square for qualitative variables. Binary logistic regression was used

Table 1: Baseline characteristic of participants in relation to metabolic syndrome.

Variable	Metabolic syndrome		Total population	*P* value
	No (n=319)	Yes (n=81)	(n=400)	
Demographic				
Age[1,a] (years)	38.0 (35.0,42.0)	37.0 (34.0, 42.0)	38.0 (35.0-42.0)	0.181
Weight[1,a] (kg)	77.0 (70.0,84.0)	80.0 (74.5, 86.0)	78.0 (70.0-85.0)	0.023
Height[1,a] (cm)	177.0 (172.0,182.0)	175.0 (170.5, 180.0)	177.0 (172.0-181.0)	0.051
Physical activity[2,b]				0.664
Low	66 (20.7)	15 (18.5)	81 (20.2)	
Moderate/high	253 (79.3)	66 (81.5)	319 (79.8)	
Smoking[2,b]				0.757
No	306 (95.9)	77 (95.1)	383 (95.7)	
Yes	13 (4.1)	4 (4.9)	17 (4.3)	
Drug use[2,b]				0.763
No	239 (74.9)	62 (76.5)	301 (75.2)	
Yes	80 (25.1)	19 (23.5)	99 (24.8)	
Disease history[2,b]				0.852
No	245 (76.8)	63 (77.8)	308 (77.0)	
Yes	74 (23.2)	18 (22.2)	92 (23.0)	
Anthropometric and metabolic profile				
BMI[3,c] (kg/m[2)]	25.0±3.1	26.3±3.4	25.3±3.2	0.001
WC[1,a] (cm)	94.0 (86.0-96.0)	96.0 (89.0-102.0)	86.0 (94.0-98.0)	<0.001
HDL[3,c] (mg/dL)	44.1±6.8	38.7±6.0	43.0±7.0	<0.001
TG[1,a] (mg/dL)	373.4 (284.6, 548.3)	381.8 (265.9, 608)	147.0 (135.0-160.0)	<0.001
SBP[1,a] (mmHg)	120 (120, 125)	130 (120, 130)	120.0 (120.0-130.0)	<0.001
DBP[1,a] (mmHg)	80 (70, 80)	80 (80, 90)	70.0 (80.0-80.0)	<0.001
FBS[1,a] (mg/dL)	117 (108.6, 125.6)	120.1 (114.5,129.5)	117.6 (110.4-126.3)	0.005

BMI: Body mass index; WC: Waist circumference; HDL: High-density lipoprotein; TG: Triglyceride; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; FBS: Fasting blood sugar; SFA: Saturated fatty acids; MUFA: Mono-unsaturated fatty acids; PUFA, poly-unsaturated fatty acids. Values are presented as mean±SD or median (IQR) for continuous and percentage for categorical variables. [a]Values are presented as median (IQR), [b]values are peresented as frequency (percentage), [c]Values are presented as mean±SD, [1]Using Mann-Whiteny u-test for continuous variables. [2]Using chi-square tests for categorical variables. [3]Using independent sample t-test for continuous variables. A $p<0.05$ was considered as the significance level.

to assess the correlation between MQI or GDQS and the risk of MetS or its components, adjusted for covariates with $p<0.2$ and clinically important factors. The final results were reported as odds ratios (ORs) and confidence interwals (CIs) regarding the statistical significance level of 0.05. All analyses were performed using SPSS software (version 26.0, (SPSS Inc., Chicago, IL, USA).

Results

Totally, 400 male staff with the median age of 38.0 (Range: 35.0-42.0) were recruited. The prevalence of MetS was about 20.3% in men staff population (81 out of 400 participants). Baseline characteristic of participants including demographic, anthropometric, and metabolic factors were shown in Table 1. Participants with MetS had significantly higher body weight ($p=0.023$), BMI ($p=0.001$), WC ($p<0.001$), TG ($p<0.001$), and FBS ($p=0.005$). However, the MetS group had significant lower level of HDL compared to healthy population ($p<0.001$). In addition. No significant differences were observed in relation to age, height, physical activity, smoking status, drug use, and disease history between the two groups.

The result of the intake of macronutrients and food groups were represented in Table 2. The analyses showed that the intake of fish and shellfish, deep orange vegetables, and green leafy vegetables were significantly higher in healthy group when compared to participants with MetS (p=040; $p=0.002$; and $p=0.039$, respectively). While, there were no significant differences between the 2 groups regarding other food parameters. Table 3

Table 2: Nutrients intake of participants in relation to metabolic syndrome.

Variable	Metabolic syndrome		*P* value*
	No (n=319)	Yes (n=81)	
Energy (Kcal)	2028.6 (1544.6, 2873.6)	2031.7 (1430.9, 2516.4)	0.501
Protein (g/d)	72.9 (53.4, 103.4)	69.6 (50.7, 94.9)	0.351
Carbohydrate (g/d)	295.6 (216.9, 434.5)	281.5 (194.2, 388.1)	0.371
Total fat (g/d)	71.8 (53.2, 100.5)	74.6 (49.0, 96.2)	0.806
Cholesterol (mg/d)	373.4 (284.6, 548.3)	381.8 (265.9, 608)	0.828
SFA (g/d)	22.1 (16.1, 33.4)	23.0 (15.1, 32.7)	0.938
MUFA (g/d)	23.6 (17.1, 33.8)	23.2 (16.1, 33.5)	0.917
PUFA (g/d)	13.2 (9.2, 19.8)	12.1 (8.8, 20.3)	0.939
Citrus fruits (g/d)	15.6 (5.6. 35.9)	124.3 (71.5, 234.3)	0.610
Deep orange fruits (g/d)	13.9 (7.5, 30)	201.6 (139.9, 327.1)	0.946
Other fruits (g/d)	176.9 (109.9, 350.4)	167.9 (101, 312)	0.354
Dark green leafy vegetables (g/d)	63.2 (37.2, 116.3)	52 (33.4, 86.6)	0.040
Cruciferous vegetables (g/d)	129.9 (74.1, 238.5)	15.6 (5.6, 22.6)	0.571
Deep orange vegetables (g/d)	13.9 (7.5, 30)	7.5 (7.5, 23.6)	0.002
Other vegetables (g/d)	146 (88.5, 243)	133.3 (89.9, 193.2)	0.464
Legumes (g/d)	12.5 (9.3, 20.3)	12.4 (9.8, 19.7)	0.667
Deep orange tubers (g/d)	17.9 (4.5, 21.4)	12.5 (4.5, 17.9)	0.624
Nuts and seeds (g/d)	19.2 (9.6, 38.4)	19.9 (16.1, 30.3)	0.254
Whole grains (g/d)	1.1 (1.1, 4.3)	1.1 (1.1, 3.5)	0.149
Liquid oils (g/d)	2.6 (1.1, 6.2)	3.4 (1.1, 5.6)	0.570
Fish and shellfish (g/d)	7.0 (3.8, 15)	3.8 (3.8, 11.8)	0.039
Poultry game meats (g/d)	8.6 (5.4, 17.2)	8.6 (5.4, 17.2)	0.632
Low fat dairy (g/d)	185.5 (85.7, 358.2)	175.5 (107.4, 355.7)	0.657
Eggs (g/d)	8.6 (8.6, 25.7)	25.7 (8.6, 25.7)	0.095
High fat dairy (g/d)	73.6 (39.6, 140)	73.9 (31.1, 151.6)	0.891
Red meat (g/d)	36.2 (26, 64.6)	34.6 (24.1, 54)	0.276
Processed meat (g/d)	6.3 (4.1, 13.6)	4.1 (4.1, 10.3)	0.103
Refined grains and baked goods (g/d)	176.5 (127, 257)	191.5 (141.5, 245.9)	0.435
Sweets and ice cream (g/d)	67.6 (45.2, 104.7)	59.9 (42.7, 102.4)	0.487
Sugar sweetened beverages (g/d)	44.8 (35.7, 116.3)	44.8 (19.6, 116.3)	0.582
Juices (g/d)	62.5 (35.7, 142.8)	35.7 (35.7, 142.8)	0.975
White root tubers (g/d)	12.9 (12,9, 38.6)	12.9 (12.9, 38.6)	0.846
Fried foods (g/d)	17.1 (5.7, 18.6)	17.1 (5.7, 18.6)	0.978

SFA: Saturated fatty acids; MUFA: Mono-unsaturated fatty acids; PUFA: Poly-unsaturated fatty acids. Values are presented as median (IQR). *Using Mann-Whiteny u-test for continuous variables. A $p<0.05$ was considered as the significance level.

Table 3: Diet quality components of study participants in relation to metabolic syndrome.

Variable	Metabolic syndrome		*P* value
	No (n=319)	Yes (n=81)	
GDQS healthy[1a]	17.8 (14.8, 20.5)	17.8 (15.5, 20.4)	0.940
GDQS unhealthy[1a]	9 (8, 11)	9 (8, 11)	0.605
GDQS total[2b]	26.7±4.1	26.7±3.8	0.945
Total.GI[1a]	51.7 (49, 55)	52.1 (48.8, 54.6)	0.831
Dietary fiber[1] (g/d)	0.02 (0.01, 0.03)	0.01 (0.01, 0.03)	0.753
Solid/total carbohydrate[1a]	0.91 (0.88, 0.94)	0.91 (0.85, 0.94)	0.310
Whole grain/total grain[1a]	0.18 (0.10, 0.29)	0.17 (0.09, 0.26)	0.479
HPPQI[1a]	1.6 (1.1, 2.2)	1.6 (1.1, 2.4)	0.641
FQI[1a]	1.6 (1.4, 1.9)	1.6 (1.4, 1.8)	0.357
CQI[1a]	12.0 (10.0, 14.0)	10.0 (8.0, 13.0)	0.005
MQI[1a]	9.0 (7.0, 11.0)	8.0 (7.0, 10.0)	0.031

GDQS: Global diet quality score; GI: Glycemic index; HPPQI: healthy plate protein quality index; FQI: Fat quality index; CQI: Carbohydrate quality index; MQI: Macronutrient quality index. Values are mean (SD) or median (IQR) for continuous and percentage for categorical variables. [a]Values are presented as median (IQR); [b]Values are presented as mean±SD. [1]Using Mann-Whiteny u-test for continuous variables. [2]Using independent sample t-test for continuous variables. A $p<0.05$ was considered as the significance level.

shows the result of the MQI, DGQS, and their components among healthy population and MetS group. Although, no significant differences were observed in DGQS and its components, CQI and MQI were significantly lower in patients with MetS compared to healthy participants (p=0.005; p=0.031, respectively).

The association between MQI and DGQS with MetS or its components were shown in Table 4. The adjusted model demonstrated that any point increase in the MQI was associated with nearly 13% increase in the risk of having high TG (OR=0.866, CI=0.774-0.970, p=0.013). Additionally, every unit elevation in the GDQS was correlated with about 8% increase in the risk of having a low HDL-C (OR=0.924, CI= 0.875-0.975, p=0.004). No significant correlation was seen between MQI or GDQS with the risk of MetS, FBS, WC, and BP.

Discussion

MetS is among the greatest health-related concerns globally. Lifestyle modifications particularly dietary approaches has been a key component in the management of MetS for a long time. The result of the current study showed that the prevalence of MetS among men staff is about 20%. In addition, the

Table 4: Association between MQI and GDQS with the risk of metabolic syndrome and its components in a multivariate analysis.

Variable	High BP		High WC		High FBS		High TG		Low HDL		MetS	
	OR (CI 95%)	*P* value	OR (CI 95%)	*P* value	OR (CI 95%)	*P* value	OR (CI 95%)	*P* value	OR (CI 95%)	*P* value	OR (CI 95%)	*P* value
MQI												
Crude	1.006 (0.932-1.086	0.876	0.935 (0.838-1.043)	0.229	1.021 (0.938-1.112)	0.624	0.867 (0.779-0.965)	0.009	0.993 (0.920-1.073)	0.866	0.925 (0.843-1.015)	0.098
Adjusted	1.001 (0.926-1.083)	0.974	0.936 (0.830-1.056)	0.284	1.014 (0.930-1.106)	0.752)	0.866 (0.774-0.970)	0.013	0.993 (0.918-1.074)	0.853	0.918 (0.834-1.011)	0.083
GDQS												
Crude	1.042 (0.989-1.0.98)	0.118	1.044 (0.970-1.123)	0.254	1.009 (0.953-1.067)	0.770	0.974 (0.909-1.043)	0.444	0.931 (0.883-0.981)	0.008	1.002 (0.943-1.065)	0.945
Adjusted	0.984 (0.945-1.025)	0.441	0.953 (0.893-1.018)	0.154	1.000 (0.956-1.045)	0.983	0.988 (0.934-1.045)	0.668	0.924 (0.875-0.975)	0.004	0.985 (0.937-1.035)	0.554

BP: Blood pressure; WC: Waist circumference; FBS: Fasting blood sugar; TG: Triglyceride; HDL: High-density lipoprotein; OR: Odds ratio; CI: Confident interval; GDQS: Global diet quality score; MQI: Macronutrient quality index. Obtained from logistic regression. Adjusted for energy intake, age, BMI, smoking, physical activity, drug use, and disease history. The $p<0.05$ was considered as the significance level.

CQI and MQI were significantly higher in healthy participants compared to those with MetS. Moreover, higher diet quality based on MQI was associated with the lower risk of having hypertriglyceridemia. Another significant finding was that the GDQS was positively associated with HDL-C. However, no significant corellation was observed between GDQS or MQI and the risk of MetS.

The result of the present study showed no significant correlation between GDQS with the MetS, FBS, WC, TG, and BP. In an inconsistant cohort study conducted to assess GDQS (measured through a 3-day food recall) in relation to nutrient inadequacy and MetS among chinese population, the findings showed that GDQS was negatively asscoiated with MetS and nutrient inadequacy (28). In addition, a cross-sectional study on Thai males and females revealed that application-based GDQS which collected 24-h food recalls of the particpants, was possitively associated with HDL-C and 24-h urinary potassium in contrast to inverse correlation between GDQS and BMI, body fat percentage, diastolic blood pressure, high midupper arm circumference, abdominal obesity, and sodium intake score. Thus, GDQS apps efficiently evaluated metabolic risk factor among healthy population (10).

It should be addressed that both inconstent studies dietary intake were collected through food recalls, while in the present study FFQ was used. Regarding the non-significant correlation between GDQS and the risk of MetS, it is worthy to show that the overall diet quality is certainly important in the managenment of MetS, while other contributers such as particular micronutrient deficiencies and lifestyle-related factors may notably affect the development of MetS. However, this study failed to find association between the GDQS and MetS, and the GDQS was inversly correlated with the risk of low HDL-C. Indeed, a higher diet quality was assumed to be correlated with an increased HDL-C level. Potential underlying link might be that high-quality dietary patterns emphasize the consumption of nuts, seeds, and fish, as well as, limitation of processed food which can lead to an increase in HDL-C due to the augmented intake of PUFAs besides restricted sources of TFAs (29, 30).

The result of the current study revealed that the MQI was associated with lower likelihood of having hypertriglyceridemia. This might be explained by a significant higher CQI in healthy population when compared to MetS group. A higher CQI reflects consuming a low glycemic diet rich in dietary fiber from whole grains, fruits, vegetables, and legumes. Satiating effects of dietary fiber results in lower energy intake,body fat accumulation, and subsequent insulin resistance. Inulin resistance per se is contributed to hyperglycemia through elevated hepatic production of TG (31).

To the best of our knowledge, there is no study investigating the association between MQI and MetS; however there are limited studies in relation to MQI sub-indices and MetS or its components. A previous study revealed disparent results in a correlation between CQI and MetS. For instance, Suara et al. illustrated an inverse association between CQI and WC, systolic and diastolic blood pressures, TG and odds of MetS, as well as, a direct association between HDL-C and CQI in a case-control study among type 2 DM patients (32). One plausible explanation for the contarary findings might be due to the different target population in two studies as DM is along with insulin resistance which leads to glycemic intolerance, obesity and dyslipidemia known as MetS constituents. However, in a cross-sectional study among Iranian adults, no significant relationship was seen between CQI and MetS or its components (14).

Whole grains:total grains ratio was not considered in the CQI measurement; while we failed to find correlation between MQI and the risk of MetS. Healthy population had significantly higher MQI and CQI in comparison with MetS group suggesting a possible causative relationshship between MQI or CQI and MetS. The associations between CQI domains inclusing dietary fiber, whole grain, solid carbohydrates, and low GI carbohdrate intake have been widely studied. For instance, meta-analyses strongly support the negative correlation between dietary fiber intake and the odds of MetS (33, 34). Higher fiber intake is assumed to be related to a more efficient glycemic hemoestasis. In most studies assessing the coorelations beteen macronutirnet quality indices and MetS, the risk of MetS has been investigated in relation to dietary fibers, glycemic index, whole grains or refined grains, PUFAs, and SFAs (33, 35-38). Thus, the associaion between MQI and MetS needs further researches to be elucidated.

These study had some limitations. First, cross-sectional studies can not explore the cuasative association between dietary score and the risk of disease development; as well as cohort studies and clinical trials. Second, even an standard validated FFQ has been used in the current study that is memory-dependant, so food frequency questionaire might lead to bias. Third, due to socioeconomic, cultural and dietary patterns and diversity among nations, the result of the current study can not be generalized to the other societies. In contrast, evaluation of MQI and GDQS can help investigate the correlation between diet quality and MetS more accurately. In addition, current researches have proved that healthy dietary patterns instead of single-nutrient recommendations to have more advantages (20). Moreover, correlation analyses have been performed after adjustment for potential covariates.

Conclusion

The finding of the current study highlighted the protective effects of MQI and GDQS that represent high-quality dietary patterns against dyslipidemia to be a major component in development of MetS. However, we failed to find significant correlation between MQI or GDQS and the risk of MetS. Prospective cohort studies and clinical trials are suggested to clarify the association between MQI or GDQS and MetS and to investigate the underlying mechanisms, in advance.

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Authors' Contribution

S.B: Writing – original draft, investigation, Validation. M.T: Formal analysis, Methodology. H.R: Project administration, Supervision, Writing – review and editing.

Conflict of Interest

None declared.

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