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Original article

Prevalence of metabolic syndrome and its components among a population-based study in south of Iran, PERSIAN Kharameh cohort study

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ABSTRACT

Objectives: over the past few years, lifestyle modification has increased the prevalence of major components of metabolic syndrome (MetS), leading to increased risk of non-communicable diseases, especially cardiovascular disease. The present study was aimed to determine the prevalence of MetS and its components and present results according to the major demographic characteristics of the participants in a population-based study.

Methods: This cross-sectional study was conducted on a total of 10663 subjects aged 40–70 years who participated in phase one of PERSIAN Kharameh cohort carried out between 2014 and 2017.

Result: According to IDF, ATP III, and an Iranian definition, the prevalence of MetS were reported as 37.00%(36.08–37.92), 33.82% (32.93–34.73), and 33.13% (32.24–34.03), respectively. The most prevalent component of MetS was abdominal obesity (73.59), followed by reduced HDL cholesterol levels (44.83), elevated triglyceride (28.3), fasting glucose (35.34), and high blood pressure (32.64). In addition, the prevalence of MetS were 50.3, 70.4, 68.2, 65.7, and 60.8 among individuals with abdominal obesity, high triglyceride levels, hypertension, impaired fasting glucose, and low HDL-C levels, respectively. Results showed that 90% of the subjects displayed at least one component of MetS, and all MetS components were associated with major demographic characteristics of the study subjects.

Conclusions: The findings of this study indicate high prevalence of metabolic risk factors among study population. This study with a large sample size would contribute to establishment of efficient interventions and programs aimed at reducing the prevalence of MetS by health staff, supervisors and policymakers.

1. Introduction

In recent decades, rapid socioeconomic growth caused changes in lifestyle patterns in modern societies, which has led to the development of key components of the metabolic syndrome (MetS).[1] MetS is defined by a cluster of risk factors such as abdominal obesity, insulin resistance, dyslipidemia and hypertension that increase the risk of diseases, such as type 2 diabetes mellitus, cardiovascular disease, cancer and premature death.[2] These medical conditions are major health problems throughout the world. MetS is associated with a twofold increase in cardiovascular diseases, and fivefold increase in risk of diabetes, thus this condition can be effectively used for CVD risk assessment.[3] Middle-aged individuals with MetS are two times more likely to develop CVD over the coming decades of their life.[4] The prevalence of MetS has shown an increasing trend over time, and increasing to epidemic proportions at present.[5] It is estimated that 20–25% of the adult population suffers from MetS worldwide.[6] A systematic review study conducted on Iranian population older than 19 years, reviewed 43 related studies and reported the prevalence of MetS as 10–60% depending on gender, age, and region.[7] The prevalence of MetS varies widely worldwide, especially in Asian countries, due to large differences in lifestyle and variety of ethnic groups.[8]

Co-occurrence of all components of MetS, increase the risk of CVDs and CVD-related consequences, including morbidity and mortality, which is beyond what is expected from a single component.[9,10] Although, metabolic components are likely to overlap,[11] most longitudinal studies have shown that abdominal obesity is an independent predictor of new onset of individual components of MetS.[12] Increased obesity to epidemic proportions, is associated with increased MetS to epidemic proportions in that community.[13] Obesity, is not always

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synonymous with MetS, but it may negatively affect diagnostic criteria for MetS, including waist circumference (WC), blood pressure, triglyceride levels, fasting glucose levels, and HDL cholesterol levels.[14,15] Previous studies have shown that MetS is associated with several factors. For example, Xi and colleagues reported female gender, older age, overweight, obesity, and urbanization as predictors of MetS.[16] In a study conducted in Iran, variables such as female gender, older age, and low educational level were associated with increased risk of MetS.[17] Thus, the literature review indicates that MetS is a multifactorial disorder.

Extraction of data on chronic diseases and associated risk factors is essential for healthcare planning in all types of communities. The majority of population-based studies with large sample size on MetS have been conducted in rich countries. Due to lifestyle variations and the specific lifestyles of each region, studies should be carried out in different regions of the world. Therefore, the present study was aimed to determine the prevalence of MetS and its components, and provide results according to the major demographic characteristics of a sample of 10,663 populations in a population-based and cohort design.

2. Materials and methods

2.1. Introduction of this study and Kharameh PERSIAN cohort

This population-based cross-sectional study extracted the required data from phase 1 Persian cohort study conducted in Kharameh County. Kharameh cohort is a part of a large Persian cohort study, Prospective Epidemiological Research Studies in Iran (PERSIAN). This cohort study was designed and conducted in 2014, and comprised of different geographical, ethnical and climatic groups in 18 provinces of Iran.[18] One of these provinces was Fars province. Kharameh County is located in Fars province, southern Iran with 54864 populations and the main ethnic group in the County is Fars (Appendix 2).

2.2. Study population

This study enrolled a total of 10663 people, aged 40–70 years who participated in first phase of Kharameh cohort conducted between 2014 and 2017. The required data were extracted from PERSIAN cohort study, in which data collection procedure constituted of registration, laboratory sample collection, obtaining anthropometric characteristics of the subjects, and questionnaire completion by study subjects. All study interviewers were selected among local residents with related collage education through qualification interview, and were provided by required practical training in a number of workshops. The main inclusion criteria were 40–70 years of age, living in Kharameh County, and Iranian nationality. The exclusion criteria were: lack of presence in clinics for physical examination, mental retardation, and unwillingness to participate into the study. All questionnaires were completed by using online survey through dedicated platform.

2.3. Clinical and demographic data

The collected data included demographic, anthropometric, blood pressure measurements, and biochemical parameters. Questions on demographic Characteristics included age, gender, area of living, marital status, current education and job. Anthropometric indicators also included weight (kg), height and WC (cm). For body mass index, participants were divided into the following groups: low weight (BMI < 18.5 kg/m2), normal weight (BMI = 18.5–24.99 kg/m2), overweight (BMI = 25–29.9 kg/m2), and Obesity (BMI ≥30 kg/m2). Also, the following blood biochemical parameters were used as components of the MetS: fasting plasma glucose (FPG), triglycerides (TG), and high density lipoprotein cholesterol (HDL-C). Blood pressure was measured two times with 15-m interval and two measures were finally recorded for each subject.

2.4. Definition of metabolic syndrome

The prevalence of MetS is provided by three different definitions, Iranian definition,[19] International Diabetes Federation (IDF) definition,[20] and Adult Treatment Panel (ATP III) definition.[6] However, the IDF definition was selected to determine the prevalence of MetS Components. According to the National Cholesterol Education program ATP III (NCEP-ATP III) criteria and Iranian definition, patients were classified as having MetS if they had three or more of the five CVD risk factors. However, international diabetes federation has introduced other diagnostic criteria for MetS to highlight the significantl role of abdominal obesity in MetS. According to IDF criteria, patients were classified as having MetS if they had abdominal obesity plus two of other MetS components.

Obesity is the first component of MetS, which is reported differently in ATP III, IDF, and Iranian definitions. As such, abdominal obesity is shown as WC ≥ 95 cm in both males and females in Iranian definition, WC ≥ 102 cm in males and ≥88 cm in females in ATP III definition, and WC ≥ 94 cm in males and ≥80 cm in females in IDF definition. Elevated triglyceride is another component of MetS (≥150 mg/dl). In addition, reduced HDL-C is another frequent component of MetS (< 40 mg/dl in males vs. < 50 mg/dl in females). Another component of MetS is elevated blood pressure (Systolic BP ≥ 130 mmHg and diastolic BP ≥ 85 mmHg) or treatment of previously diagnosed elevated blood pressure. Finally, fasting glucose (≥100 mg/dl) or previous detection of type 2 diabetes.

2.5. Statistical analysis

The descriptive data were expressed as mean ± standard deviation, and frequency (percentage). The prevalence of MetS and its components were computed with 95% confidence interval. Also, chi-square test was used to assess statistically significant relationship between qualitative variables. Data analysis was performed using Stata, version 11.0 for Windows (Stata Corp., College Station, TX, USA). the significance level was set at < 0.05.

2.6. Ethical issues

Prior to conducting the study, ethics committee confirmation were taken from Shiraz University of Medical Sciences (ethical code: IR.SUMS.REC.1398.445). Confidentiality of their personal data was emphasized.

3. Result

The mean age of the participants was 51.94 8 ± 8.27 years. Of the 10663 participants in the Kharameh cohort study, 4719 cases were males (44.3%) and 4416 cases were living in rural areas (41.4%), %, 9492 cases (89%) were married, and 5587 (52.4%) were illiterate. (Demographic characteristics are presented in Table 1).

The IDF, ATP III, and an Iranian definition, reported the prevalence of MetS as 37.00 (36.08–37.92), 33.82 (32.93–34.73), and 33.13 (32.24–34.03), respectively (appendix 1). All results and analyses were obtained using IDF criteria. The most prevalent component of MetS was abdominal obesity (73.59), followed by reduced HDL cholesterol levels (44.83), fasting glucose (35.34), and high blood pressure (32.64), elevated triglyceride (28.33) (Table 2).

The findings of our study indicate that demographic characteristics of the subjects were associated with MetS ($p < .05$). Accordingly, the risk of MetS is increased by each decade of life, as the prevalence of MetS is 31.8% in subjects younger than 50 years and 45.9% in subjects aged 60–70 years. Also, MetS is two times more prevalent among female patients (50.2%) than males. The MetS was shown to be more prevalent in subjects living in urban areas compared to those living in rural areas, but the difference was not magnificent, as the prevalence of

Table 1
Demographic characteristics of subjects in Kharameh cohort by presence of MetS according to IDF definition (n = 10663).

Variable	Subgroup	(%) N (n = 10663)	Metabolic Syndrome		p-value
			Yes (%) N (n = 3946)	No (%) N (n = 6717)	
Age group (years)	40–49	4686(43.9)	1490(31.8)	3196(68.2)	< 0.001
	50–59	3759(35.3)	1439(38.3)	2320(61.7)	
	60–69	2218(20.8)	1017(45.9)	1201(54.1)	
Sex	Male	4719(44.3)	962(20.4)	3757(79.6)	< 0.001
	Female	5944(55.7)	2984(50.2)	2960(49.8)	
Place of residence	Urban	4416(41.4)	1697(38.4)	2719(61.6)	0.011
	Rural	6247(58.6)	2249(36.0)	3998(64.0)	
Marital status	Married	9492(89.0)	3301(34.8)	6191(65.2)	< 0.001
	Single	1171(11.0)	645(55.1)	526(44.9)	
Education	Illiterate	5587(52.4)	2370(42.4)	3217(57.6)	< 0.001
	Literate	5076(47.6)	1576(31.0)	3500(69.0)	
Job	Employed	5516(51.7)	1356(24.6)	4160(75.4)	< 0.001
	Unemployed	5147(48.3)	2590(50.3)	2557(49.7)	
Body Mass Index (kg/m2) (BMI)	Low weight	411(3.9)	9(2.2)	402(97.8)	< 0.001
	Normal	3882(36.4)	764(19.7)	3118(80.3)	
	Overweight	4451(41.7)	2033(45.7)	2418(54.3)	
	Obese	1919(18.0)	1140(59.4)	779(40.6)	

MetS was 38.4 and 36.0 among subjects living in urban and rural areas, respectively. Results also showed that single, illiterate and employed individuals are more likely to develop MetS. Furthermore, the prevalence of MetS was 45.7 in overweight, and 59.4 in obese patients (Table 1).

According to IDF criteria, abdominal obesity is defined as WC, thus those with no abdominal obesity displayed no MetS, and 50.3% of those with abdominal obesity reported MetS. Also, the prevalence of MetS was 70.4% in subjects with elevated triglyceride, whereas 23.8% of those with normal triglyceride levels displayed MetS. In addition, the prevalence of MetS among those with high blood pressure, impaired fasting glucose, and low HDL-C levels were 68.2, 65.7, and 60.8, respectively (Table 2).

Analysis of the relationship between MetS components and demographic characteristics revealed that MetS components were most prevalent in patients with abdominal obesity by age, as 77.81% of subjects aged 60 years and older displayed MetS components. Also, MetS components were least frequent in patients with high blood pressure, as 24.34% of subjects with high blood pressure reported MetS components in subjects younger than 50 years. Moreover, the frequency of components of MetS were shown to increase with age. However, reduced HDL-C decreased, and elevated triglyceride was stable with age.

Beides, all five MetS components were more prevalent among females, that is more than 90% of female subjects reported abdominal obesity. All MetS components were significantly different between male and female patients, with no significant difference in elevated triglyceride ($p < .001$).

The prevalence of high blood pressure, abdominal obesity and impaired fasting glucose were significantly higher in illiterate subjects ($p < .001$). also, the prevalence of all MetS components were significantly higher in single and unemployed subjects ($p < .001$). those living in urban areas were more likely to display most of significant MetS components than those living in rural areas (Table 3).

Results showed that 90% of the subjects displayed at least one component of MetS (80% in males vs. 97% in females). Besides, 1.27% of male patients and 5.33% of female patients reported having all five components of MetS. In most cases, the highest prevalence of MetS was observed in subjects who had two or three MetS components (almost one third of the total study population). The frequency of MetS components by demographic characteristics are presented in Table 4.

4. Discussion

The present study determined the prevalence of MetS and its individual components by demographic characteristics. The prevalence of MetS was reported 37% by IDF definition, which was higher than other definitions. Also, the most frequent MetS component was abdominal obesity (73.59%), and the most prevalent MetS component among subjects with MetS was elevated triglyceride (70.4%). Besides, 90% of the subjects displayed at least one component of MetS. All five components of MetS were associated with major demographic characteristics.

The prevalence of MetS by IDF and ATP III were 37% and 33.82%, respectively. The prevalence of MetS varies widely throughout the

Table 2
Prevalence of MetS components in Kharameh cohort participants by presence of MetS according to IDF definition (n = 10663).

Variable	Subgroup	(%) N (n = 10663)	Metabolic Syndrome		p-value
			Yes (%) N (n = 3946)	No (%) N (n = 6717)	
Central obesity	Ok	7847(73.6)	3946(50.3)	3901(49.7)	< 0.001
	No	2816(26.4)	0	2816(100)	
Raised fasting blood sugar	Ok	3769(35.3)	2477(65.7)	1469(34.3)	< 0.001
	No	6894(64.7)	1292(21.3)	5425(78.7)	
Raised TG level	Ok	3021(28.3)	2126(70.4)	895(29.6)	< 0.001
	No	7642(71.7)	1820(23.8)	5822(76.2)	
Reduced HDL cholesterol	Ok	4781(44.8)	29.6(60.8)	1875(39.2)	< 0.001
	No	5882(55.2)	1040(17.7)	4842(82.3)	
Raised blood pressure	Ok	3481(32.6)	2373(68.2)	1108(31.8)	< 0.001
	No	7182(67.4)	1573(21.9)	56.9(78.1)	

Table 3
Prevalence of MetS components by demographic characteristics according to IDF Definition (n = 10663).

Variable	Subgroup	Metabolic Syndrome	Central obesity	Raised FBS	Raised TG level	Reduced HDL cholesterol	Raised blood pressure
Age group (years)	40–49	31.79(30.47–33.14)	71.08(69.76–72.36)	26.61(25.36–27.89)	27.40(26.14–28.69)	47.20(45.77–48.63)	24.34(23.14–25.59)
	50–59	38.28(36.73–39.84)	74.22(72.79–75.59)	39.15(37.61–40.73)	30.08(28.64–31.57)	43.30(41.73–44.90)	34.95(33.44–36.49)
	60–69	45.85(43.78–47.93)	77.81(76.04–79.49)	47.33(45.26–49.42)	27.32(25.50–29.21)	42.42(40.38–44.49)	46.25(44.18–48.33)
	P-value	< 0.001	< 0.001	< 0.001	0.012	< 0.001	< 0.001
Sex	Male	20.38(19.26–21.55)	49.18(47.75–50.61)	31.00(29.69–32.33)	27.76(26.50–29.05)	28.71(27.44–30.02)	25.34(24.12–26.60)
	Female	50.20(48.93–51.47)	92.96(92.28–93.59)	38.79(37.56–40.04)	28.78(27.64–29.95)	57.63(56.37–58.88)	38.44(37.21–39.68)
	P-value	< 0.001	< 0.001	< 0.001	0.243	< 0.001	< 0.001
Place of residence	Urban	38.42(37.00–39.87)	76.17(74.89–77.41)	35.52(34.13–36.95)	31.79(30.43–33.18)	45.99(44.52–47.46)	31.74(30.39–33.13)
	Rural	36.00(34.81–37.20)	71.76(70.63–72.86)	35.21(34.04–36.41)	25.88(24.81–26.98)	44.02(42.79–45.25)	33.27(32.12–34.45)
	P-value	0.011	< 0.001	0.739	< 0.001	0.044	0.097
Marital status	Single	55.08(52.21–57.91)	89.49(87.60–91.12)	46.45(43.61–49.32)	31.25(28.66–33.97)	54.14(51.27–56.98)	47.39(44.54–50.26)
	Married	34.77(33.82–35.74)	71.62(70.71–72.52)	33.97(33.02–34.93)	27.97(27.07–28.88)	43.68(42.69–44.68)	30.82(29.90–31.76)
	P-value	< 0.001	< 0.001	< 0.001	0.019	< 0.001	< 0.001
Education	Illiterate	42.41(41.12–43.72)	77.17(76.05–78.26)	40.18(38.90–41.47)	27.72(26.56–28.91)	45.53(44.23–46.84)	41.04(39.75–42.33)
	Literate	31.04(29.78–32.33)	69.64(68.36–70.89)	30.02(28.77–31.29)	28.99(27.76–30.26)	44.07(42.70–45.44)	23.40(22.25–24.58)
	P-value	< 0.001	< 0.001	< 0.001	0.145	0.129	< 0.001
Job	Unemployed	50.32(48.95–51.68)	88.90(88.01–89.73)	41.36(40.02–42.71)	30.56(29.31–31.83)	54.07(52.70–55.42)	41.48(40.14–42.83)
	Employed	24.58(23.46–25.73)	59.30(57.99–60.59)	29.73(28.53–30.95)	26.25(25.10–27.42)	36.22(34.96–37.49)	24.40(23.28–25.55)
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Total		37.00(36.08–37.92)	73.59(72.75–74.42)	35.34(34.43–36.25)	28.33(27.41–29.18)	44.83(43.89–45.78)	32.64(31.75–33.53)

world, as it was reported as 34.1% among American adults aged older than 20 years,[21] 21.5% in france,[22] 33.5% in turkey,[23] 54.8% in Mexico City,[24] 36.4 in Taiwan[25] and Korea,[26] and 23% in Sweden.[27] Delavari and colleagues conducted a national study in Iran, and reported the prevalence of MetS as 34.7% by ATP III definition, and 37.4% by IDF definition.[28] Also, Mokhayeri and colleagues reported the prevalence of MetS as 28%,[29] while Hajian and colleagues reported the prevalence of MetS as 42.3%,[17] which was significantly higher than other studies and was supported by Iranian national study. the estimation of the prevalence of MetS depends on the applied diagnostic definition, time of study, age, gender, and ethnicity of the population.[30] Differences between assessment criteria make it difficult to accurately compare inter-population differences. Besides, in populations with lower prevalence of obesity, the estimation of MetS by IDF and ATP III definitions would be similar.[31] Therefore, due to these contradicting definitions, comparison of different study results should be done with great caution.

The most prevalent component of MetS was abdominal obesity (73.59), followed by reduced HDL-C levels (44.83), fasting glucose (35.34), high blood pressure (32.64), and elevated triglyceride (28.33). a study conducted in southern Iran reported the prevalence of components of MetS were as follows: 29.4% for abdominal obesity, 40.2% for elevated triglyceride, 40.2% for reduced HDL-C, 15.4% for hypertension, and 37.8% for high fasting glucose.[32] Ryu and colleagues reported that the most prevalent components of MetS were high WC (27.5%), elevated glucose levels (23.1%), elevated triglyceride (22.2%), reduced HDL-C (13.4%), and high blood pressure (9.4%),[33] which were not supported by results of our study.

The findings of our study demonstrated higher prevalence of obesity among females, which was supported by results of previous studies. Mirzazadeh and colleagues performed a systematic review and meta-analysis, and indicated that women are two times more likely than men to develop obesity.[34] Cuschieri and colleagues conducted a study in Malta and revealed that men displayed higher rate of abdominal obesity, because waist circumference was significantly higher in men than in women in this region of the world.[35] In fact, WC and HDL-C levels are the most important risk factors that explain the higher susceptibility of women compared to men.[36] Hajian-Tilaki et al. also reported that obesity was significantly higher in females.[37] According to the results of our study, elevated triglyceride was the second most prevalent component of MetS after obesity. Noshad and colleagues reported the prevalence of elevated triglyceride as 37.39%,[38] while Ortiz-Rodriguez reported the prevalence of elevated triglyceride as 77.8% among 65-year old elderly.[39] Reducing abdominal obesity to prevent MetS and its consequences should be a priority for prevention programs because reduced abdominal obesity is associated with reduced risk of MetS and adverse cardiovascular consequences.

Results show higher prevalence of MetS with increased age decades, and the frequency of all components of MetS were shown to increase at higher age categories. However, reduced HDL-C decreased, and elevated triglyceride was stable with age. Mokhayeri and colleagues showed increased prevalence of MetS with age in both male and female patients.[29] Noshad and colleagues also demonstrated that the

Table 4
Prevalence of abnormal components of MetS by demographic characteristics based on IDF definition (n = 10663).

Variable	Subgroup	0	1	2	3	4	5
Age group (years)	40–49	12.74(11.81–13.72)	24.32(23.12–25.57)	29.81(28.51–31.13)	21.83(20.67–23.03)	9.24(8.44–10.10)	2.04(1.67–2.49)
	50–59	9.44(8.54–10.42)	20.85(19.58–22.18)	29.52(28.09–31.00)	23.27(21.95–24.65)	12.47(11.45–13.57)	4.41(3.80–5.12)
	60–69	6.89(5.91–8.03)	18.53(16.96–20.20)	27.41(25.59–29.30)	26.01(24.22–27.88)	15.96(14.49–17.54)	5.18(4.33–6.18)
Sex	Male	20.34(19.21–21.51)	29.43(28.15–30.75)	26.95(25.70–28.23)	15.68(14.67–16.74)	6.31(5.65–7.04)	1.27(0.98–1.63)
	Female	2.43(2.07–2.86)	15.91(15.00–16.86)	31.00(29.84–32.19)	29.18(28.04–30.35)	16.11(15.20–17.07)	5.33(4.78–5.93)
Place of residence	Urban	8.67(7.87–9.45)	20.78(19.61–22.01)	30.54(29.20–31.92)	23.91(22.67–25.19)	12.77(11.81–13.78)	3.30(2.81–3.87)
	Rural	11.55(10.78–12.37)	22.68(21.66–23.73)	28.26(27.16–29.39)	22.71(21.69–23.77)	11.07(10.32–11.88)	3.69(3.25–4.19)
Marital status	Single	3.07(2.22–4.23)	14.43(12.53–16.56)	26.64(24.18–29.25)	29.46(26.91–32.14)	19.29(17.13–21.66)	7.08(5.75–8.70)
	Married	11.26(10.64–11.91)	22.81(21.98–23.67)	29.53(28.62–30.45)	22.43(21.61–23.29)	10.85(10.24–11.49)	3.09(2.79–3.46)
Education	Illiterate	8.37(7.67–9.13)	19.13(18.12–20.18)	28.65(27.48–29.85)	25.00(23.88–26.15)	13.94(13.05–14.87)	4.88(4.35–5.48)
	Literate	12.54(11.66–13.48)	24.94(23.76–26.15)	29.82(28.58–31.10)	21.23(20.13–22.38)	9.39(8.62–10.23)	2.04(1.69–2.47)
Job	Unemployed	3.65(3.17–4.20)	15.67(14.71–16.69)	29.39(28.16–30.65)	28.91(27.68–30.16)	16.63(15.63–17.67)	5.73(5.12–6.40)
	Employed	16.62(15.66–17.63)	27.70(26.53–28.89)	29.04(27.85–30.25)	17.89(16.90–18.92)	7.52(6.59–7.96)	1.48(1.19–1.84)
Total		10.36(9.79–10.95)	21.89(21.12–22.69)	29.21(28.35–30.08)	23.21(22.41–24.02)	11.77(11.18–12.40)	3.53(3.20–3.90)

prevalence of MetS and all its components were significant in all five-year age groups, except reduced HDL-C,[38] which was consistent with our study. The Isfahan healthy heart program study in Iran revealed the prevalence of MetS as 49.7% and 17.5% in subjects aged 60 years and older, and 60 years and younger, respectively.[40] Kuzuya and colleagues showed increased frequency of MetS and its components with age, and reported the highest prevalence of MetS in 60–69 age category.[41] Although older age is associated with development of more frequent risk factors, our results showed that older age may affect the prevalence of MetS regardless of genetic and environmental changes[42] therefore, we suggest that training intervention aimed at prevention and reduction of MetS must focus on elderly.[43]

The prevalence of MetS was shown to be two times higher in females (50.2%) than males. Also, all components of MetS were more prevalent amongst female subjects. Hattori and colleagues conducted a study on japenesse people, and reported that the prevalence of MetS was significantly higher in male subjects (23.3%) than female subjects (8.7%).[44] Ebrahimi et al. reported the prevalence of MetS as 10.88% among males and 13.03% among females.[45] Hajian-Tilaki and colleagues also reported the overall prevalence of MetS as 42.3% (36.5% in males vs. 47.1% in females).[17] Mokhayeri and colleagues reported the prevalence of MetS as 22% and 33% among male and female subjects, respectively.[29] Some studies also proposed that the prevalence of MetS was two times higher in females,[35] which was in compliance with the present study. the higher prevalence of MetS in our study may be due to higher prevalence of obesity and physical inactivity among women.

The frequency of MetS was higher in illiterate subjects. The prevalence of high blood pressure, abdominal obesity and impaired fasting glucose were significantly higher in illiterate subjects. However, the prevalence of elevated triglyceride and reduced HDL-C were not significantly different. Ross and colleagues proposed that the risk of MetS was 12% lower in subjects with 9 or higher years of schooling.[27] A number of previous studies also revealed a reverse association between lower educational level and risk of MetS.[46,47] Ha et al. reported that subjects with high school education or higher were less likely to develop three or four components of MetS compared with those with high school and primary school education.[48] In contrast, a study conducted on Chinese adults showed that CVD risk factors are more prevalent in high-income families with high educational level.[49] Accordingly, there is evidence that lower education is correlated with lower income and lower socioeconomic status.[46] Besides, higher educated individuals tend to have more health information and subsequently have better health status and healthier lifestyle.

The MetS was shown to be more prevalent in subjects living in urban areas compared to rural subjects, but the difference was not significant. Cozma and colleagues stated that living in rural areas is a major risk factor for MetS.[46] Noshad and colleagues also showed that MetS and all is individual components were significant by area of living, with more significant difference in subjects living in urban areas,[38] which was in accordance with results of our study. the mild difference between the results of these two studies may be contributed to urbanization of Iran as well as diet modification in both urban and rural areas,[50] which significantly affect the frequency of abdominal obesity and subsequently other components of MetS. Moreover, the cultural background and lifestyles of urban subjects is relatively similar to rural subjects in Kharameh County.

About 90% of the subjects displayed at least one component of MetS (80% in males vs. 97% in females). Noshad and colleagues reported that 87% of the subjects had at least one MetS component, and 6% had all five components.[38] Fakhrzadeh et al. also revealed that 88% of adults displayed at least one MetS component.[51] Thus, identification of MetS at early stages may significantly contribute to prevention of MetS and its progression in the future.

4.1. Strength and limitations of the study

Some of the strength of this study were large sample size and that it used data from a population-based study. Besides, data collection was performed using accurate and valid tools and all questionnaires were electronically completed and all study data were recorded online in the cohort study through a dedicated platform, which insured the accuracy of the collected data. since we obtained all data on treatment and patient's medical history, all implications regarding medical conditions and related medications, such as diabetes and hypertension drugs were included in the definitions. Therefore, those studies lacking such information were more likely to report lower prevalence of MetS and related components. The cross-sectional design of the present paper made it difficult to derive causal relationships. Moreover, lack of evaluation of changes in MetS and its components was another limitation of this study.

5. Conclusion

The findings of this study indicate high prevalence of metabolic risk factors for CVDs in Fars province. The frequency of all risk factors were shown to be higher in male gender, older people, illiterates, singles, and unemployed individuals. This study with a large sample size would contribute to establishment of efficient interventions and programs aimed at reducing the prevalence of MetS by health staff, supervisors and policymakers. We suggest more accurate assessment of MetS components in other phases of PERSIAN cohort study because assessment of causal relationships requires longitudinal-type studies. According to the results of this study, medication treatment is not the best approach to control MetS, but lifestyle modification, including improvement of lifestyles and provide health training intervention for identified high-risk cases may reduce the prevalence of MetS.

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Declaration of competing interest

No declare.

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Appendix A. Supplementary data

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