

Prevalence and Incidence of Metabolic Syndrome in Iran: A Systematic Review and Meta-Analysis

Abstract

Metabolic syndrome (MetS) is a predictor of several diseases such as cardiovascular diseases, diabetes, dyslipidemia, stroke, osteoarthritis, certain cancers, and death leading to public health concern in most societies. We aimed to estimate the pooled prevalence and incidence of MetS in Iranian population through a meta-analysis study. We included cross-sectional and cohort studies to estimate the overall prevalence and incidence rates of MetS in Iran National databases including MagIran, Science Information Database, IranMedex, and international databases including Medline, Web of Sciences, and Scopus were searched up to October 2017. Finally, 125 studies were included. The total sample size was 472,401 with a mean age of 38 ± 7.8 years. The overall pooled prevalence and incidence rate among the general population of Iran was 0.26 (95% CI: 0.26, 0.29) and 97.96 (95% CI: 75.98, 131.48), respectively. The pooled prevalence of MetS was higher in females and in urban areas. The highest and lowest prevalence of MetS was obtained by the Iranian definition criteria (0.43) and the NHANES III (0.12). The highest and lowest incidence rates of MetS were obtained by IDF (144.07 per 1000) and the JIS (89.73 per 1000). The prevalence of MetS was higher in women and those living in urban areas. Furthermore, the prevalence of MetS increased with increasing age in both genders.

Keywords: Incidence, Iran, meta-analysis, metabolic syndrome, prevalence, review

Introduction

Metabolic syndrome (MetS) or X syndrome is defined as a set of metabolic and nonmetabolic disorders, including high fasting blood glucose, hypertriglyceridemia, high blood pressure, low HDL, and obesity.^[1] People who have three symptoms or more simultaneously are diagnosed as cases of metabolic syndrome.^[1]

MetS is a predictor of several diseases such as cardiovascular diseases, diabetes, dyslipidemia, stroke, osteoarthritis, certain cancers, and death leading to public health concern in most societies.^[2-4] Moreover, MetS imposes high costs on the health system and generally reduces the quality of life.^[5,6]

The prevalence of metabolic syndrome in the United States is estimated at 34%.^[7] In Iran, based on the Tehran Lipid and Glucose Study (TLGS), the prevalence of metabolic syndrome was 42% in men and 24% in women in adult adolescents.^[8] Further, the overall incidence of metabolic syndrome in adults aged 20 years and above was

reported at 550.9 per 10,000; in men, it was 794.2 per 10,000, and in women, it was reported at 443.5 per 10,000.^[9]

According to statistics in Iran, the prevalence of MetS among adolescents is more than 30%, which is higher than in most developed countries such as the United States. In general, there has been an increase in the prevalence of this syndrome in the Iranian society.

MetS is known as a multifactorial disorder. Numerous studies^[5,8-13] have shown that several factors are involved in the etiology of metabolic syndromes such as abdominal obesity, insulin resistance, impaired glucose tolerance, hypertension, low level of physical activity, genetic factors, psychosocial stress, and nutritional factors.

Given the high prevalence of metabolic syndrome and its important role in the development of cardiovascular diseases and diabetes, several studies^[10,14-16] have been conducted in Iran. However, due to errors in repeated sampling, the measurements of the prevalence of MetS have been controversial and imprecise.

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In meta-analyses the sample size is large and a combination of various studies is examined, thus providing a precise result and reducing the confidence intervals of estimates. Therefore, we aimed to estimate the pooled prevalence and incidence of MetS in the Iranian population through a meta-analysis study.

Methods

Eligibility criteria

In this systematic review, we included cross-sectional and cohort studies to estimate the overall prevalence and incidence rates of metabolic syndrome in Iran. The study population in this review was the general population of Iran regardless of gender, age, and ethnicity. There were no restrictions on the time, location, and language of the studies. The outcome of interest was syndrome metabolic that is a clustering of at least three of the five following medical conditions: central obesity, high blood pressure, high blood sugar, high serum triglycerides, and low serum high-density lipoprotein (HDL).

Search strategy

The following keywords were used to design a search strategy: Metabolic syndrome, MetS, Iran, prevalence and incidence. National databases including MagIran (from January 2001), Science Information Database (SID) (from January 2004), and IranMedex (from January 2001), and international databases including Medline (From January 1950), Web of Sciences (January 1945), and Scopus (January 1973) were searched up to October 2017.

Two investigators (A.F. and Z.Ch.) were independently responsible for the screening of the titles and abstracts of the retrieved studies. In case of any disagreement, it was resolved upon discussion and judgment of a third investigator. In addition, the kappa index was calculated to evaluate the agreement of the two investigators. The inter-authors reliability based on kappa statistics was 84%. In the next step, the full texts of the selected studies were reviewed to assess the eligibility criteria. Finally, the studies that met the inclusion criteria were selected.

Data extraction

The following data were extracted using a predesigned datasheet from the studies that met the inclusion criteria: the first author's name, year of publication, location of study, the scale used for the diagnosis of metabolic syndrome, the mean age of the participants in each study, gender, sample size, and number of participants with metabolic syndrome. In case of missing data in the included studies, we contacted the authors.

Risk of bias assessment

The quality of the included studies was assessed using the STROBE checklist.^[17] The following items were used for quality assessment: (1) sample size calculation;

(2) defining the outcome and method of measuring it; (3) the participants' eligibility criteria; (4) reporting precision for the outcome (95% CI or standard deviation); (5) describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.

Assessment of heterogeneity

The statistical heterogeneity was evaluated using the Chi-square test at 10% significance level. In addition, we quantified the heterogeneity using I^2 . The between-study variance was estimated using tau-square (τ^2).

We used the following approaches to deal with the heterogeneity: (1) recheck the extracted data; (2) meta-regression to identify the source of heterogeneity, and (3) subgroup analysis.

Data analysis

The Stata 11 (Stata Corp, College Station, TX, USA) was used for data analysis. We calculated the prevalence in each study by dividing the number of participants by the sample size. In addition, the standard error of prevalence was calculated as follows:

$$\sqrt{\frac{P \times (1 - P)}{n}}$$

In this formula, P and n are prevalence and sample size, respectively. In cohort studies, we calculate the standard

error by $\sqrt{\frac{1}{d}}$ the logarithmic scale. In this formula, d is the

number of new cases of metabolic syndrome. For studies that had not been reported, the number of new cases, we calculated the standard error by a 95% confidence interval

using this formula $\frac{\text{Upper limit} - \text{Lower limit}}{2 \times 1.96}$

The inverse variance method was used to obtain pooled prevalence and incidence. In the studies in which prevalence was close to zero or one, we calculated the 95% CI using the exact method, and the "meta prob" module was used for data analysis. The random-effects model was used for reporting the results at 95% CI.

Results

In this review, 2528 articles were retrieved through searching electronic databases and 1038 were excluded because of duplication. In the next stage, 1320 articles were excluded upon checking the titles and abstracts and another 45 were excluded upon checking the full texts as they did not meet the eligibility criteria.

Finally, 125^[13,18-140] studies remained in the final analysis, of which 105 were cross-sectional studies (that assessed the prevalence of metabolic syndrome) and 20 cohort studies (that assessed the incidence of metabolic syndrome), involving 138,182 and 434,219 individuals in the cohort

and cross-sectional studies, respectively [Figure 1]. The mean (SD) age of the participants was 38 ± 7.8 years.

In cross-sectional studies (105 studies), 63.80% of studies (67 studies) used the NCEP/ATP III criteria, 16.19% of studies (17 studies) used the IDF criteria, 7.61% of studies (8 studies) used the WHO criteria, and remaining studies (12.3%) used the other criteria for definition of metabolic syndrome. Further, in cohort studies (25 studies), 56% of studies (14 studies) used the NCEP/ATP III criteria, 12% of studies (3 studies) used the IDF criteria, 8% of studies (2 studies) used the AHA criteria, and 4% of studies (1 study) used the NHANES criteria for defining metabolic syndrome.

Data gathering and validity assessment of studies

Two investigators (Z.Ch. and A.F.) read the retrieved publications simultaneously and independently to select the studies that would meet the inclusion criteria. The investigators were not blinded to the authors' names, the journals' names, and abstracts and results. Any disagreements were resolved by adjudication with a third investigator (A.D.I.). The kappa index (an index for interrater reliability) was 0.906. Also, we

appraised the risk of bias (quality) of the included publications using the STROBE checklist. The same investigators (Z.Ch. and A.D.I.) appraised the studies independently. Based on the recommended items of the STROBE checklist, we classified the cross-sectional studies into categories of high-quality (77.4%), intermediate-quality (20.7%), and low-quality (1.90%). Similarly, the cohort studies were also classified into high-quality (92.3%) and intermediate-quality (7.9%) [Figure 2].

To reduce the heterogeneity, we divided the studies into subgroups by gender, habitat, and criteria of diagnosis of MetS to achieve homogeneity. However, homogeneity was not achieved.

Estimated prevalence and incidence

We considered all the studies (cohort and cross-sectional) that had addressed MetS in them. As mentioned earlier, 105 cross-sectional studies had estimated the prevalence of MetS in healthy Iranian population. The overall prevalence of MetS based on the random-effects model was 0.26 (95% CI: 0.26, 0.29. $I^2 = 99.6\%$) [Table 1]. Also, 20 cohort studies had estimated the incidence of

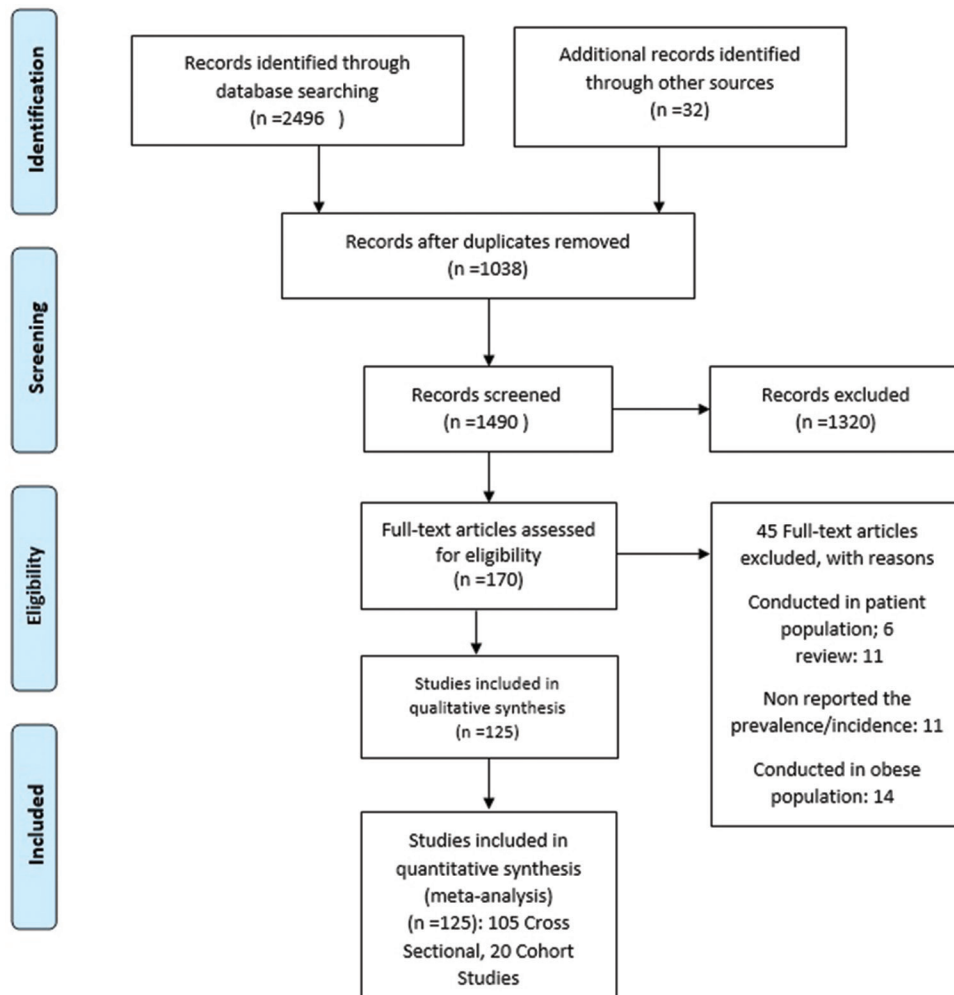


Figure 1: A flow diagram depicting the phases of retrieving articles, checking eligibility criteria, and including the articles into the meta-analysis

Mets. The overall incidence rate of MetS based on the random-effects model was 97.96 (95% CI: 75.98, 131.48. $I^2 = 99.7%$) [Figure 3].

Subgroup analysis

Since the studies included in this systematic review had used different diagnostic criteria for the detection of metabolic syndrome, we intended to report the pooled prevalence and incidence of MetS based on the criteria for diagnosis of MetS. The overall prevalence of MetS, based on WHO, IDF, JIS, AHA/NHLBI, ATP III, the Iranian Definition, NHANES III, EGIR, and AACE, were 0.19 (0.95 CI: 0.15, 0.23. $I^2 = 99.7%$), 0.27 (0.95 CI: 0.21, 0.33. $I^2 = 99.8%$), 0.43 (0.95 CI: 0.35, 0.5. $I^2 = 98.4%$), 0.22 (0.95 CI: 0.08, 0.36. $I^2 = 99.8%$), 0.27 (0.95 CI: 0.24, 0.29. $I^2 = 99.7%$), 0.44 (0.95 CI: 0.17, 0.53. $I^2 = 99.8%$), 0.12 (0.95 CI: 0.02, 0.21. $I^2 = 98.5%$), 0.17 (0.95 CI: 0.01, 0.34. $I^2 = 98.8%$), and 0.26 (0.95 CI: 0.24, 0.29. $I^2 = 98.9%$), respectively. Therefore, the highest and lowest prevalence of MetS was obtained by the Iranian definition criteria and the NHANES III (0.43 vs. 0.12). [Table 1]. The highest and lowest incidence rates of MetS were obtained by the IDF and JIS (144.07 per 1000 vs. 89.73 per 1000) [Figure 3]. The pooled prevalence of MetS was higher in females (0.34 vs. 0.22) [Table 1 and Appendix 1]. The overall pooled prevalence of MetS was higher in urban areas compared to rural areas (0.39 vs. 0.26) [Table 1]. Pooled estimates of the incidence rate of metabolic syndrome were not possible based on gender and habitat, as only one study had reported incidence by gender, and no other study had reported it by habitat (urban/rural).

Heterogeneity

For quantitative and qualitative heterogeneity, I^2 and Chi-square (at a significance level of 0.05) tests were used. Also, the tau-squared test was used to estimate the variances among the studies. In all the subgroups of the analysis (gender, habitat, and diagnostic criteria of MetS), considerable heterogeneity (over 90%) was observed. These inconsistencies were also found to be significant with the Cochrane test ($P < 0.001$). These results have

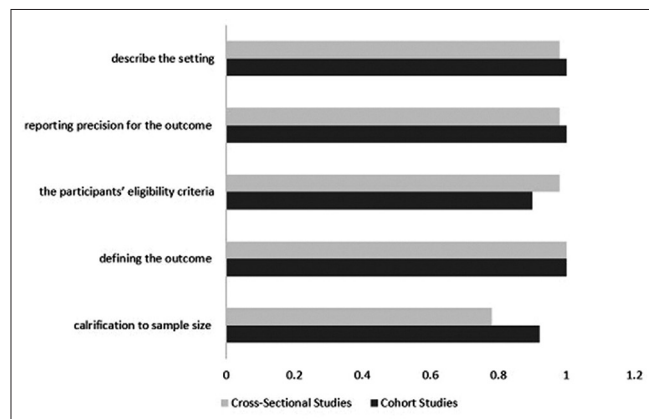


Figure 2: The quality assessment of studies

been observed both in the cross-sectional and cohort studies [Tables 2 and 3].

Discussion

In this systematic review, 125 studies were included in the final analysis. The total sample size was 472,401. Based on our results, the overall pooled prevalence and incidence rate among the general population of Iran were/was 0.26% and 97.96 per 1000, respectively. Moreover, the pooled prevalence of MetS was higher in

Table 1: The prevalence of metabolic syndrome in Iranian general population

Variables	Category	Prevalence (%)	[95% CI]	Weight %
Gender	Male	0.22	[0.21,0.24]	44.01
	Female	0.34	[0.31,0.37]	55.99
	Both Genders	0.26	[0.24,0.29]	0.26
Habitat	Urban	0.39	[0.21,0.33]	84.36
	Rural	0.26	[0.27,0.3]	15.64
Criteria	WHO	0.19	[0.15,0.23]	5.26
	IDF	0.27	[0.21,0.33]	16.42
	JIS	0.43	[0.35,0.5]	3.91
	AHA/NHLBI	0.22	[0.08,0.36]	3.93
	NCEP/ATP III	0.27	[0.24,0.29]	64.57
	Iranian Definition	0.44	[0.17,0.53]	1.30
	NHANES III	0.12	[0.02,0.21]	1.98
	EGIR	0.17	[0.01,0.34]	1.31
	AACE	0.21	[0.03,0.4]	1.31

Table 2: The results of heterogeneity test of prevalence of metabolic syndrome in cross-sectional studies

Subgroups	Category	Chi ²	P	I^2	τ^2
Gender	Female	12938.10	<0.001	99.1	0.01
	Male	40324.10	<0.001	99.1	0.03
	Total	57619.27	<0.001	99.6	0.02
Criteria	WHO	539.19	<0.001	98.70	0.0031
	IDF	14936.96	<0.001	99.80	0.0257
	JIS	310.15	<0.001	98.40	0.0083
	AHA/NHLBI	2174.96	<0.001	99.80	0.0316
	NCEP/ATPIII	31008.93	<0.001	99.70	0.0172
	Iranian definition	553.91	<0.001	99.80	0.1894
	NHANE III	136.19	<0.001	98.50	0.0064
	EGIR	84.21	<0.001	98.80	0.0139
Habitat	AACE	90.38	<0.001	98.90	0.017
	Urban	12147.94	<0.001	99.80	0.0256
	Rural	21.36	<0.001	81.30	0.0002

Table 3: The results of heterogeneity test of incidence rate of metabolic syndrome in cohort studies

Subgroups	Category	Chi ²	P	I^2	τ^2
Criteria	IDF	647.21	<0.001	99.70	0.788
	NCEP/ATPIII	2526.57	<0.001	99.50	0.9131
	JIS	878.91	<0.001	99.90	3.5147

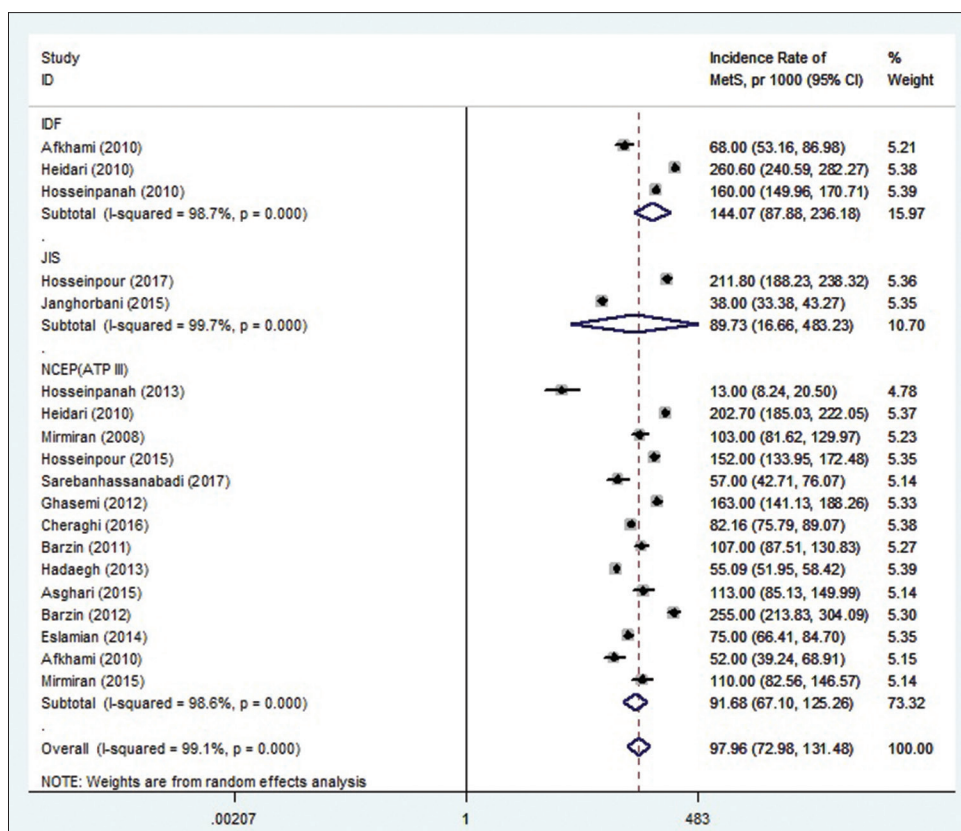


Figure 3: A forest plot for the incidence of Metabolic Syndrome (MetS) by criteria for diagnosis of MetS

females (0.34 vs. 0.22) and in urban areas (0.39 vs. 0.26). The highest and lowest prevalence of MetS was obtained by the Iranian definition criteria and the NHANES III (0.43 vs. 0.12). On the other hand, the highest and lowest incidence rates of MetS were obtained by IDF and the JIS (144.07 per 1000 vs. 89.73 per 1000). Pooled estimates of the incidence rate of metabolic syndrome were not possible based on gender and habitat, as only one study reported incidence by gender, and no study had reported it by habitat (urban/rural). Considerable heterogeneity (over 90%) was observed, both in cross-sectional and cohort studies. These inconsistencies were also found to be significant with the Cochrane test. Heterogeneity remained even after subgroup analysis (by gender, criteria, and habitat).

The highest prevalence of MetS among 105 cross-sectional studies was 91%, which was reported by Bayani (2016).^[35] In this study, the mean age of the participants was 68.5 years. The lowest prevalence was 0.9%, which was reported by Mehrdad (2006); this study was conducted on children aged 6–9 years. Upon assessing the rank of prevalence in other studies, it is clear that there is a direct relationship between increasing age and the prevalence of MetS. We also observed that with increasing age, BMI (as one of the major determinants of metabolic syndrome) increased in both sexes. In Aguilar’s study, more than 50% of people aged 60 years and older had metabolic syndrome.^[141]

In the present study, the pooled prevalence of MetS was significantly higher in women (34% vs. 22% in men). It is noteworthy that the highest difference of prevalence of MetS has been reported in older age groups. This finding is consistent with this important point, that the risk of cardiovascular disease after menopause is higher in women than in men.^[142] On the other hand, there are common risk factors for cardiovascular diseases and MetS (such as obesity, high blood pressure, diabetes, and high blood lipids).^[141,142]

Furthermore, in a meta-analysis study,^[143] MetS has been mentioned as a strong risk factor for cardiovascular disease and mortality. Therefore, the detection, prevention, and treatment of the underlying risk factors for MetS should be an important approach in reducing the burden of cardiovascular disease in societies.

In the present review, the prevalence of MetS was 27% based on the IDF criteria and the ATP III criteria. Sayehmiri (2014) conducted a review study^[144] on 26 studies (total sample size was 60,635 with an age range of 3–90 years); the results indicated that the prevalence of MetS based on the IDF and ATP III criteria were, 36% and 27%, respectively. Upon comparison, our results are consistent with the second criteria. In Delvand’s (2015)^[39] review, that was conducted on 32 cross-sectional studies with a total sample size of 7444, the overall prevalence of MetS was 32%. In the present study, the overall prevalence was lower, i.e., 26%.

Finally, according to the results of this review, the prevalence of MetS was higher in the urban areas. One of the main reasons behind this finding may be the difference in lifestyles of people living in the city and the countryside. Based on the results of previous studies,^[12,145] the prevalence of common risk factors of MetS such as cardiovascular disease, obesity, and hypertension in people living in urban areas is significantly higher than in rural areas.

Strengths and limitations of the study

In this study, a significant number of eligible studies^[124] were included. In the previous reviews,^[15,16,143] less than 40 publications had been studied. This may add to the generalizability of the results.

In the current review, we could not conduct certain subgroup analysis (e.g., the incidence rates of MetS based on gender and habitat) in the cohort studies, since the number of cohort studies were not sufficient (only one study reported incidence by gender and no studies were based on their habitat). Furthermore, we could not estimate the role of important risk factors on MetS such as physical activity and diet, since the studies included had not measured the effects of these factors.

Conclusions

In Iran, the prevalence of metabolic syndrome was 0.26 and the incidence was 97.96 per 1000. The prevalence of MetS was higher in women and those living in urban areas. Furthermore, the prevalence of MetS increased with increasing age in both genders. The findings of this study indicate a high prevalence of metabolic syndrome, hence the need to pay more attention to target populations

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Conflicts of interest

There are no conflicts of interest.

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