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Dietary Approach And Its Relationship With Metabolic Syndrome Components

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Abstract : Metabolic syndrome is a constellation of conditions that increases a risk of diabetes and cardiovascular disease. The objective of this study is to investigate the association between dietary behaviour and the prevalence of metabolic syndrome (MS), and/or its components among female teachers living in cities and villages in Al-Ahssa region, Saudi Arabia. Six hundreds of female teachers, aged 30–55 years, were recruited at random from among different primary schools living in cities and villages in the Al-Hassa region, Saudi Arabia. Each participating subject submitted a general questionnaire containing demographic and medical history, as well as a food frequency questionnaire. Anthropometric and systolic and diastolic blood pressure was carried out. The prevalence of MS among the study sample, in accordance with AHA/NHLBI and ESC/ESH criteria, was 28% and 24% respectively, and increased significantly with the increase in age ($P<0.05$). There was a significant association between the prevalence of MS and obesity, diabetes and high blood pressure (BP) ($P\leq0.05$). It showed that a significant association between soft drinks and the appearance of the remaining indicators of MS. We found that waist circumference (WC) was ranked first (27%), followed by low HDL-C, (21.3%; $P\leq0.05$), high BP (19%), high fasting blood glucose (FG) (18.3%) and high triglycerides (TG) (12%) respectively, in accordance with AHA/NHLBI. By the definition of ESC/ESH, WC was ranked first (22.6%; $P\leq0.05$); high BP was ranked second (17%); after that came high FG (16.6%), low HDL-C (14.6%) and high TG (116%) respectively. In regarding to the prevalence of MS, there is no significance difference of females living in cities and village. This study indicated that the prevalence of MS has increased significantly with the increase in age among the study sample. Healthful dietary patterns were associated with a reduced risk for MS in Saudi women at middle age.
Key Words: Metabolic syndrome, lipid profiles, nutrition behavior, serum glucose and middle age.

Introduction

Metabolic syndrome is becoming highly prevalent in many populations worldwide.[1] It is a cluster of metabolic risk factors associated with increased risks of cardiovascular diseases and type II diabetes[2,3]. The components of MS include abdominal obesity, hyperglycaemia, hypertension, and dyslipidemia (>TG, > low density lipoprotein (LDL-C), <HDL-C). This syndrome predicts the development of type II diabetes and CVD [4], and all-cause mortality[5].

There are several working definitions for MS proposed by the World Health Organization, the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATPIII), the European Group for the Study of Insulin Resistance (EGIR), and the International Diabetes Federation (IDF) [6]. There are different definitions, which leads to the difficulty of comparing data from all over the world, and between the different sectors of the population [7]. However, the NCEP & IDF descriptions of MS are among the most appropriate tools on clinical and epidemiological practices[8].

Published studies all over the world indicate that the prevalence MS is limited. Among Arab populations, epidemiological studies about MS have not been widely conducted, but the available data indicate that there is an increase to a common problem[9-14] .

The prevalence of MS is 39% in the Kingdom of Saudi Arabia(KSA) [15], 37.6% in the United Arab Emirates (UAE)[16] and appears to be increasing around the world, probably as a result of increasing obesity rates and sedentary lifestyles[17]. In regardless to the region, several studies confirm an equally alarming prevalence of MS among Arab population[18,19]. No study has been carried out on a large-scale to determine the extent of MS in a community based setting including learn, apparently healthy females. Many studies show a clear relationship between diet and risk factor of MS[20,21]. To prevent or manage MS, it has been suggested that we need to understand lifestyle-accompanying risk factors and then modify them. According to Orchard et al. [22], three year cumulative incidences of MS were significantly reduced in a lifestyle intervention group compared with a placebo group, among people who had impaired glucose tolerance at baseline. MS abnormalities were affected by several lifestyle factors, including high body mass index (BMI), smoking, alcohol consumption, lack of exercise and eating habits. Among dietary patterns, the Mediterranean diet and the Dietary Approaches to Stop Hypertension diet were reported to have a strong impact on MS[23-25].

Recent dietary studies have increasingly used dietary pattern approaches rather than the traditional focus on individual foods, nutrients or dietary components. Dietary pattern approaches are beneficial as they capture the complex nature of dietary intake and explore its relationship with health outcomes. Till date, many studies have reported associations between dietary patterns and MS [26,27,6]. Despite some inconsistencies in those findings, it is interesting to note that dietary patterns, rich in whole-grains, legumes, vegetables and fish have favorable effects on metabolic abnormalities. On the other hand, Western patterns—characterized by high fat foods—have shown to increase the risks of metabolic abnormalities such as type II diabetes and CVD [6,28]. In this study, we investigate the association between dietary behaviour and the prevalence of metabolic syndrome (MS), and/or its components among female teachers living in cities and villages in Al-Ahssa region, Saudi Arabia.

Materials And Methods

Subjects

A cross-sectional study was conducted in females teacher aged 30–55 years. They were recruited randomly from primary schools in cities and villages in the Al-Hassa region of Saudi Arabia. The sociodemographic characteristics were done, including age, occupation, nationality; smoker habits and physical activity. Medical history and laboratory examination as well as diet information from the food frequency questionnaire were performed. Each participating subject a signed consent forms. Ethical approval was obtained from the Medicine Research Center Ethics Committee of Medicine Collage, King Saud University, Riyadh, Saudi Arabia.

Anthropometric measurements

Anthropometric measurements were performed after an overnight fast for each participating subject. Body weight (kg) and height (cm) were recorded in light clothes and no shoes. Body mass index (BMI) was calculated (kg/m^2).Waist (cm) and hip (cm) circumferences were performed midway between the iliac crest and the lower costal margin. Blood pressure was recorded by using a standard mercury sphygmomanometer on the left arm after at least five minutes of rest; the mean value of the two measurements was taken.

Biochemical measurements

After a 12-hour fast, a venous blood sample was taken. Both whole blood and serum were stored in plain polystyrene tubes. Fasting BG, glycolated hemoglobin (HbA1c), TG, total cholesterol, and HDL-C were quantified using routine laboratory analysis (Konelab, Finland). LDL-C was calculated using the Friedwald equation [$L = C - H - 0.16T;$ where H is HDL -C, L is LDL -C, C is total cholesterol, T is TG, and k is 0.20 mg/dl.

Definition of metabolic syndrome

The definition of MS was formed according to (AHA/NHLBI) and (ESC/ESH) of the National Cholesterol Education Program-Third Adult Treatment Panel (NCEP ATP III). In this regard, three or more of the following criteria must be fulfilled [29]: raised fasting plasma glucose (BG) level ≥ 100 mg/dl [5.6 mmol/l], raised blood pressure (BP): Systolic BP ≥ 130 or diastolic BP ≥85 mm Hg, raised TG level: ≥150 mg/dL (1.7 mmol/L), Reduced HDL-C: <40 mg/dL (1.03 mmol/) in males and <50 mg/dL (1.29 mmol/L) in females and raised waist circumference ≥0.102 cm for men and ≥ 0.88 cm for women.

Statistical analysis

Data was analysed using the Statistical Package for Social Sciences (SPSS) version 11.5 (Chicago, IL, USA), while continuous variables were presented as mean ± standard deviation. Frequencies were presented in percentage (confidence interval), and the MS prevalence was presented as overall prevalence, age-adjusted prevalence, and prevalence according to age.

Results and Discussion:

The socio-demographics of female teachers are presented in Table (1). The percentage of female Participants living in the cities were the most of the sample (59.3%), followed by those living in villages (40.7%) (Table 1). Among the female participants, those who were obese constituted 17%, 11% of them suffered from high BP, and 6.7%, 3.3% and 0.7% suffered from diabetes, hyperlipidemia and cardiac diseases respectively. With respect to physical activity, it has been observed that a high proportion did not engage in physical activity compared to those who did (65.3% vs. 34.7%). The proportion that engages in daily physical activity was 11%; this percentage was very low compared to the size of the sample being studied.

The present results show a significant association between the prevalence of MS and obesity, diabetes, BP and blood lipids (P≤0.05). No significant difference for female participants suffering from cardiac diseases and the prevalence of MS (Table 1). Several epidemiological studies have reported regarding the incidence of obesity, diabetes, high BP, high blood lipids and high prevalence of MS. El-Shahri [29] and Bener et al. [30] found a positive association between prevalence of MS and obesity or BMI. A study of Filip et al. [31] in Poland indicated that there was a significant association between high levels of blood lipids and incidence of the prevalence of MS in females. Also, a study conducted on 1,424 males and females reported that there was a significant association between high prevalence of MS and type-2 diabetes [32]. The high prevalence of MS ranging from obesity, diabetes, high BP to high blood lipids, was itself the MS criteria. The possibility of this relationship was the resistance of body tissues to the insulin receptor.

Table 1: Demographic changes, clinical charcteristic and physical activities of teacher's particpatants in villages and cities Al-Ahssa region

Demographic changes	Groups	Number (NO)	Percentages (%)
Age Groups	35-41	200	66.7
	42-48	86	28.7
	49-55	13	4.7
	villages	122	40.7
	cities	178	59.3
Educate level	Middle educate	26	8.7
	Universities	274	91.3
Clinical characteristic		Diseases	
		NO	%, P<
Obesity		51	17 P< **
Diabetes		20	6.7 P< **
Hypertensive		33	11 P<**
Hyperlipidimia		4.0	1.4
Cardiac diseases		2.0	0.7
Physical activity		No	%
Physical activity practice		105	35
Type of physical activity	Walk	97	32.3
		4.0	1.3
	Sports game	12	4.0
	Swimming	1.0	0.3
NO of physical activity	Daily	34	11.3
	weekly	43	14.3
	Monthly	26	8.7
Time of physical activity	1/4 hr	28	9.3
	½ hr	54	18
	≥ 1 hr	21	7.0

Table 2. The relationship between metabolic syndrome and age, commendations among female teacher's participant

MS criteria (NO) %	**Prevalence of metabolic syndrome**					
	MS according to AHA/NHLBI			**MS according to ESC/ESH**		
	(85) 28			**(73) 24**		
	Age groups					
MS criteria	35-41 age		42-48 age		49-55 age	
	No	%	NO	%	NO	%
MS according to AHA/NHLBI	42	21	36	42	7	50
MS according to ESC/ESH	38	19	29	34	6	43
MS criteria	**commendation place**					
	Villages		**Cities**			
	No	**%**	**No**	**%**		
Prevalence of MS according to AHA/NHLBI	34	28	51	29		
Prevalence of MS according to ESC/ESH	35	27	40	22		

Study sample: 300 samples

Table (2) displays the distribution of MS. It showed that the prevalence of MS among the study sample—in accordance with AHA/NHLBI and ESC/ESH definitions—was 28% and 24% respectively. This prevalence of MS among participating females was more or less with the previous studies conducted in Saudi Arabia. Al-Zahrani et al [33] reported that the prevalence of metabolic syndrome was 21% among healthy adults (35-50 years) in the western region of Saudi Arabia. Al-Nozha et al. [34] found that the prevalence of MS among females (30–70 years) was 42%. Al-Daghri et al. [35] found that the prevalence of the syndrome among females

(18–80 years) was 34.1%. Our results indicated that a low prevalence of the syndrome could be properly attributed to the average age of the study sample (age 40 years). The present study showed that the prevalence of MS increases significantly as age increases ($P<0.05$), whereas no significant difference in the prevalence of MS between participants females living in cities and those living in villages (Table 2). In accordance with previous workers, there was a positive association between the high prevalence of MS and the tendency to increase of the age among Saudi females [35-38]. The high prevalence of MS with the progression of age is probably due to hormonal disturbances with progress in age, which result in weight gain and the consequence of lipid impairment [39]; this indicates a direct effect of age progressing [40]. Several studies suggested that there was a relationship between MS and participants females living in cities or villages, but others did not find any. Isezou and Ezunu [41] revealed no significant correlation between the syndrome and place of residence in Nigeria, whereas there was a high significant association between the prevalence MS in the population of cities than in villages. In the present data, there was no significant association between the prevalence of MS between participants females living in the cities compared to those living in villages (Table 3). These results are related to several reasons; lifestyle and nutrition behaviour in cities is the same as in villages in Saudi Arabia.

Table 3. The prevalence of metabolic syndrome among participant's teacher for villages and cities in Al-Ahssa region as definition of (AHA/ NHLBI) and (ESC/ ESH)

Classification of metabolic syndrome	Metabolic syndrome indicators									
	WC		TG		HDL-C		BP		FG	
	NO	%	NO	%	NO	%	NO	%	NO	%
Infected as (AHA/ NHLBI)	81	27*	36	12*	64	21.3*	58	19.3*	55	18.3*
Infected as (ESC/ ESH)	68	22.6*	35	11.6*	44	14.6*	51	17*	50	16.6*
MS indicators (AHA/ NHLBI) and (ESC/ ESH).										
Cities	57.8	57.8	24	13.4	94	52.8	63	35.4	50	23
Villages	64	52.5	26	21.3*	54	443	32	26.2	41	33.6

$P \leq 0.05$

Table 4. The relationship between prevalence, metabolic syndrome indicators among participant's teacher as definition by (AHA/ NHLBI &ESC/ ESH) for villages and cities in Al-Ahssa region.

Metabolic syndrome Classification	Dietary habits				
	Very Bad	**Bad**	**Good**	**Very Good**	**Total**	**P ≤**
Metabolic syndrome as defined (AHA/ NHLBI)	7	28	41	9	85	N.S.
Metabolic syndrome as defined (ESC/ ESH)	6	24	36	7	73	N.S.
Metabolic syndrome Indicators defined as (AHA/ NHLBI)	**Dietary habits**					
	Very Bad	**Bad**	**Good**	**Very Good**	**Total**	**P ≤**
WC	9	68	76	14	167	N.S.
TG	3	14	26	7	50	N.S.
HDL-C	9	58	68	13	148	N.S.
BP	8	38	41	8	95	N.S.
FG	4	40	38	9	91	N.S.
Metabolic syndrome Indicators defined as (ESC/ ESH)	**Dietary habits**					
	Very Bad	**Very Bad**	**Very Bad**	**Very Bad**	**Very Bad**	**Very Bad**
WC	9	68	76	14	167	N.S.
TG	3	14	26	6	49	N.S.
HDL-C	17	37	43	4	101	N.S.
BP	8	38	41	8	95	N.S.
FG	4	40	38	9	91	N.S.

Table 5.The effect of food intake on the metabolic syndrome prevalent defined as (AHA/ NHLBI &ESC/ ESH among participant's teacher for villages and cities in Al-Ahssa region

Metabolic syndrome	defined as (AHA/ NHLBI)		defined as (ESC/ ESH)	
Dietary patterns	**Injury**	**Non-injury**	**Injury**	**Non-injury**
Red Meat	79	193	67	205
Chickens	84	203	71	216
Fishes	79	199	68	210
Crustaceans	60	142	49	144
Cool Meats	18	45	17	43
Livers	70	185	59	193
Tuna	38	99	32	105
Eggs	80	202	67	215
Legumes	82	207	70	219
High fat of dairy milk	83	209	71	221
Low fat of dairy milk	47	113	38	122
White dread & CHO	84	214	71	227
Grain dread & CHO	55	132	47	140
Local foods	83	211	71	223
Fruits &Vegetables	84	213	71	226
Dates	78	190	116	202
Fast food	82	208	70	220
Sugars	83	215*	71	227
Sweets	79	202	64	208
Soft Drinks	50	144*	43	151*
Tea	83	207	71	212
Cap-techno	83	203	70	116
Nuts	80	200	68	112
Margarines	56	167	48	175

The highest prevalence of MS criteria in the study sample was presented in Table (5) in accordance with the definition of AHA/NHLBI & ESC/ESH (Table 4); we found that WC, according to the definition of AHA/NHLBI, was first ranked (27%) with respect to the prevalence of MS criteria, followed by low HDL-C (21.3%; P≤ 0.05), high BP (19%), high FG (18.3%), high TG (12%) respectively. On the other hand, as defined by ESC/ESH, WC was first ranked (22.6%; P≤ 0.05), followed by high BP (17%), FG (16.6%), low HDL-C (14.6%) and high TG (116%) respectively. Some studies suggested that obesity, followed by low HDL-C, were the highest criteria of MS prevalent among males and females [36,37]. A cross-sectional study of 4,039 subjects, suffering from hypertension in both sexes, WC was the most prevalent of the components among those participants [42]. Several epidemiological studies have reported that the low HDL-C was the first ranked among components of MS. In another cross-sectional study on 530 Saudis with type II diabetes in villages, the low HDL-C was the greatest indicator of MS that was prevalent [43]. Otherwise, some studies showed different results, WC [35] and HDL-C [44] were the lowest indicators of MS prevalent among Saudis. With respect to general education, the MS indicators among participants' females in the present study, according to the definition of AHA/NHLBI, indicated that the TG was significantly higher among teachers in villages than cities (Table 5). In a cross-sectional study of people in villages and cities, there was a significant difference in hypertriglyceridemia (P≤0.05), whereas no significant differences in diabetes and hypertension prevalence were seen between villages and cities[45].

Table 6. The effect of food intakes on the prevalence of metabolic syndrome Indicators as (AHA /NHLBI &ESC/ ESH) among participant's teacher for villages and cities in Al-Ahssa region

Dietary patterns	**WC**	TG	HDL-C	BP	FG
Red Meat	151	46	129	86	84
Chickens	163	49	141	90	89
Fishes	156	48	133	91	86
Crustaceans	144	35	96	72	68
Cool Meats	35	5	32	15	26
Livers	145	41	122	73	76
Tuna	80	24	65	41	39
Eggs	159	46	139	89	83
Legumes	162	48	139	93	90
High fat of dairy milk	164	41	148	94	90
Low fat of dairy milk	91	29	80	45	50
White dread & CHO	165	48	147	96	90
Grain dread & CHO	104	34	97	55	56
Local foods	164	50	143	93	91
Fruits &Vegetables	165	50	145	95	90
Dates	151	47	127	86	86
Fast food	162	48	141	43	89
Sugars	165	49	145	95	90
Sweets	157	43	138*	93	85
Soft Drinks	30	11	27	17	15
Tea	108	29	90	58	55
Cap-techno	162	45	141	94	86
Nuts	156	46	135	91	87
Margarines	118	35	105	73	62
Oil- Mayonnaise	142	43	130	84	82
Olive Oil	140	42	125	82	76

In the present results, there was a significant association between soft drinks and the appearance of the remaining indicators of MS, as defined by AHA/NHLBI and ESC/ESH, whereas there was no significant difference between the appearance of the syndrome and the remaining foods (Tables 7,8). Our results were similar to several previous studies that reported a significant increase (48%) in the prevalence of MS in persons who consume soft drinks of one pack or more per day, compared to persons who consume less than one pack on a daily basis [46]. In addition, the frequent consumption of drinks and sugars were significantly associated with the increase in the MS components [7]. In a cross-sectional study, soft drink consumption has a significant association ($P \leq 0.001$) with females having MS [47]. In another cross-sectional study, the traditional style of dietary patterns, characterized by low soda intake, had a significant association with high serum HDL-C and low waist circumference ($P \leq 0.05$) [48]. In this study, the underlying mechanism of the effect of soft drink consumption on MS is not clear, and more research is needed to confirm this effect.

The current study revealed a significant association between intake of sweets and low HDL-C ($P \leq 0.05$) among the individual samples. No relationship was found with the rest of foods that have been studied (Table 10). In addition, no relationship was found between food intake and place of residence among females participants with metabolic syndrome (data not shown). There were directions in this study, not only with respect to the intake of sugars and sweets on the effect of HDL-C level, but also more than one direction. Metabolic syndrome is a heterogeneous outcome; thus, no single pathogenesis has been elucidated. Various factors, including physiological differences and genetic factors, may affect the underlying contribution of diet to MS [49-50]. A greater incidence of diabetes increases significantly in women who consume high percentage of carbohydrates ($P \leq 0.05$;>70% of energy) and significantly decreases the HDL-C level [51]. Additionally, the Western dietary style, characterized by frequent sweets and soft drinks, was inversely associated with HDL-C ($P \leq 0.05$) [52]. In another cross-sectional study, the triglycerides level showed a significant increase among the study sample, which characterized the dietary style by the high intake of sweets ($P \leq 0.05$) [48].

Considering to the prevalence of MS increases with age, the age and health status of the female participants might affect the association. In the present study, 45% of persons were found who follow healthful (good) dietary habits (high fruits, vegetables, cereals and their products, and low animal fat), whereas 6% of them who followed non-healthful (bad) dietary habits (high fast foods, soft drinks, sweets and sugars). No significant association was observed between MS prevalence and dietary habits or between types of MS components and dietary habits (Tables 9,10). In the absence of the significance, we cannot draw conclusions about the incidence of the syndrome and dietary habits.

Limitations

This study has some limitations, the sample was not large enough to determine ethnic patterns of metabolic syndrome. Additionally, a small population studied, due to the ethnic and cultural heterogeneity of the population of this region.

Conclusion

This study indicated that the prevalence of MS was 28% and 24%, in accordance with AHA/NHLBI / ESC/ESH criteria and there was no statistical difference between female participants living in cities and village, The dietary pattern that is characterized by high consumption of vegetables, fruits, legumes, lean meat, fish, cereals and low animal fat was associated with a reduced risk for MS in Saudi women in middle age.

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