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Metabolic syndrome and its associated factors in Shiraz Heart Study. A cohort--based cross-sectional study

ABSTRACT

Background. Metabolic syndrome (MetS) with modifiable and non-modifiable risk factors is an increasing global concern. It predisposes individuals to a significant cardiovascular risk that is the leading cause of death in Iran. The presented study investigated MetS prevalence and its risk factors in Shiraz, Iran.

Methods. 7225 participants in the age range of 40 to 70 years were recruited from the Shiraz Heart Cohort Study. MetS was diagnosed according to the Adult Treatment Panel III definition. The trend test, univariate, and multiple logistic regression were performed via SPSS version 16 at 0.05 significance level.

Results. Among the cases, 3780 (52.3 %) were female, and more than 73.4 % were overweight or obese. MetS prevalence in Shiraz is estimated at around 45.5 % (95% CI: 44.4 –46.7%), and female odds were 1.91 times more than males. Participants with low physical activity had nearly twice the risk of metabolic syndrome in comparison to individuals with high physical activity. The univariate logistic regression showed that age, gender, job, education, marital status, and physical activity are significantly associated with MetS.

Conclusions. The prevalence of MetS in the Shiraz urban population is relatively high and has become more common amongst middle-aged people, which can significantly endanger public health. Since most of the risk factors are modifiable, it is imperative to set policies to control MetS and its associated risk factors.
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Key words: metabolic syndrome, physical activity, urban population

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Introduction

Metabolic syndrome (MetS) is a collection of metabolic states in which there are at least three risk factors among five, including abdominal obesity, impaired glucose tolerance, hypertriglyceridemia, lower levels of high-density lipoprotein cholesterol (HDL), and hypertension. MetS is a predictor of two major global concerns: cardiovascular diseases (CVD) and type 2 diabetes mellitus [1, 2]. Each component of MetS predispose individuals to cardiovascular disease, including microvascular dysfunction, coronary atherosclerosis and calcification, cardiac dysfunction, myocardial infarction, and heart failure [3].

MetS is distributed globally at different rates from 24% to more than 35% in different regions in the United States [4]. The wider variation was found in the Asia-pacific region; for instance, the lowest prevalence was 11.9% in the Philippines, and the highest was 49.0% in Pakistan's population [5]. The prevalence of MetS among Iranians was 30.4%, with a significant

difference among genders, 34.8% in women compared to 25.7% in men, as reported by a recent meta-analysis of 69 studies [6]. The prevalence of MetS has increased over time; nevertheless, the prevalence of hypertriglyceridemia, a MetS' criteria component, was reduced by 15.5% in a 12-year cohort of Iranian adults [7, 8]. Many studies have associated this growing trend with the wide prevalence of sedentary lifestyle, consumption of high-calorie food, and the spread of modernization, especially in developing countries [9, 10]. Moreover, other aspects of people live like their socio-economic status, occupation, education level can alter the risk of MetS [10]. As mentioned, most determinants among MetS' risk factors are modifiable, which means that prevention can play an essential role in reducing the prevalence of MetS and its management. Considering its prevalence and life-threatening comorbidities, the aim was to investigate the prevalence of MetS and its associated factors in Shiraz, the most populous city in southern Iran.

Method and materials

We used a part of the Shiraz Heart Study (SHS). In the main study of SHS, profile paper, methods were reported in detail [11] . In summary, in that study, 7225 participants in the age range of 40 to 70 years were recruited by cluster random sampling according to the family physician clinic in the city of Shiraz. The authors used information of these participants after cleaning the data from the SHS database. Baseline data such as demographic characteristics, laboratory data, including fasting blood sugar and lipid profile, blood pressure, anthropometric measures, and physical activity data, were extracted from the SHS data. According to Adult Treatment Panel III (ATP III), If three or more of the following five criteria are met, a person is diagnosed with MetS; Waist circumference (WC) more than 102 cm in men or more than 88 cm in women, blood pressure over 130/85 mmHg, fasting triglyceride (TG) level over 150 mg/dL, fasting high-density lipoprotein (HDL) cholesterol level less than 40 mg/dl (men) or 50 mg/dL (women), and fasting blood sugar (FBS) over 110 mg/dL [12]. All individuals who met the ATP III criteria were included in the study and were compared with healthy controls. Physical activity was measured by International Physical Activity Questionnaire (IPAQ) in a categorical (low activity levels, moderate activity levels or high activity levels) approach [13].

Data are presented as mean ± SD for continuous data and number (%) for categorical data. Trend test, univariate, and multiple logistic regression were used for analysing the data. A P-value of less than 0.05 was statistically significant. All analysis was done via SPSS for Windows, Version 16.0. Chicago, SPSS Inc.

This study was approved by the Ethical Committee of Shiraz University of Medical Sciences.

(Approval ID: IR.SUMS.REC.1398.946) (Approval date:14.9.2019)

Results

We have studied 7225 individuals aged 40-70 years from SHS, of which, 3780 (52.3 %) were female. The mean body mass index (BMI) was 27.92 ± 4.56, and 73.4 % were overweight or obese. Demographic characteristics, along with BMI status and physical activity, are summarized in Table 1.

The prevalence of MetS in this study was 45.5 % (95% CI: 44.4–46.7%), which was significantly higher in females (53.1%) than males (37.2%) ($P < 0.001$). Among its components, high FBS with 23.8% was the least, and low HDL (59.6 %) was the most prevalent. The occurrence of MetS and its components in males and females is summarized in Table 2. The frequency of each component in males and females is depicted in Figure 1. As shown in this figure, the number of females with 3, 4, or 5 components was more than the males. The unadjusted odds ratio (OR) resulting from univariate logistic regression analysis is presented in Table 3. The result displays a significant relationship between age and the prevalence of MetS. A one-year increase in age raised the odds of MetS by 4%. The significance of the trend test confirmed this finding and showed that as age increases, the MetS prevalence would also increase ($P < 0.001$). Female odds were 1.91 times more likely than males to have MetS ($P < 0.001$).

Moreover, unemployed participants had a higher chance of having MetS compared to employed ones ($P < 0.001$). Individuals with higher education were less likely to have MetS ($P < 0.001$); however, the univariate logistic regression analysis did not represent the linear relationship. The trend test also supported education's role in MetS ($P < 0.001$). Married and widowed, and divorced individuals had higher odds than single individuals ($P < 0.05$). Besides, BMI was significantly associated with MetS prevalence; the higher the BMI, the greater the chance. The trend test also exhibited the same result ($P < 0.001$).

We found a significant relationship between physical activity and MetS. People with moderate physical activity were 1.58 times more at risk of MetS compared to those with high physical activity. The odds of participants with low physical activity were 1.94 times higher than people with high levels of physical activity. The trend test also revealed a significant increasing trend ($P < 0.001$). The results of the multiple logistic regression analysis are presented in Table 4. Moreover, due to BMI's strong linear relationship with other variables,

Table 1. Demographics, BMI, and Physical activity data among total population

Predictors	Statistic	
	Mean/number	SD/Percent
Age(years)	52.9	8.1
40-45	1840	25.5
45-50	1513	20.9
50-55	1356	18.8
55-60	1213	16.8
60-65	845	11.7
65-70	458	6.3
Gender		
Female	3780	52.3
Male	3445	47.7
Job		
Unemployed	4543	62.9
Employed	2682	37.1
Education		
Illiterate	398	5.5
Primary school	1450	20.1
Middle school	1173	16.2
High school/diploma	2194	30.4
University degree	1980	27.4
Marital status		
Single	217	3.0
Married	6588	91.2
Widow	102	1.4
Divorced	318	4.4
BMI (kg/m^2) (mean ± SD)	27.92	4.56
< 18.5 (Underweight)	77	1.1
18.5–25 (Normal)	1824	25.5
25–30 (Overweight)	3181	44.5
30–35 (Obese Class I)	1563	21.9
35–40 (Obese Class II)	416	5.8
40+ (Obese Class III+)	84	1.2
Physical activity		
High	585	8.1
Moderate	1965	27.2
Low	4675	64.7

Note: Some data may be missed

BMI was omitted from the final analysis. Based on the multiple analysis of logistic regression, variables such as age, gender, marital status, and physical activity were identified as influencing variables in the prevalence of MetS. The details of this analysis are presented in Table 4.

Discussion

MetS was classically has been recognized as western countries' disease, but today It often is more prevalent in the metropolitan city of some developing countries than in their western counterparts. Lifestyle changes have forced individuals to consume more high-calorie low-fibre food and be less physically active, two main reasons for MetS. MetS is a risk factor for serious medical conditions like type 2 diabetes, coronary diseases, stroke, etc. [14, 15] .The prevalence of MetS amongst 40 to 70 years old age Shiraz population was 45.5% based on ATP III criteria in this study. It was found that the chances of developing MetS increases by 4% by increasing one year. A meta-analysis of three systematic reviews found the prevalence of MetS among the Iranian population 23.8%, 30%, 30.4%, respectively [6, 16, 17]. Furthermore, two studies among the adult and healthy population in Shiraz reported 26.8% and 27.7% [18, 19]. Genetic factors and lifestyles could be the main reasons for the differences [6]. It seems that age and ageing are some of the most critical risk factors for MetS [20]. The difference could also be attributed to various diagnostic criteria and the age groups selected from the Iranian population.

The trend study on MetS and its component amongst the Iranian adult population from 2001 to 2013 detected an upward trend for the overall prevalence of MetS [8]. Therefore, a higher prevalence than previous studies was expected at the time of this study; Moreover, all of the women were middle-aged women, that about 40% of them were housewives. Middle-aged women are more prone to MetS because of the high triglyceride level, and abdominal obesity was seen in this group [6, 21, 22]. This can also justify the high prevalence of MetS in this study.

The MetS prevalence has been diminished with a stable and declining trend in some countries like Korea and the United States. Modification of direct and indirect risk factors for MetS, such as obesity, smoking and alcohol consumption, socioeconomic status, and education level, might have been the reason for those trends [20, 23]. The MetS prevalence was significantly higher in women than in men in this study. This finding is comparable with other studies in Iran [16–18, 24]. The prevalence of low HDL-C and abdominal obesity was higher in females compared to males [8]. A systematic review reported hypercholesterolemia, high LDL-C, and low HDL-C were more common among Iranian women [25]. Interestingly, significant gender differences were not detected in the study from Brazil

Table 2. Prevalence (95% CI) of MetS and its components in males and females

Component	Total	Gender		
		Male	Female	P value
Mets	54.5 (44.5–46.7)	37.2 (35.6–38.8)	53.1 (51.5–54.7)	< 0.001
WC	55.9 (54.7–57.0)	27.0 (25.5–28.4)	82.2 (81.0–83.4)	< 0.001
TG	52.9 (51.8–54.1)	53.7 (52.1–55.4)	52.2 (50.6–53.7)	0.176
HDL	59.6 (58.4–60.7)	52.0 (50.4–53.7)	66.5 (65.0–68.0)	< 0.001
FBS	23.8 (22.8–24.8)	24.3 (22.9–25.8)	23.3 (22.0–24.7)	0.321
HTN	43.3 (42.1–44.4)	46.6 (44.9–48.3)	40.2 (38.7–41.8)	< 0.001

WC — waist circumference; TG — triglyceride; HDL — high density lipid; FBS — fasting blood sugar; HTN — hypertension; MetS — metabolic syndrome

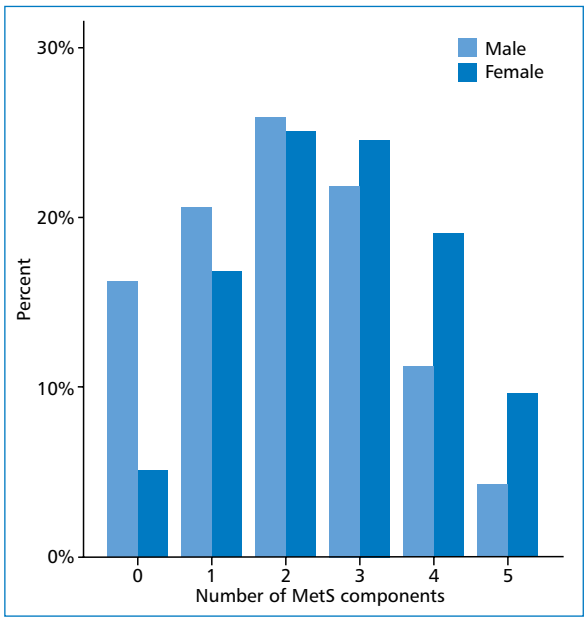

Figure 1. Percentage of number of MetS components in male and female participants. Zero = those who did not have any of the five Mets components, 1 those who have just one component and 2 those who have just two components and so on

[14]. Higher levels of education and good income would reduce the MetS threat in women. These factors influence health self-improvements, such as physical activity, healthy eating, and regular health check-up [20, 23].

Furthermore, the unemployed had a higher chance of getting MetS in contrast to employees. It may be due to the relativity of people's activity that can predispose them to MetS. This in line with Strau and his colleagues' study [26]. The univariate logistic regression (Table 3) shows that age, gender, job, education, marital status, and physical activity are significantly associated with MetS. However, multiple logistic regression tests found all as the last predictors except people's jobs among these variables. Statistical analysis has shown that if the literacy level increase, the chances of developing MetS would be decreased. Evaluating the individuals' educational level showed that this factor was closely related to MetS [14, 27]. Using educational platforms can help prevent MetS by increasing people's knowledge, attitude, and as a result, change their practice. However, knowledge and attitude are not enough to prevent CVD. Comprehensive and sustainable interventions are required to prevent these complications and transform knowledge and attitude to practice. Overall health literacy influences the nutritional quality and dietary behaviours [15, 28].

Married people and widows were more likely to acquire this syndrome compared to single people in this study, which is consistent with previous studies [29, 30]. Marriage can affect people's lifestyle and eating habits broadly. Concerning the level of physical activity, people with moderate physical activity are more likely to develop MetS than those with high levels of physical activity. Studies have shown that physical inactivity is correlated with obesity and overweight, which can lead to MetS [18, 19]. The study result of Hajian-Tilaki el al., is consistent with our survey [23]. However, Mulatinho et al. [25] did not find any relationship between physical activity and MetS. It seems that people with high levels of physical activity are much less likely to develop MetS than people with low levels of physical activity. Different study designs and different questionnaires for physical activity were contributed to these results. There were some limitations to this study. One of those is its cross-sectional methodology with related bias. The study population was selected from the population under the coverage of SHS who might be different in terms of some of the confounding variables such as free access to health care services. However, it is helpful to work on a large population of at-risk age group.

Table 3. Effect of predictors on MetS according to univariate logistic regression results

Predictors	Group		Unadjusted		Trend
	MetS (n = 3294)	Healthy (n = 3931)	OR (95% CI)	P value	P value
Age (year) (mean ± SD)	53.74±7.87	50.79±7.87	1.04 (1.04–1.05)	< 0.001	
40–45	595 (32.3)	1245 (67.7)	Ref		
45–50	628 (41.5)	885 (58.5)	1.48 (1.28–1.71)	< 0.001	
50–55	698 (51.5)	658 (48.5)	2.22 (1.92–2.56)	< 0.001	< 0.001
55–60	619 (51.0)	594 (49.0)	2.18 (1.87–2.53)	< 0.001	
60–65	488 (57.8)	357 (42.2)	2.86 (2.41–3.38)	< 0.001	
65–70	266 (58.2)	192 (41.9)	2.89 (2.35–3.57)	< 0.001	
Sex					
Female	2,010 (53.2)	1,770 (46.8)	1.91 (1.74–2.10)	< 0.001	–
Male	1,284 (37.3)	2,161 (62.7)	Ref		
Job					
Unemployed	2,190 (48.2)	2,353 (51.8)	1.33(1.21–1.46)	< 0.001	–
Employed	1,101 (41.2)	1,578 (58.8)	Ref		
Education					
Illiterate	241 (60.6)	157 (39.4)	Ref		
Primary school	790 (54.5)	660 (45.5)	0.78(0.62–0.97)	0.031	< 0.001
Middle school	533 (45.5)	640 (54.6)	0.54 (0.43–0.68)	< 0.001	
High school/diploma	947 (43.2)	1,247 (56.8)	0.49 (0.39–0.61)	< 0.001	
University degree	766 (38.7)	1,214 (61.3)	0.41 (0.33–0.51)	< 0.001	
Marital status					
Single	63 (29.0)	154 (71.0)	Ref		–
Married	2,983 (45.3)	3,605 (54.7)	0.24 (0.16–0.35)	< 0.001	
Widow	48 (47.1)	54 (52.9)	0.48 (0.38–0.61)	< 0.001	
Divorced	200 (62.9)	118 (37.1)	0.52 (0.33–0.82)	0.005	
BMI (kg/m^2) (mean ± SD)	29.68 ± 4.34	26.43 ± 4.20	1.20 (1.18–1.21)	< 0.001	
< 18.5 (Underweight)	2 (2.6)	75 (97.4)	0.09 (0.02–0.37)	0.001	
18.5–25 (Normal)	409 (22.4)	1,415 (77.6)	REF		
25–30 (Overweight)	1,477 (46.4)	1,704 (53.6)	2.99 (2.63–3.41)	< 0.001	< 0.001
30–35 (Obese Class I)	1,018 (65.1)	545 (34.9)	6.46 (5.55–7.51)	< 0.001	
35–40 (Obese Class II)	306 (73.6)	110 (26.4)	9.62 (7.54–12.2)	< 0.001	
40+ (Obese Class III+)	64 (76.2)	20 (23.8)	11.0 (6.66–18.5)	< 0.001	
Physical activity					
High	219 (42.4)	299 (57.6)	Ref		
Moderate	1,070 (53.7)	923 (46.3)	1.58 (1.26–1.98)	< 0.001	< 0.001
Low	2,771 (58.8)	1942 (41.2)	1.94 (1.57–2.40)	< 0.001	

Conclusion

In summary, the results of this study show that in recent years MetS has become more common amongst middle-aged people. It was found that age, gender, marital status, and physical activity can alter the chance of MetS. Since most of the risk factors are modifiable, it is essential to manage them in order to prevent negative sequels such as CVD.

Table 4. Adjusted effect of predictors on MetS by multiple logistic regression

Predictors	Adjusted			P value
	OR	95% CI for OR		
		Lower	Upper	
Age (year)	1.05	1.04	1.06	< 0.001
Gender				
Female	1.67	1.41	1.96	< 0.001
Male	Ref			
Job				
Unemployed	1.37	1.13	1.67	0.001
Employed	Ref			
Education				
Illiterate	Ref			
Primary	1.19	0.92	1.53	0.175
Middle school	1.20	1.02	1.42	0.029
High school/diploma	1.10	0.92	1.30	0.274
University level	0.97	0.84	1.24	0.721
Marital status				
Single	Ref			
Married	1.85	1.35	2.59	< 0.001
Widow	1.74	1.05	2.88	0.030
Divorced	2.04	1.38	3.02	< 0.001
Physical activity				
High	Ref			
Moderate	1.24	1.14	1.36	< 0.001
Low	1.40	1.29	1.51	< 0.001

Human rights statement and informed consent

This study was approved by the ethical committee of Shiraz University. The data was extracted from the Shiraz Heart Study database. Shiraz Heart Study is in accordance with the Helsinki Declaration and has been approved by the Research Ethics Committee of Shiraz University of Medical Sciences (No: 2017-358). Signing a written informed consent was the preliminary step.

Conflict of interest

There is no conflict of interest.

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