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Prevalence of Metabolic Syndrome in Iran: A systematic review and meta-analysis

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ABSTRACT

Background: Metabolic syndrome is a set of metabolic disorders, including abdominal obesity, hypertension, increased fasting blood sugar, increased serum triglyceride level, and decreased high-density lipoprotein (HDL) cholesterol level. This condition elevates the risk of cardiovascular diseases and diabetes. Regarding this, the present study aimed to evaluate the prevalence of metabolic syndrome in Iran.

Methods: This systematic review was conducted on the articles published within 2000-2015. The search was performed using the international databases, including Google Scholar, Science Direct, PubMed, and Scopus, and Persian databases of SID, IranMedex, and MagIran. The keywords employed during the searching process entailed: "Prevalence", "Frequency", and "Metabolic syndrome". The heterogeneity between the studies was assessed using I2 index. Data analysis was performed through meta-analysis technique (random-effects model) in Stata version 12.

Results: In the 32 studies conducted in Iran with the sample size of 74,440 cases, the total prevalence of metabolic syndrome was reported to be 32% (95% CI: 28-35). Based on the National Cholesterol Education Program/Adult Treatment Panel III, International Diabetes Federation, and Joint Interim Statement criteria, the prevalence rates of metabolic syndrome were reported to be 30% (95% CI: 25-34), 34% (95% CI: 29-40), and 39% (95% CI: 33-45) in 23, 13, and 5 studies, respectively.

Conclusion: As this study indicated, metabolic syndrome has a high prevalence in Iran. However, no significant changes have been observed in the prevalence of metabolic syndrome in the past few years in this country. Therefore, the high prevalence of metabolic syndrome can be prevented by focusing on the reduction of risk factors for this disorder.

1. Introduction

Metabolic syndrome was first used in 1920 to refer to three conditions of hypertension, high blood sugar, and gout. In 1988, Reaven introduced insulin resistance as the main feature of this disorder, calling it syndrome X.[1] After about one year, Kaplan added the most important component of this disorder to this list, i.e., abdominal obesity and abdominal subcutaneous adipose tissue. He recognized this series (i.e., hypertriglyceridemia, glucose intolerance, abdominal obesity, and hypertension) as the "Deadly Quartet".[2]

In 1998, the World Health Organization provided a definition for metabolic syndrome. Subsequently, the National Cholesterol Education Program/American Adult Therapy Panel III (NCEP/ATP III) and International Diabetes Federation (IDF) presented the diagnostic criteria of this disorder.[3-6] In all of the mentioned definitions, the presence of three abnormal factors out of abdominal obesity, hypertension, high triglyceride, low high-density lipoprotein (HDL), and high blood sugar is indicative of metabolic syndrome.

Specific cut-points have been determined for all components of metabolic syndrome. However, the

waist circumference, which is used for the measurement of abdominal obesity, requires more evaluation and depends on the national and regional cutoffs and definitions.[7] Several studies have indicated that metabolic syndrome is associated with diabetes and mortality due to cardiovascular diseases.[8]

The prevalence of coronary diseases and diabetes is respectively 2-3 and 3-5 times higher in the individuals with metabolic syndrome than in the people without such syndrome.[9, 10] Several studies investigated the prevalence of metabolic syndrome have reported various results based on different diagnostic criteria. According to the NCEP criteria, the prevalence rates of metabolic syndrome are 32.1%, 18.3%, 14.9%, and 24.5% in Iran, India, Japan, and China, respectively.[11-14]

In a systematic review and meta-analysis conducted by Maleki et al. in Iran, the prevalence rates of metabolic syndrome were reported to be 36% and 27% within 2003-2011 according to the IDF and ATPII criteria, respectively.[15] In another meta-analysis, which reviewed the published studies on the prevalence of metabolic syndrome in Iran within 2000-2013, a high prevalence was reported.[16] However, in the mentioned study, the prevalence of metabolic syndrome was not assessed based on the NCEP/ATPIII criteria.

The growing prevalence of hypertension, hyperlipidemia, obesity, and metabolic disorder in Iran[17-19] over the past few years requires proper planning and policy-making for the intervention and modification of factors affecting metabolic syndrome in this country. Regarding this, it is essential to determine the prevalence of metabolic syndrome in Iran. With this background in mind, this study was conducted to determine the prevalence of metabolic syndrome in Iran based on the NCEP/ATPIII, IDF, and JIS criteria.

2. Methods

2.1. Design

This systematic review and meta-analysis was conducted based on the IDF, JIS, and NCEP/ATPII criteria disaggregated by gender in 2016 in Iran.

2.2. Data Sources

This systematic review was conducted on the articles published within 2000-2015. The search was performed using the international databases, including Google Scholar, Science Direct, PubMed, and Scopus, as well as Persian databases of SID, IranMedex, Medlib, and MagIran. The keywords employed during the searching process entailed: “Prevalence”, “Frequency”, “Metabolic syndrome”, and “Iran”. The Persian translations of these keywords were applied along with their possible combinations for searching the Persian databases.

2.3. Study Selection

At first, a list was prepared by the researchers from the titles and abstracts of all the available articles in the mentioned databases. At this stage, all of the cross-sectional studies, which entailed the keywords of “Prevalence” and “Metabolic syndrome”, were added to the primary list. After the elimination of the articles with repeated titles, the abstracts of the listed articles were evaluated to find the suitable papers. All of the cross-sectional studies, which investigated the prevalence of metabolic syndrome in Iran based on the NCEP/ATPII, IDF, and JIS criteria and published in Persian and English languages without a time limitation were evaluated.

The exclusion criteria included: 1) non-representativeness of the study population, 2) use of non-random sampling technique, 3) investigation of the high-risk groups (e.g., pregnant women as well as patients with cirrhosis, hepatitis, and certain diseases), and 4) use of non-standard measurement tools.

2.4. Instrument

The quality of the related articles was determined using a checklist developed by Mousazadeh.[20] This checklist records such data as study objective, type of study, sample size, sampling method, data collection tool, evaluation of variables, study groups, and data analysis. Each article has a score range of 0-12 (once score is given to each part), and a score of ≥ 8 is indicative of acceptable methodological quality.

2.5. Data Extraction

In order to avoid bias, the process of searching for articles was performed by two separate researchers, and the research director's opinion was applied in case of disagreement on an article. Considering the inclusion and exclusion criteria, the intended data of the selected articles were recorded in the data collection form that was prepared in the EXCEL software. The recorded data included the first author, publication year, study setting, gender of the study population, sample size, diagnostic criteria, and number of patients with metabolic syndrome.

2.6. Data analysis

The reported prevalence of metabolic syndrome in each study was estimated using point estimation

with a confidence interval of 95% desegregated by gender and different provinces. The heterogeneity of the studies was evaluated through the Cochran's Q test and I^2 index. In this study, the I^2 of < 25%, 25-75%, and > 75% were considered as low, medium, and high heterogeneity, respectively.

Due to the observation of heterogeneity between the studies that was indicated by obtaining a statistically significant I^2 index, the DerSimonian and Laird's random effects model was used to combine studies and obtain the point estimate at the significance level of 0.1. In addition, the forest plot was applied for the visual assessment of heterogeneity between the selected studies. In addition, the Egger's test and funnel plot were employed to evaluate the publication bias and effect of studies with small sample size. Moreover, the sensitivity analysis was used to assess the role of each study in the final result.

The relationship of metabolic syndrome prevalence with publication year and sample size of the studies was evaluated using meta-regression analysis. On the other hand, the subgroup analysis was run to estimate the prevalence based on the diagnostic criteria of metabolic syndrome and gender differentiation. The prevalence rate and confidence interval based on diagnostic criteria were presented in cumulative flow diagrams. Data analysis was performed in the Stata software, version 12.

2.7. Ethical considerations

This article was derived from a research project approved by the Kurdistan University of Medical Sciences, Sanandaj, Iran.

3. Results

Out of the 335 retrieved articles, 130 studies were found relevant to the topic of interest by the title evaluation. In the next stage, the abstract of these 130 papers were evaluated. Finally, 32 articles were entered into the study, which were published within 2006-2015 (Diagram 1).

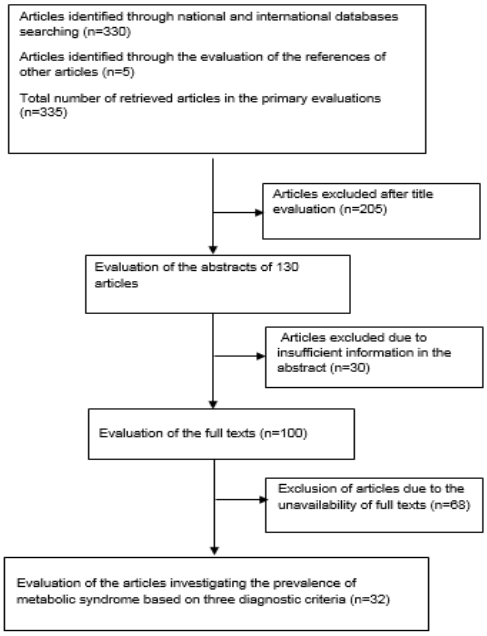


Diagram 1. Flow diagram of the stages of article inclusion to this systematic review

The selected articles were published within 2006-2015. The total sample size in the 32 evaluated articles was 74,440 individuals (mean population in each article: 2,327 cases). In all of the studies, the eligible individuals were selected through random sampling technique, and all of the selected studies were cross-sectional. The characteristics of the selected articles are presented in Table 1. Out of the 32 reviewed studies, the prevalence rates of metabolic syndrome were estimated based on the IDF, JIS, and NCEP/ATPIII criteria in 13, 5, and 23 articles, respectively. Furthermore, the total prevalence of metabolic syndrome was estimated as 32% (95% CI: 28-35).

Since the heterogeneity index of the studies (I2=99.1%) was significant, the random effects model was applied. The forest plot of the present meta-analysis is presented in Figure 1. The highest

and lowest prevalence rates of metabolic syndrome based on the IDF criteria were 65% and 4% in Kerman (95% CI: 62-68) and Zanjan, Iran (95% CI: 2-6), respectively.

According to the JIS criteria, the highest (44%) and lowest (31%) prevalence rates of metabolic syndrome were related to Tehran. In addition, the highest and lowest prevalence rates of this disease according to the NCEP/ATPII criteria were reported to be 45% (CI 95%: 41-49) and 9% (CI 95%: 8-10) in Hamedan and Ahvaz, respectively (Figure 1).

The prevalence rates of metabolic syndrome were 36% and 27% in women and men, respectively, which was indicative of the higher prevalence of this disease in the females as stated in all definitions. The related forest plot based on gender differentiation according to diagnostic criteria is presented in figures 2 and 3. The results of the sensitivity analysis revealed that the one-by-one elimination of the selected articles from the analysis process based on the three given diagnostic criteria led to no significant changes in the shared estimation of the prevalence in none of the criteria.

The publication bias of the reviewed articles was assessed using the Egger's regression test, indicating that according to the IDF (P=0.496) and NCEP/ATPIII (P=0.496) criteria, the publication bias was not statistically significant. However, based on the JIS criteria, a significant publication bias was obtained (P=0.030). The Egger diagram of publication bias related to the evaluated diagnostic criteria is presented in Figure 4.

With regard to the meta-regression results, no significant relationship was observed between the total prevalence of metabolic syndrome based on the IDF (P=0.260), JIS (P=0.932), and NCEP/ATPIII (P=0.540) criteria and the year of publication. The constant slope of meta-regression lines in all diagnostic criteria of Figure 5 is also indicative of this lack of association.

According to Figure 6, it can be inferred that with regard to the constant meta-regression slope, the prevalence of metabolic syndrome based on the IDF (P=0.504) and NCEP/ATPIII (P=0.617) criteria had no significant relationship with sample size. Nevertheless, there was a significant association between the prevalence of metabolic syndrome and increased sample size based on the JIS criteria. In other words, the prevalence of this syndrome decreased with increased sample size (P=0.012). In these diagrams, the circles signify the weight of the studies, i.e., the larger circles indicates bigger sample size.

Table 1. Characteristics of articles entered into the meta-analysis

Number	First author	Year	City	Age of participant	Gender of participants	Diagnostic criteria for metabolic syndrome	Sample size	Prevalence	Confidence interval	
									Bottom limit	Upper limit
1	Jalali 21	2009	Akbarabad (Kavar, Fars)	>19	Both	IDF	1402	31	28	33
						NCEP		29	27	31
2	Hadayegh 22	2009	Tehran	>65	Both	IDF	720	42	38	46
3	Keykhaei 23	2012	Zahedan	>19	Both	IDF	1802	25	23	27
						NCEP		21	19	23
4	Hadayegh 24	2007	Tehran	>20	Both	IDF	10368	32	31	33
						NCEP		33	32	34
5	Forouzanfar25	2015	Kerman	Unknown	Both	IDF	950	65	62	68
						NCEP		73	71	76
6	Ghorbani 26	2012	Semnan	70-30	Both	IDF	3799	36	34	37
						NCEP		28	27	30
7	Ostovaneh 27	2014	Zahedan	>16	Both	IDF	2243	12	10	13
						NCEP		12	11	13
			Amol	>16	Both	IDF	5826	27	26	28
						NCEP		28	27	29

8	Ebrahimi Mamghani 28	2011	Tabriz	Unknown	Males	IDF	76	57	45	68
							73	60	49	72
9	Maharlouei 29	2013	Shiraz	>40	Females	IDF	434	53	49	58
							490	32	28	36
10	Mohebi 30	2012	Zanjan	67-20	Males	IDF	12138	32	32	33
11	Ebrahimi 31	2009	Shahr Reza	49-15	Females	IDF	1501	17	15	19
12	Kazemi 32	2008	Zanjan	21-17	Both	IDF	507	4	2	6
13	Esmailzadeha 33	2013	Qazvin	78-20	Both	IDF	1107	34	31	37
						JIS		39	36	42
						NCEP		31	28	33
14	Zarkesh 34	2012	Tehran	>19	Both	JIS	365	44	39	49
15	Hosseinpanah 35	2012	Tehran	84-21	Both	JIS	347	38	33	43
16	Faam 36	2013	Tehran	70-20	Both	JIS	4665	31	30	33
17	Amiri 37	2014	Tehran	>20	Females	JIS	603	44	40	48
18	Keikhah 38	2013	Isfahan	60-30	Both	NCEP	3228	36	34	37
19	Rashidi 39	2014	Ahvaz	19-10	Both	NCEP	2246	9	8	10
20	Marjani 40	2012	Gorgan	>20	Female	NCEP	160	21	14	27
21	Esmail Nasab 41	2012	Kurdistan	64-25	Both	NCEP	1194	29	27	32
22	Mehrabian 42	2011	Isfahan	90-53	Females	NCEP	539	25	21	29
23	Fakhrzadeh 11	2006	Tehran	64-25	Both	NCEP	1480	28	25	30
24	Marjani 43	2012	Gorgan	>45	Females	NCEP	100	31	22	40
25	Gharipour 44	2011	Isfahan	>19	Both	NCEP	12514	23	22	24
26	Jamshidi 45	2014	Hamedan	83-40	Both	NCEP	550	45	41	49
27	Hajian-Tilki 46	2014	Babol	70-20	Both	NCEP	1000	42	39	45
28	Tabatabaei 47	2015	Shiraz	>20	Both	NCEP	377	27	22	31
29	Saberi 48	2009	Kashan	>30	Males	NCEP	429	36	31	40
30	Delavar 49	2009	Babol	50-30	Females	NCEP	916	31	28	34
31	Mahjoub 50	2012	Babol	>20	Both	NCEP	933	24	21	26
32	Moeini 51	2012	Tehran	40-15	Both	NCEP	282	23	18	28

IDF: International Diabetes Federation, NCEP: National Cholesterol Education Program, JIS: Joint Interim Statement

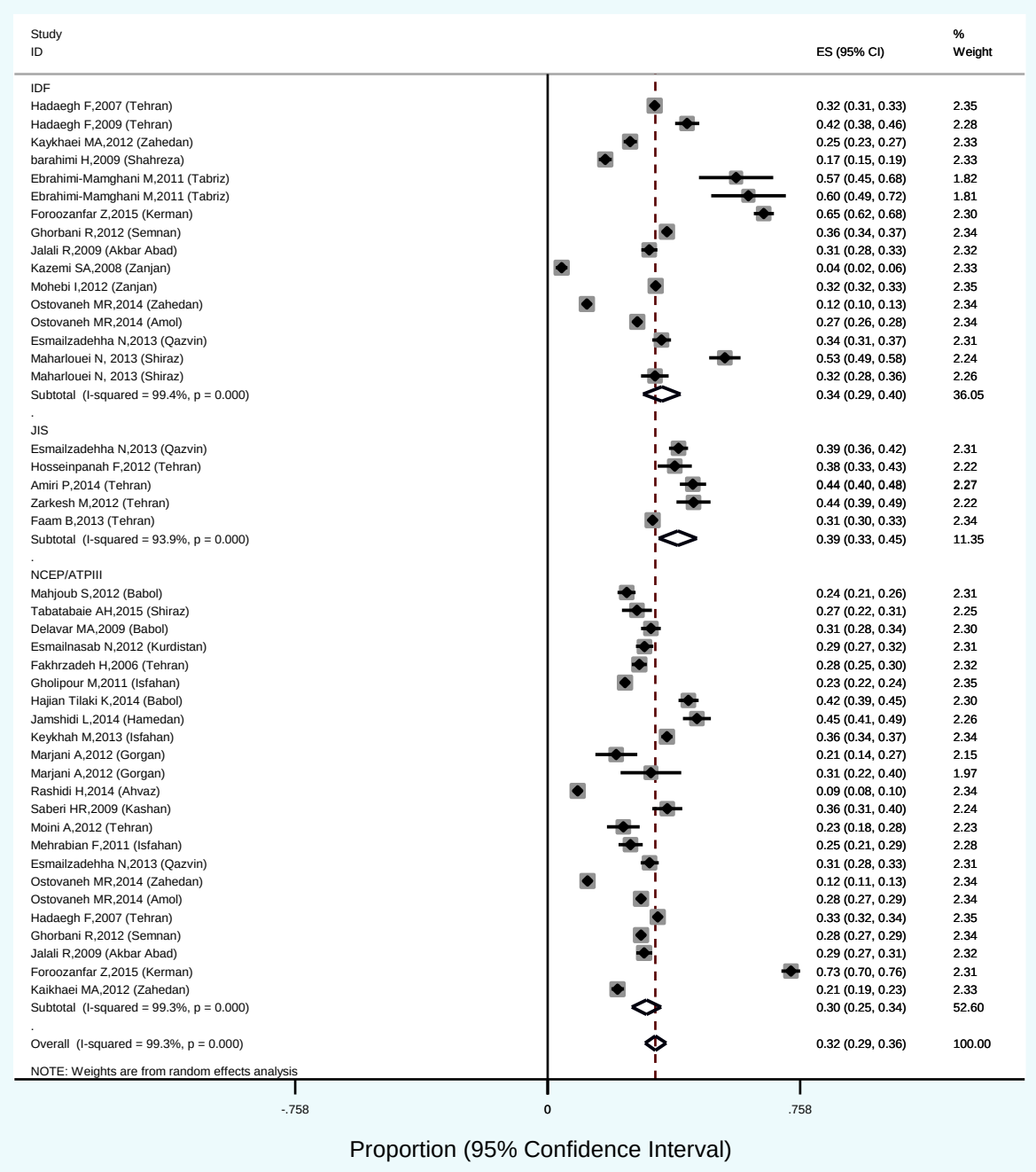


Figure 1. Forest plot of metabolic syndrome prevalence in Iran based on three diagnostic criteria

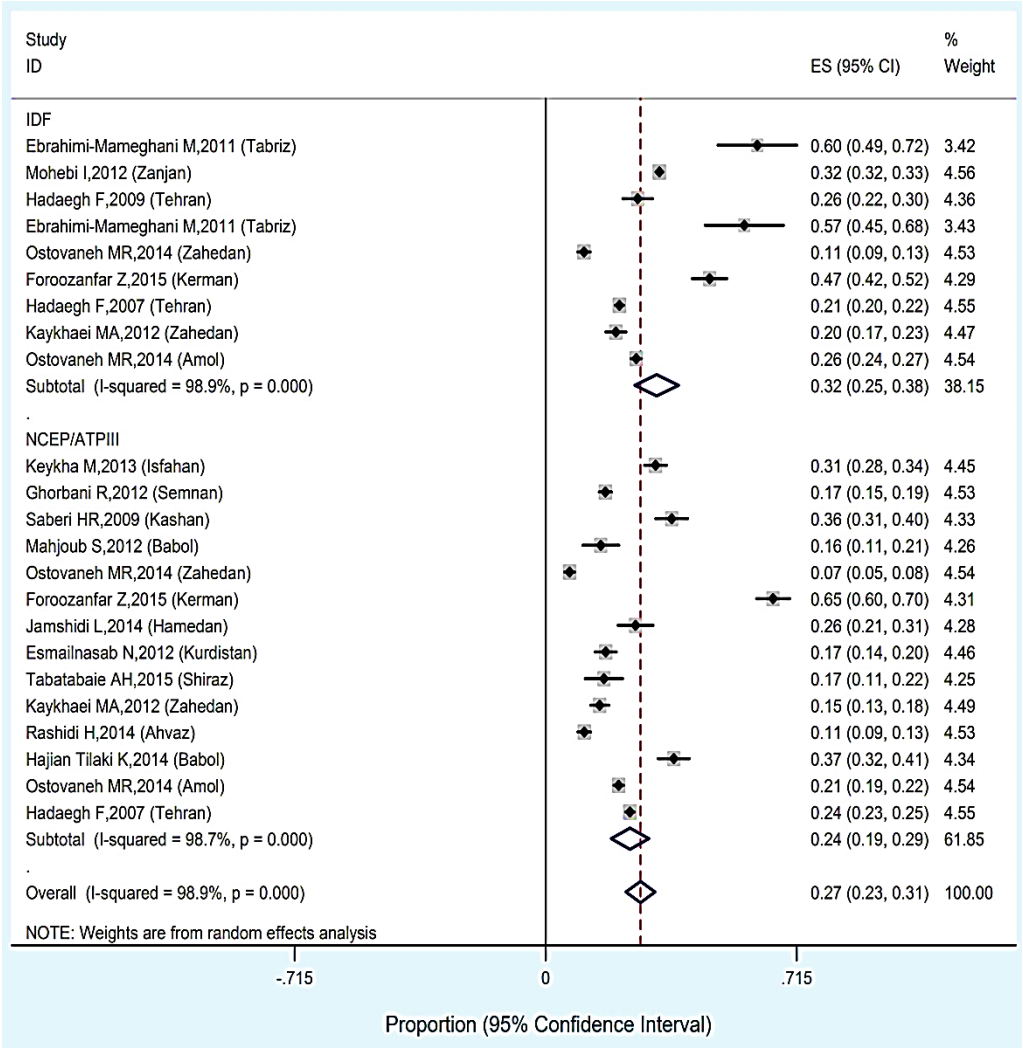


Figure 2. Forest plot of metabolic syndrome prevalence in males based on three diagnostic criteria

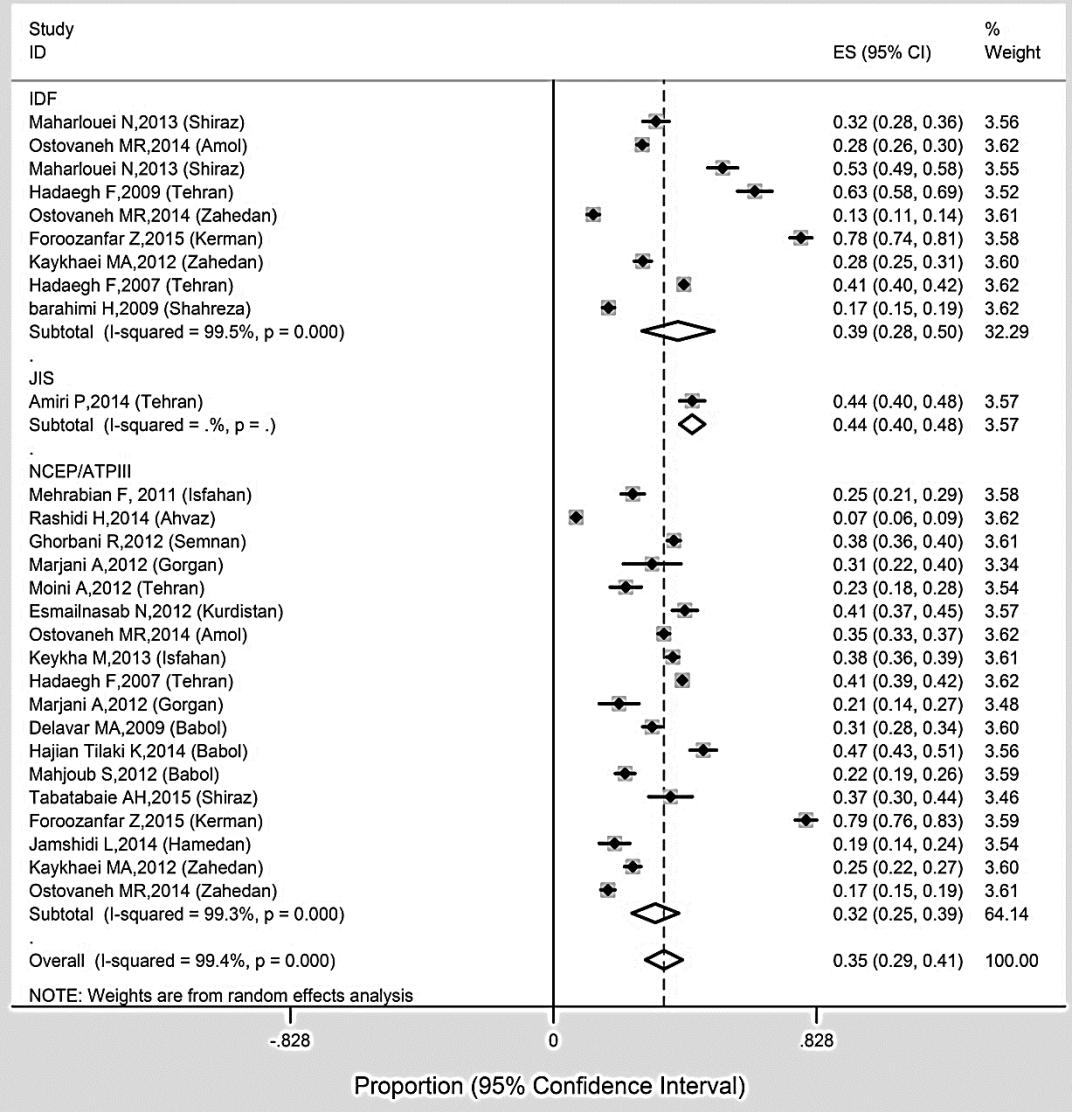
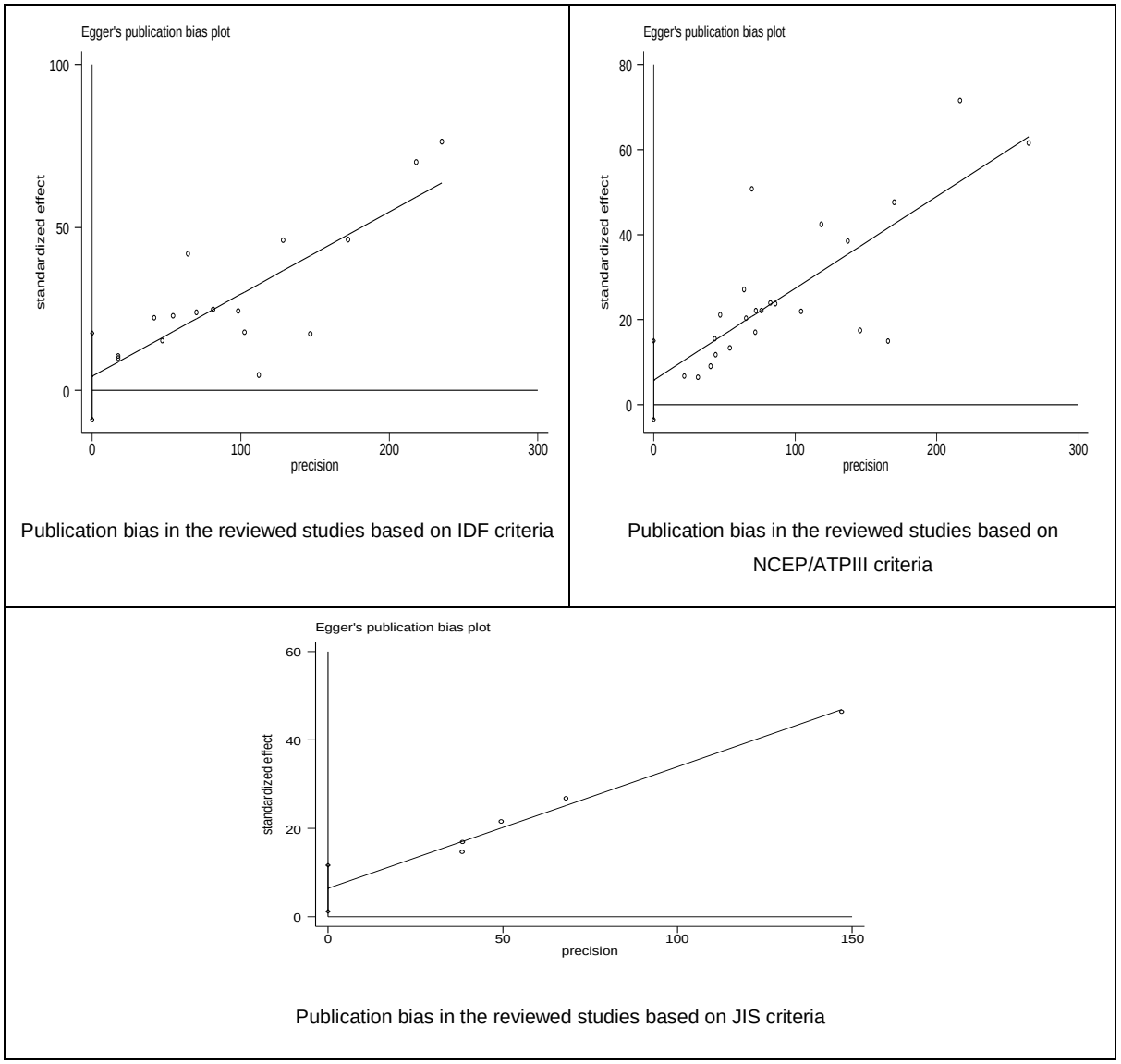


Figure 3. Forest plot of metabolic syndrome prevalence in females based on three diagnostic criteria

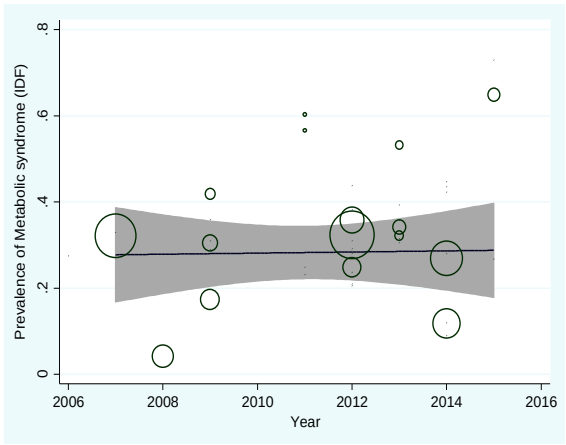


Publication bias in the reviewed studies based on IDF criteria

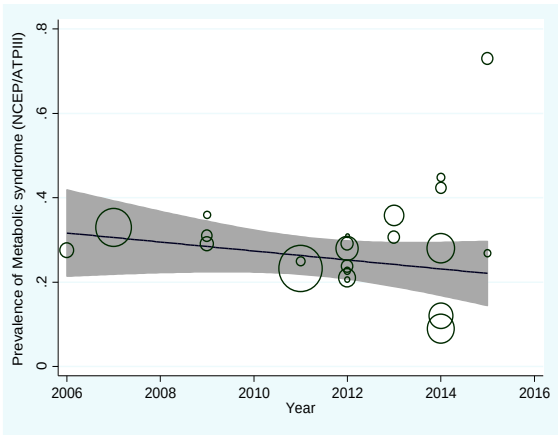
Publication bias in the reviewed studies based on NCEP/ATPIII criteria

Publication bias in the reviewed studies based on JIS criteria

Figure 4. Funnel plot for the evaluation of publication bias in the reviewed studies based on three diagnostic criteria



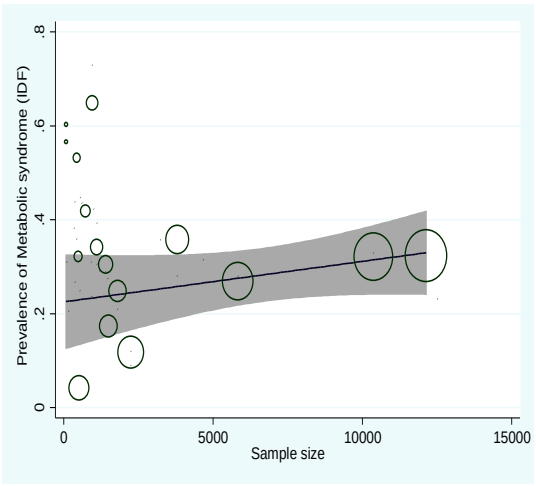
Meta-regression of metabolic syndrome prevalence according to the publication years of studies based on IDF criteria



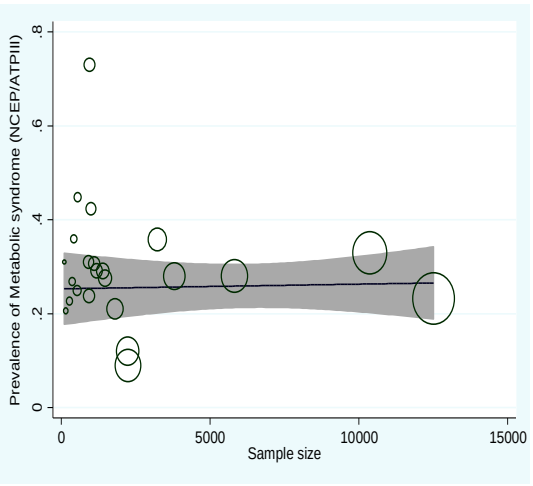
Meta-regression of metabolic syndrome prevalence according to the publication years of studies based on NCEP/ATPIII criteria

Meta-regression of metabolic syndrome prevalence according to the publication years of studies based on JIS criteria

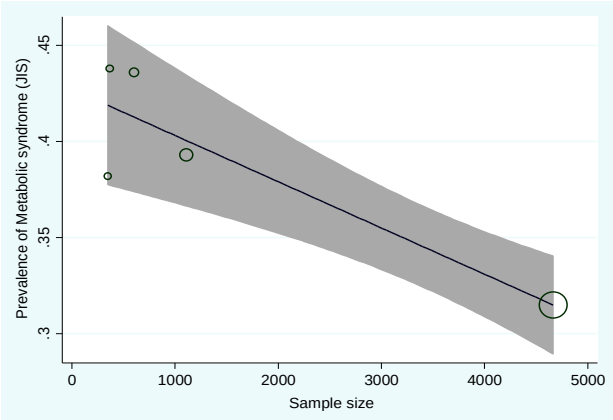
Figure 5. Meta-regression of metabolic syndrome prevalence according to the publication years of studies based on three diagnostic criteria



Meta-regression of metabolic syndrome prevalence according to the sample size of studies based on IDF criteria



Meta-regression of metabolic syndrome prevalence according to the sample size of studies based on NCEP/ATPIII criteria



Meta-regression of metabolic syndrome prevalence according to the sample size of studies based on JIS criteria

Figure 6. Meta-regression of metabolic syndrome prevalence according to the sample size of studies based on diagnostic criteria

4. Discussion

In the 32 evaluated studies with the total sample size of 74,440 cases, the total prevalence of metabolic syndrome was reported to be 32% in Iran, which was higher compared to those of other countries. In addition to such factors as inactivity, changes in individuals' lifestyle, and increased urbanization, other factors, such as larger waist size and lower HDL cholesterol were the cause of increased prevalence of metabolic syndrome in the Iranian population, compared to that in the Western countries.[21]

In a meta-analysis conducted by Maleki *et al*. (2014), the total prevalence of metabolic syndrome was reported to be 36% based on the IDF criteria.[15] In another systematic review and meta-analysis carried out by Amir Kalali *et al*. (2015) to determine the prevalence of metabolic syndrome based on the IDF criteria in Iran, this rate was reported as 34.6%.[16] In the present study, the prevalence of this syndrome was reported to be 33% according to the IDF criteria. The majority of the published systematic reviews on the prevalence of metabolic syndrome (13 studies) have used the IDF criteria. With regard to the increased accumulation of sample size, our results could provide a more accurate estimation of the prevalence of this disorder, according to the diagnostic criteria in the country, compared to the studies conducted by Amir

Kalali (seven studies) and Maleki (five studies). The total prevalence of metabolic syndrome according to the JIS criteria was lower in the present study, compared to the research carried out by Ami Kalali et al. (39% versus 41.5%, respectively). Similar to the mentioned study, the prevalence of metabolic syndrome according to the JIS in the present study was higher, compared to the other criteria.[15, 16] However, it should be noted that limited numbers of studies have reported the prevalence of this syndrome according to the JIS criteria. In the present study, only five articles used the JIS criteria. Therefore, further evaluations are required for more accurate detection of metabolic syndrome prevalence based on this criterion. According to the results of the present study, the prevalence of metabolic syndrome based on the NCEP/ATPIII criteria was lower, compared to the other criteria (30%). In this regard, no meta-analysis has been performed to assess the prevalence of metabolic syndrome according to the NCEP/ATPIII criteria. Therefore, it is not possible to compare the shared estimate of metabolic syndrome prevalence according to this diagnostic criteria with other meta-analysis in the Iranian population. According to the results of a study conducted on 26,000 Hindi adults, the prevalence rates of metabolic syndrome were reported to be 25.8% and 18.3% according to the IDF and NCEP criteria, respectively.[21] In another study carried out in China, the prevalence rate of this syndrome was 25.8% and 15.7% according to the definitions of IDF and NCEP, respectively.[22] The higher prevalence rate of this syndrome based on the IDF criteria, compared to the NCEP criteria, might be due to the presence of lower cut-off point for the waist size in the definition of the IDF.

In line with other studies,[23-28] the current review revealed that the prevalence rate of metabolic syndrome based on all diagnostic criteria was higher in females, compared to that in males. Similarly, in a meta-analysis performed by Maleki et al. and Amir Kalali et al, this syndrome was more prevalent in the females, compared to that in males based on all the three criteria.[15, 16] However, in some countries, the metabolic syndrome was reported to have an equal prevalence rate in both genders.[29-31] Tabatabaei et al. conducted a study to determine the relationship between gender and prevalence of metabolic syndrome. They reported the prevalence of this disorder as 15.9% and 29.1% in male and female participants, respectively, which was indicative of a statistically significant difference in this regard.[32] The higher prevalence of metabolic syndrome among the women is attributed to abdominal obesity, which is mainly due to low physical activity, higher birth rate, presence of estrogen receptors, and menopause.[17, 33] For instance, abdominal obesity was reported to be more prevalent in women, compared to that in men in the studies conducted in South Korea (27% versus 0.2%) and Turkey (54.8% versus 17.2%).[28, 34]

In the studies conducted on the European societies, the mean prevalence of this syndrome was reported to be about 24% according to various diagnostic criteria, age groups, and geographical situation.[35] In the Latin American countries, about one-fourths of the people are diagnosed with this syndrome.[36, 37] This difference in reports might be due to various etiologies, including insulin resistance, obesity (especially abdominal obesity), lipid disorders, glucose intolerance, hypertension, pre-inflammatory condition, genetics, intrauterine growth retardation, fast urbanization, nutrition transition, inactivity, social-mental stresses as well as economic, social, and cultural factors.[17, 38] One of the major drawbacks of this study was the lack of access to full texts and insufficient information of some articles.

5. Conclusion

According to the results of the reviewed studies, metabolic syndrome has a high prevalence in Iran according to the IDF, JIS, and NCEP/ATPIII criteria. In addition, this prevalence is higher in the females based on the three given criteria, compared to that in the males. The high prevalence of metabolic syndrome in Iran can be ascribed to modern lifestyle, low level of activity, increased use of processed food with little nutritional value, increased urbanization, and more tendency toward western lifestyle.

On the other hand, a healthy life style can prevent the high prevalence of metabolic syndrome by focusing on reducing the risk factors for this disorder. Therefore, to obtain a global health level, we should perform more studies in this regard, optimally inform the policy-making organizations, and allocate more resources for the development of health in Iran.

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

Sahar Dalvand: Study concept and design and Statistical analysis and interpretation of data and Manuscript drafting and Technical and material support. Enayatollah Bakhshi: Study concept and design and Critical revision of the manuscript. Masoud Taheri-Asl: Data collection. Mozhdeh Zarei: Data collection and Manuscript drafting. Reza

Ghanei Gheshlagh: Manuscript drafting and Technical and material support.

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