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Prevalence of Metabolic Syndrome and Its Components in the Iranian Adult Population: A Systematic Review and Meta-Analysis

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Abstract

Context: Metabolic syndrome (MetS) increases the risk of most non-communicable diseases; gathering information about its prevalence can be very effective in formulating preventive strategies for metabolic diseases. There are many different studies about the prevalence of MetS in Iran, but the results and the study populations of these studies are very different; therefore, it is very important to have an overall estimation of its prevalence in Iran.

Objectives: This study systematically reviewed the findings of all available studies on MetS in the adult Iranian population and estimated the overall prevalence of MetS in this population.

Data Sources: International databases (Scopus, ISI Web of Science, and PubMed) were searched for papers published from January, 2000 to December, 2013 using medical subject headings (MeSH), Emtree, and related keywords (metabolic syndrome, dysmetabolic syndrome, cardiovascular syndrome, and insulin resistance syndrome) combined with the words "prevalence" and "Iran." The Farsi equivalent of these terms and all probable combinations were used to search Persian national databases (IranMedex, Magiran, SID, and Irandoc).

Study Selection: All population-based studies and national surveys that reported the prevalence of MetS in healthy Iranian adults were included.

Data Extraction: After quality assessment, data were extracted according to a standard protocol. Because of between-study heterogeneity, data were analyzed by the random effect method.

Results: We recruited the data of 27 local studies and one national study. The overall estimation of MetS prevalence was 36.9% (95% CI: 32.7 - 41.2%) based on the Adult Treatment Panel III (ATP III) criteria, 34.6% (95% CI: 31.7 - 37.6%) according to the International Diabetes Federation (IDF), and 41.5% (95% CI: 29.8 - 53.2%) based on the Joint Interim Societies (JIS) criteria. The prevalence of MetS determined by JIS was significantly higher than those determined by ATP III and IDF. The prevalence of MetS was 15.4% lower in men than in women (27.7% versus 43.1%) based on the ATP III criteria, and it was 11.3% lower in men based on the IDF criteria; however according to the JIS criteria, it was 8.4% more prevalent in men.

Conclusions: There is a high prevalence of MetS in the Iranian adult population, with large variations based on different measurement criteria. Therefore, prevention and control of MetS should be considered a priority.

Keywords: Metabolic Syndrome, Prevalence, Meta-Analysis, Iran

1. Context

Metabolic syndrome (MetS) (1) is a collection of interrelated disorders, namely obesity, dyslipidemia, hyperglycemia, and hypertension. Each MetS component increases the risk of cardiovascular disease (CVD), diabetes, and all-cause mortality. According to a study conducted by Gami et al., the synergistic effects of these disorders increase the risk of further disease and mortality much more than the sum of the risk increases from each component (2). However, other studies have provided different results (3-5). MetS increases total mortality from cardiovascular disease by 1.5 fold and risk for cardiovascular death by 2.5 fold (6). Moreover, individuals with MetS are five times more likely to develop type 2 diabetes (7). The main causes of MetS remain to be determined. However, it seems that abdominal obesity and insulin resistance are the key components (6-8). The most commonly used

definitions for MetS are those provided by the world health organization (WHO), the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III), the international diabetes federation (IDF), and the joint interim societies (JIS), as presented in following sections.

MetS is a common disorder, and given that its predisposing factors including obesity, sedentary lifestyle, and exposure to some environmental factors are escalating in many countries, the incidence of MetS is increasing as well (9). Therefore, MetS is now an emerging health problem at the public and individual levels. Because programs for primary prevention of non-communicable diseases emphasize appropriate evaluation and management of risk factors, (10) gathering reliable information about the prevalence of MetS in various populations can be very effective in the planning and use of preventive strategies for such diseases.

The prevalence of MetS is not only influenced by excess weight but also by ethnic predisposition, gender, age, race, cultural and lifestyle habits, and environmental factors; thus, its prevalence has large variations in different societies (11, 12). Grundy reported that between 20% and 30% of the adult population in most countries have MetS (13). Asians have an ethnic predisposition to MetS (14, 15), and it is of special concern for Middle Eastern populations, which are predicted to experience the greatest global burden of diabetes by 2020 (14). As a country in this region, Iran is reported to have one of the highest prevalence rates of MetS worldwide (16). The nationwide prevalence of MetS is reported to be 35.6% based on ATP III criteria (14). In metropolitan Tehran, 42% of women and 24% of men have MetS, with a total age-standardized prevalence of 33.7% (16). Iran is a vast country with about 70 million people and different ethnicities including Turkish, Kurdish, Arab, Fars, Turkmen, and Baluch living in different regions of the country. The difference in their cultures, socioeconomic status, lifestyle habits, and environmental factors may cause variation in the prevalence of MetS (17-23), so it is very important to have an overall estimation of its prevalence in Iran.

2. Objectives

This study aimed to systematically review the findings of available studies and to combine them to estimate the overall prevalence of MetS in Iran. The other objective of this study was to explore potential sources of heterogeneity in the study findings.

3. Data Sources

The English-language medical literature was searched from January, 2000 to December, 2013 in Scopus, ISI Web of Science, and PubMed. Using medical subject headings (MeSH), Emtree, and related keywords, we searched for "metabolic syndrome," "dysmetabolic syndrome," "cardiovascular syndrome," and "insulin resistance syndrome" combined with "prevalence" and "Iran," including all subheadings. The Farsi equivalent of these terms and all probable combinations were used to search in Persian databases (i.e., IranMedex, Magiran, SID, and Irandoc). Moreover, the references of selected citations and non-published national surveys were hand-searched. In addition, when articles had incomplete data, at least three e-mails were sent to corresponding authors.

4. Study Selection

All types of studies, including local and national surveys that reported the prevalence of MetS and were conducted in Iran were reviewed. However, the final review was limited to studies with random sampling on healthy adults and/or on the general population who were aged 18 years and over. The studies that were conducted on subjects with known health disorders were excluded. In the case of multiple publications from the same population, only the largest study was included. The STROBE (strengthening the reporting of observational studies in epidemiology) statement was used for quality control of the studies (24). The quality of studies was assessed according to variables related to the study objectives, characteristics of the study population, clearly explained inclusion/exclusion criteria, data collection method, as well as the validity, explicit findings, and appropriate data analysis methods of the studies. Non-qualified studies were excluded. Moreover, duplicated citations were not included.

5. Data Extraction

After determining the qualified papers, data were extracted according to a standard protocol. To improve accuracy and critical appraisal, data extraction was conducted by two independent researchers, and disputes between researchers were resolved by consensus. The following items were extracted from the studies:

General information: first author's name, study location, study date, publication date, definition used for MetS

Population characteristics: sex groups, mean age, and age range

Methodological information: sampling method, sample size, scope of study (urban, rural, or survey)

Study outcomes: reported prevalence of MetS extracted by sex (men, women, and total), and its 95% confidence interval (CI) concerning the prevalence of MetS components.

5.1. Statistical Analysis

Prevalences are reported with 95% confidence intervals (CI). A Chi-square-based Q test was used to analyze the heterogeneity of reported prevalences and was regarded to be statistically significant at $P < 0.1$. Tau-square ($\tau 2$) was estimated (using the restricted likelihood method) as the indicator of heterogeneity. After using the heterogeneity test, we found significant variations between study findings; thus, in order to obtain better results, the random effect model was used to estimate the overall prevalence of MetS in Iran. The findings are described in forest plots (the point estimations and their 95% CI). In the next step,

meta-regression was used to check the effects of age and publication date as possible sources of heterogeneity among the study findings. The analyses were conducted with STATA software, version 11.0.

6. Results

In our primary search, and after removing duplicates, we found 379 relevant articles. After excluding non-eligible studies, we recruited the data of 27 local studies and one national study, which included all provinces of Iran. The details of our study selection method are shown in Figure 1. In each selected study, the prevalence of MetS was reported according to different criteria. Among the 28 studies, we found 21 reports given according to ATP III (including 12 based on ATP III (25) and nine based on modified ATP III (26)), six reports according to IDF (7), and one report according to the Iranian modified IDF (27), one report according to the WHO criteria, (28) and five reports according to the JIS criteria (29).

The findings of this systematic review are summarized in Table 1. For data analysis, we merged the ATP III and modified ATP III reports. The reports of IDF and Iranian modified IDF (27) were also merged; the meta-analysis was performed on three groups of reports: ATP III, IDF, and JIS. The only study that had used the WHO criteria for MetS was excluded from the analysis. If an article reported the prevalence of MetS according to both ATP III and modified ATP III, both were used as separate reports in the analysis.

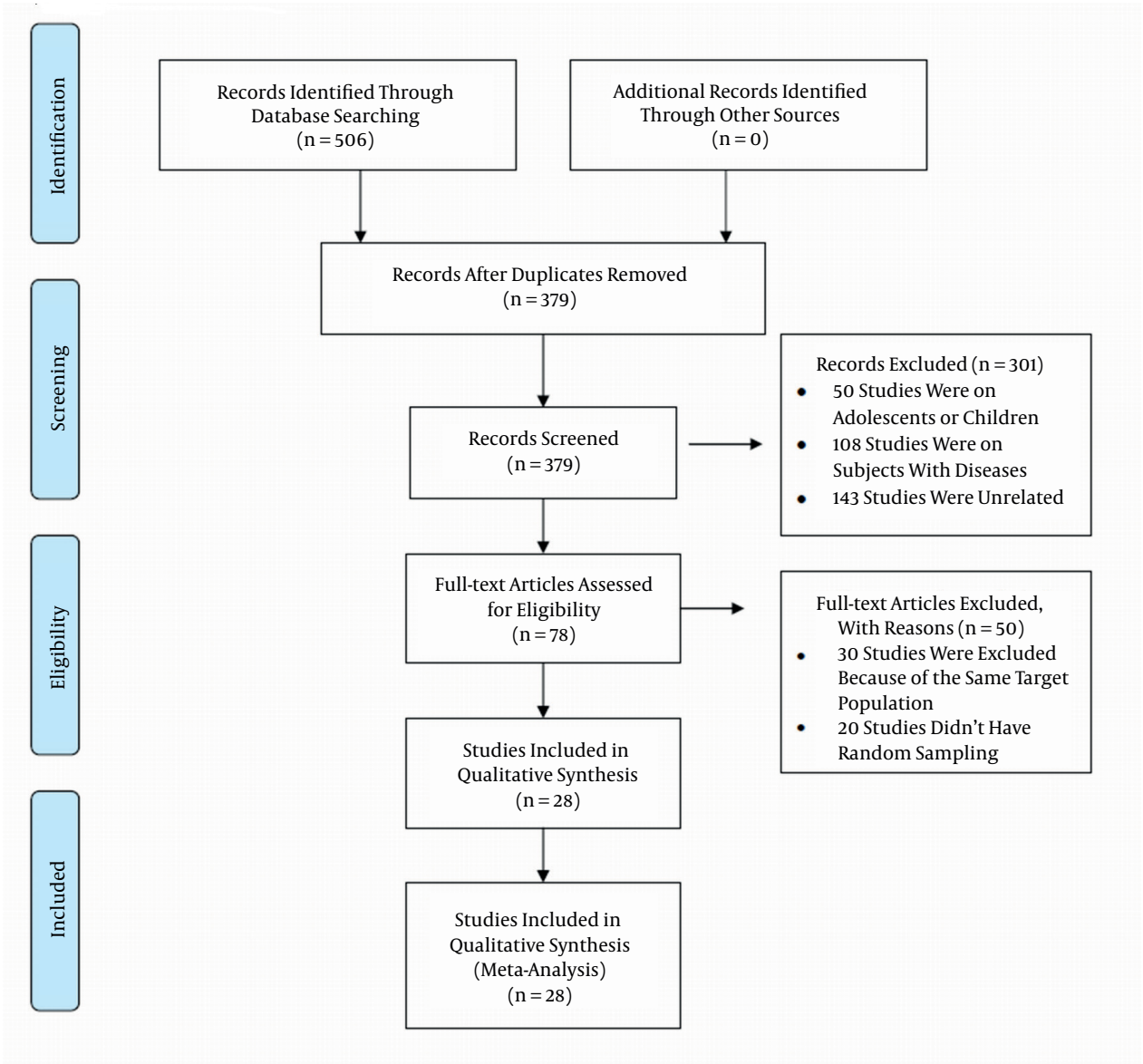

Figure 1. Flow Diagram of the Study Selection Process

Table 1. The Prevalence (95% CI) of Metabolic Syndrome in Iranian Adults in Population-Based Studies

Reference	Location and Study Type	Study Population	Sampling Method	Study Date	Publication Date	Age Range, Y	Mean Age (Mean ± SD)	Gender	Urban/ Rural	Sample Size	Criteria	Considerations	Prevalence of MetS (95% CI)
Faam et al. (30)	Tehran (TLGS, phase 3), local study	Healthy adults	Random sampling	2005 - 2008	2013	20 - 70	T: 40.7 ± 13.9	Both	U	T: 4,665; M: 1,976; F: 2,689	JIS	Participants who had diabetes mellitus (n = 390) or body mass index (BMI) less than 18 kg/m (n = 152) were exclude.Waist circumference cut-off points were not mentioned	T: 31.5 (30.1 - 32.8)
Ziaee et al. (31)	Mindoodar district of Qazvin, local study	Healthy adults	Multistage random cluster sampling	2010 - 2011	2013	20 - 78	T: 40.08 ± 10.33; M: 42.31 ± 10.56; F: 38.02 ± 9.69	Both	R	T: 1,107; M: 529; F: 578	JIS	Waist circumference cut-off points were ≥ 94 cm in men or ≥ 80 cm in women	T: 39.3 (36.4 - 42.2)
Movahed et al. (32)	Bushehr Port, (Iranian Multicentral Osteoporosis Study), local study	Postmenopausal women	Randomcluster sampling	2006	2012	50 - 83	F: 58.78 ± 7.8	F	U	T: 382	ATP III		T: 68.32 (63.3 - 72.9)
Yousefzadeh et al. (33)	Kerman,local study	Healthy adults	Random sampling		2012	15 - 75	T: 46.52 ± 14.76	Both	U	T: 200; M: 81; F: 119	Modified ATP III		T: 60 (52.8 - 66.8)
Azimi-Nezhad et al. (34)	Greater Khorasan province, (National Survey on Non-communicable Disease), local study	Healthy adults	Multistage random sampling	2003	2012	35 - 55		Both		T: 1,194; M: 58; F: 605	Modified ATP III		T: 42.66 (39.8 - 45.4); M: 30.1 (26.3 - 33.9); F: 55.0 (50.9 - 59.0)
Hadaegh et al. (35)	Tehran (TLGS, phase 1), local study	Subjects free of CVD	Random sampling	1999 - 2001	2012	40 ≤	T:54 ± 9.8; M: 55.3 ± 10.5; F: 53.0 ± 9.3	Both	U	T: 4,248; M:1,856 F:2,392	JIS	Waist circumference cut-off point was ≥ 94.5 cm for both Iranian men and women	T: 51.6 (50 - 53.1); M: 45.7 (43.4 - 47.9); F: 56.2 (54.1 - 58.1)
Talaei et al. (36)	Isfahan, Arak and Najafabad, local study	Healthy adults	Multistage random sampling	2001	2012	≥ 35	T: 50.7 ± 11.6; M: 51.1 ± 11.9; F: 50.3 ± 11.3	Both	Both	T: 6,323; M: 3,068; F: 3,255	Modified ATP III		T: 37.1 (35.9 - 38.3); M: 21.5 (20.0 - 23.0); F: 51.7 (49.9 - 53.4)
Zarkesh et al. (37)	Tehran, (TLGS, phase III), local study	Healthy adults	Random sampling	2006 - 2008	2012	≥ 19	T: 46.1 ± 16.1	Both	U	T: 365; M: 134; F: 231	JIS	Waist circumference cut-off point was > 89 cm in men and > 91 cm in women	T: 43.8 (38.6 -49)
Ghorbani et al. (38)	Semnan, local study	Healthy adults	Multistage random sampling	1384	2012	30 - 70	T: 45.7 ± 10.06; M: 46.6 ± 10.4; F: 45.1 ± 9.8	Both	Both	T: 3,799; M: 1,695; F: 2,104	Modified ATP III; IDF		T: 28.5 (27.1 - 29.9); M: 17 (15.2 - 18.8); F: 37.8 (35.7 - 39.8). T: 35.8 (34.3-37.3); M: 25.4 (23.3-27.5); F: 44.1 (41.9-46.2)

Rezaianzadeh et al. (39)	Yazd (phase I of Yazd Healthy Heart Program)	Healthy adults	Cluster sampling	2004 - 2005	2012	20 - 74	T: 48.75 ± 15; M: 48.8 ± 15; F: 48.6 ± 15	Both	U	T: 2,000	IDF		T: 30.16 (0.02); M: 31.6 (0.02); F: 30.2 (0.02)
Hosseinpanah et al. (40)	Ghazvin, Kermanshah, Golestan, and Hormozgan (Iranian PCOS Prevalence Study), multicity study	Females	Stratified, multistage cluster sampling	2009 - 2010	2011	18 - 45	T: 36 ± 7.5	F	U	T: 423	JIS	Waist circumference cut-off point was ≥ 91 cm	T: 18.3 (15.1 - 21.5)
Esteghamati et al. (27)	Tehran, (the Third National Surveillance of Risk Factors of Non-communicable Diseases), local study	Individuals with body mass index < 18.5 kg/ m^2 were excluded	Random Cluster sampling	2007	2011	25 - 64	T: 43.18 ± 0.3; M:43.4 ± 0.3; F: 43.0 ± 0.3	Both	U	T: 2,660; M: 1,245; F: 1,415	Modified ATP III; Iranian modified IDF (waist circumference cut-off point was ≥ 90 cm for both men and women)	Individuals with self-reported diabetes were excluded	T: 38.09 (36.23 - 39.9); M: 29.9 (27.3 - 32.5); F: 45.3 (42.6 - 47.9). T: 38.4 (36.5-40.2); M: 39.1 (36.3-41.8); F: 37.8 (35.2-40.3)
Sahebari et al. (41)	Great Khorasan province, local study	Healthy adults			2011		T: 45.6 ± 12; M: 44.7 ± 12; F: 44.1 ± 13	Both	Both	T: 500; M: 69; F: 431	ATP III; IDF		T: 53.8 (49.3 - 58.2); M: 21.7 (12.7 - 33.3); F: 51 (46.2 - 55.8). T: 34.2 (30 - 38.5); M: 29 (18.6 - 41.1); F: 57.8 (52.9 - 62.4)
Esmaillzadeh et al. (42)	Tehran, local study	Female teachers	Multistage random cluster sampling	2007	2011	40 - 60	T: 49 ± 6	F	U	T: 486	ATP III	Subjects taking antihypertensive, lipid lowering, or antidiabetic medications were excluded	T: 30 (25.9 - 34.3)
Esteghamati et al. (43)	All 30 provinces of Iran (the Third National Surveillance of Risk Factors of Non-Communicable Diseases) (SuRFNCD), national study	Healthy adults	Random cluster sampling	2007	2011	25 - 64	T: 43.59 ± 11.2; M: 43.69±11.6; F: 43.5 ± 10.9	Both	Both	T: 3,045; M: 1,468; F: 1,577	IDF	Waist circumference cut-off point was ≥ 90 cm in both males and females	T: 39.9 (38.1 - 41.6); M: 38.2 (35.7 - 40.7); F: 41.5 (39 - 43.9)
Ramezani et al. (44)	Ghazvin, Kermanshah, Golestan, and Hormozgan, multicity study	Healthy adults	Multistage random cluster sampling		2011	18 - 45		F	U	T: 914	Modified ATP III		T: 17.5 (15.09 - 20.1)
Ghasemi et al. (45)	Tehran, (TLGS, phase 3), local study	Healthy adults	Multistage, stratified random cluster sampling	2007 - 2008	2010	60 - 90		Both	U	T: 137; M: 89; F: 48	ATP III		T: 43.8 (35.3 - 52.5); M: 30.3 (21.03 - 40.99); F: 68.8 (53.6 - 61.3)

Delavari et al. (14)	All 30 provinces in Iran, national study	Healthy adults	Multistage Random cluster sampling	2007	2009	25 - 64	T: 41.3 ± 3.81; M: 41.5 ± 2.64; F: 41.2 ± 2.74	Both	Both	T: 2,966 M: 1,431; F: 1,535	ATP III; Modified ATP III		T: 35.6 (34.1 - 37.1); M: 28.8 (27.0-30.5); F: 42.8 (40.4 - 45.1). T: 42.3 (40.7-43.8); M: 36.3 (34.4-38.1); F: 48.5 (46.2-50.9)
Jalali et al. (46)	Akbar abad Koar Fars near Shiraz, local study	Healthy adults	Simple random sampling	2008	2009	18 - 90	T: 38.7 ± 14.3; M: 40.5 ± 15.9; F: 37.4 ± 13.7	Both	R	T: 1,402; M: 360; F: 1,042	ATP III; Modified ATP III; IDF		T: 25.6 (23.3 - 27.9); M: 29.16 (24.5 - 34.1); F: 24.28 (21.7 - 27.0). T: 29 (26.5 - 31.4). T: 33 (30.4 - 35.4)
Delavar et al. (47)	Babol, local study	Female adults	Systematic random sampling		2009	30 - 50	F: 40.2 ± 0.2	F	U	T: 944	ATP III		T: 31 (28.1-33.9)
Sharifi et al. (48)	Zanjan, local study	Healthy adults	Stratified, multistage random sampling	2002 - 2003	2009	> 20		Both	U	T: 2,941; M: 1,396; F: 1,545	Modified ATP III		T: 23.7 (22.1 - 25.2); M: 23.1 (20.8 - 25.2); F: 24.4 (22.2 - 26.5)
Sarrafzadegan et al. (49)	Isfehan, Irak, and Najaf-Abad, local study	Healthy adults	Two-stage random cluster sampling	2000 - 2001	2008	≥ 19		Both	Both	T: 12,514; M: 6,123; F: 6,391	ATP III		T: 23.3 (22.5 - 24.0); M: 10.7 (9.9 - 11.4) F: 35.1 (33.9 - 36.2)
Hadaegh et al. (50)	Tehran, (TLGS, phase 1), local study	Healthy adults	Multistage random cluster sampling	1999 - 2001	2008	≥ 20	T: 42.6 ± 13.6	Both	U	T: 4,568; M: 1,882; F: 2,686	WHO	Diabetes patients were excluded	T: 9.2 (8.3 - 10.0)
Zabetian et al. (51)	Tehran, (TLGS, phase 1), local study	Healthy adults	Multistage random cluster sampling	1999 - 2001	2007	≥ 20	T: 42.7 ± 15.0 ; M: 44.1 ± 15.6; F: 41.7 ± 14.4	Both	U	T: 10,368 M: 4,397; F: 5,971	IDF		T: 31 (30.1 - 31.8); M: 21 (19.7 - 22.2); F: 41 ; (39.7 - 42.2)
Nabipour et al. (52)	Bushehr, Genaveh, and Deilam, local study	Healthy adults	Random Cluster sampling	2003 - 2004	2007	≥ 25		Both	Both	T: 3,723; M: 1,746; F: 1,977	ATP III		T: 52.1 (47.3 - 50.6); M: 54.6 (50.3 - 53.6); F: 49.9 (44.5 - 48.5)
Sadrbafghi et al. (53)	Yazd, local study	Healthy adults	Random Cluster sampling	2004	2006	20 - 74	T:49 ± 18; M: 48.9 ± 15.4; F: 49.2 ± 21.4	Both	U	T: 1,110; M: 550; F: 557	ATP III		T: 32.1 (29.3 - 34.9); M: 37.8 (33.7 - 42.0); F: 62.2 (57.9 - 66.1)
Fakhrzadeh et al. (54)	Tehran, local study	Healthy adults	Single-stage cluster sampling	2003	2006	25 - 64	T: 41.26 ± 12.06	Both	U	T: 1,480; M: 571; F: 909	ATP III		T: 29.9 (27.6 - 32.2); M: 20.3 (17.08 - 23.85); F: 35.9 (32.74 - 39.07)
Azizi et al. (16)	Tehran, (TLGS, phase 1), local study	Healthy adults	Multistage, stratified random cluster sampling	1999 - 2001	2003	≥ 20		Both	U	T: 10,368; M: 4,397; F: 5,971	ATP III		T: 33.7 (32.8 - 34.6); M: 24 (22.7 - 25.2); F: 42 (40.7 - 43.2)

The total sample sizes of studies using the criteria of ATP III, IDF, and JIS were 54,043, 23,774, and 1,088, respectively (Table 2). For ATP III criteria, the maximum and minimum sample sizes were 12,514 (in Isfahan) and 137 (in Tehran), respectively. Maximum and minimum sample sizes for IDF were 10,368 and 486 (both in Tehran) and for JIS, they were 4,665 and 365 (both in Tehran), respectively. The overall estimation of MetS prevalence was 36.9% (95% CI: 32.7 - 41.2%) according to ATP III, 34.6% (95% CI: 31.7 - 37.6%) for IDF, and 41.5% (95% CI: 29.8 - 53.2%) based on the JIS criteria (Table 2 and Figure 2). The prevalence of MetS measured by JIS was higher than those measured by the ATP III and IDF definitions (41.5% versus 36.9% and 34.6%); however, this difference was not statistically significant. Maximum and minimum prevalence rates of MetS were 60% and 23% based on the ATP III criteria, 40% and 30% for the IDF criteria, and 52% and 31% for the JIS criteria, respectively (Figure 2).

Table 2. The Overall Prevalence of Metabolic Syndrome in the Iranian Adult Population According to Different Criteria and Sex Using Random Effect Meta-Analysis of Data From Population-based Studies

Criteria	Extracted articles (n)	Sample size (n)	Prevalence (%)	CI 95%
ATP III				
Male	15	24,760	27.7	21.8 - 33.6
Female	19	32,046	43.1	37.9 - 48.4
Total	17	54,043	36.9	32.7 - 41.2
Heterogeneity ATP III (I-square)				
Male	99.9%	P < 0.001		
Female	99.8%	P < 0.001		
Total	99.8%	P < 0.001		
IDF				
Male	6	9,874	30.7	23.9 - 37.5
Female	6	12,498	42.0	37.4 - 46.6
Total	7	23,774	34.6	31.7 - 37.6
Heterogeneity IDF (I-square)				
Male	99.6%	P < 0.001		
Female	99%	P < 0.001		
Total	98.9%	P < 0.001		
JIS				
Male	1	1,856	45.7	44.6 - 46.8
Female	2	2,815	37.3	32.4 - 42.2
Total	4	10,385	41.5	29.8 - 53.2
Heterogeneity JIS (I-square)				
Male	-			
Female	99.9%	P < 0.001		
Total	99.8%	P < 0.001		

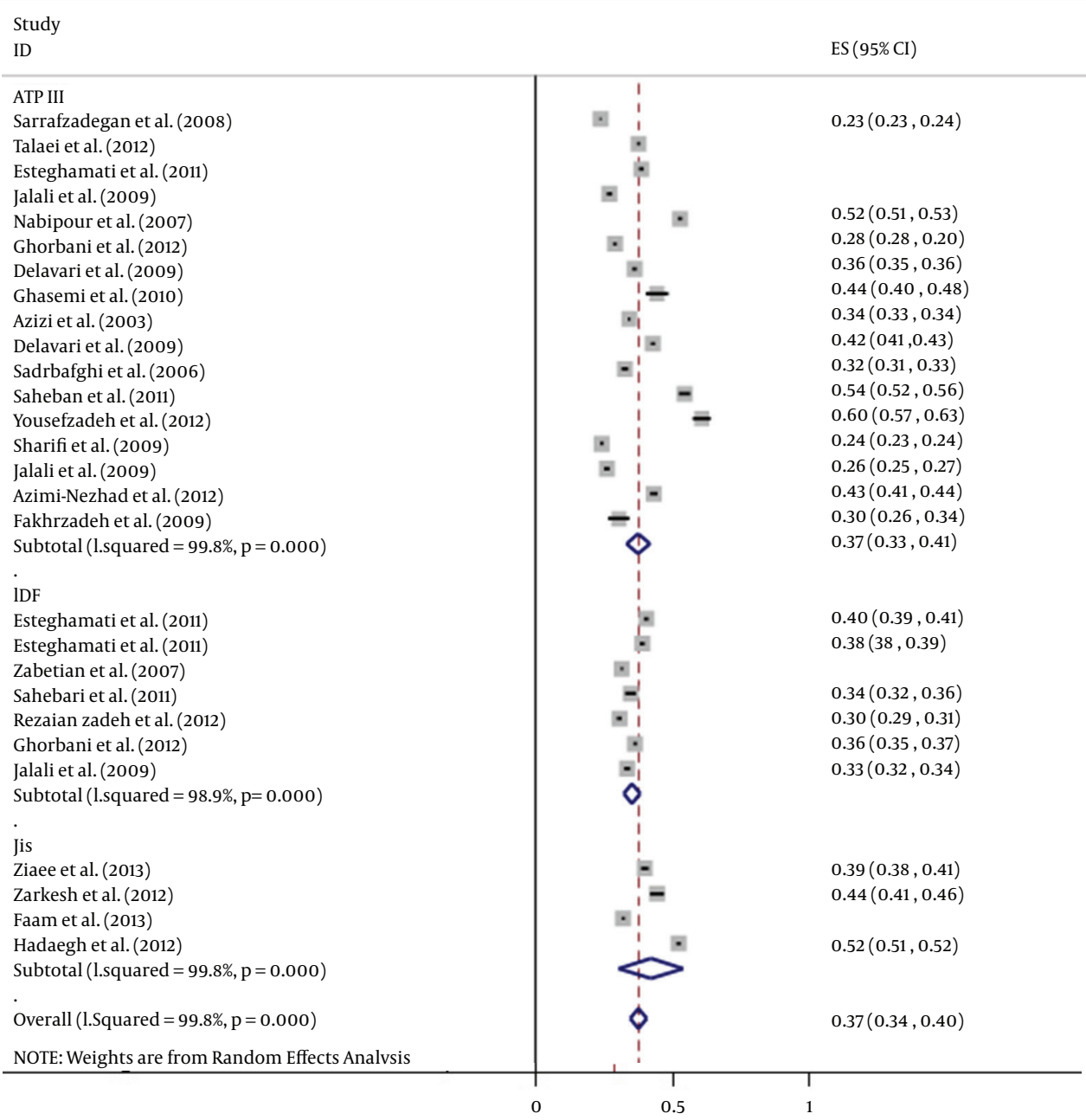

Figure 2. Forest Plot of the Prevalence of Metabolic Syndrome in the Iranian Adult Population

According to the ATP III criteria, the prevalence of MetS was significantly (15.4%) lower in men than in women (27.7% versus 43.1%, respectively). The same trend was obtained for the IDF definition, which found MetS to be 11.3% less prevalent in men than in women (30.7% versus 42.0%, respectively). However, the reverse was true for the

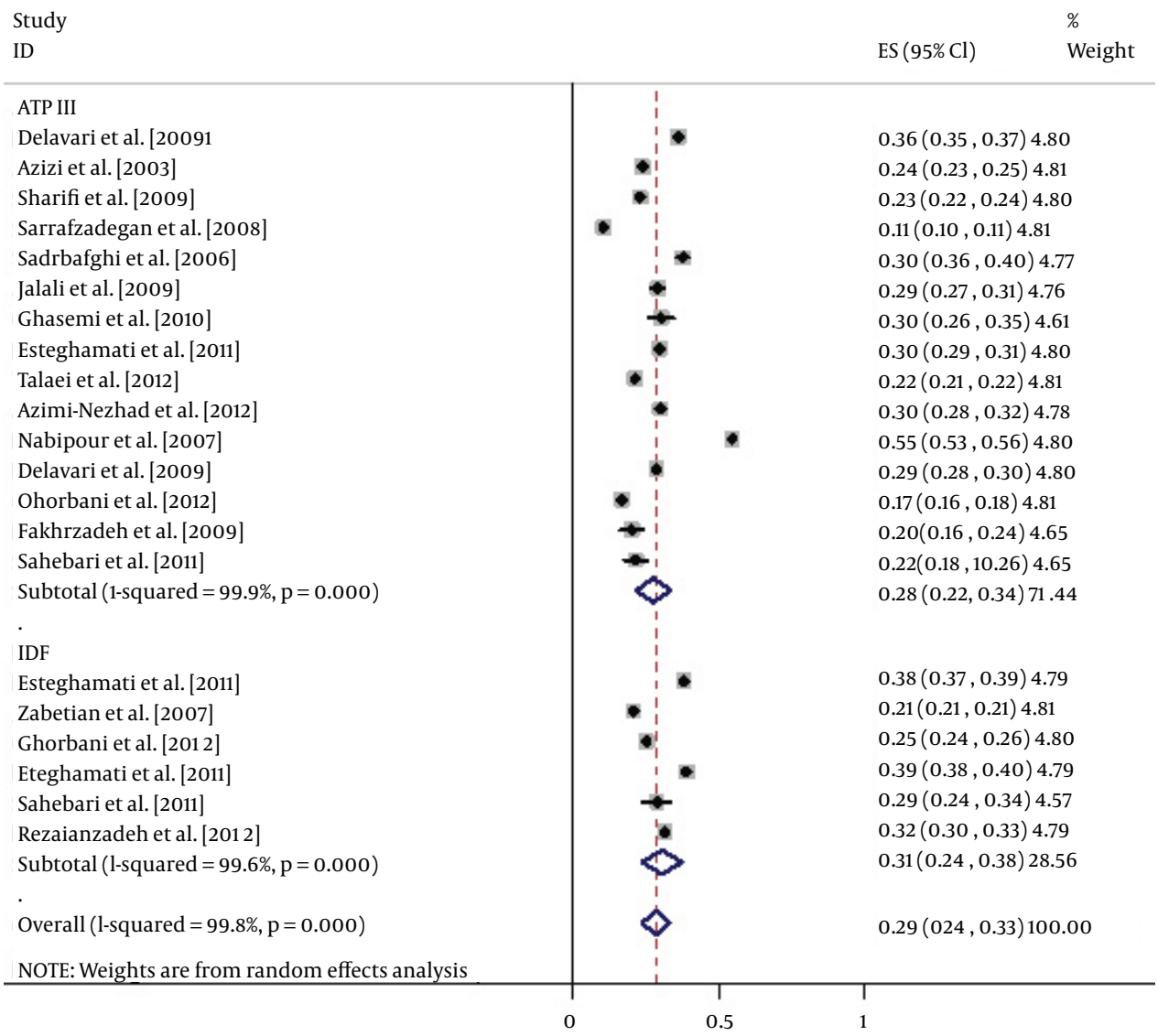

Figure 3. Forest Plot of the Prevalence of Metabolic Syndrome in the Iranian Male Adult Population

JIS definition, which showed a significantly higher (8.4%) prevalence in men than in women (45.7% versus 37.3%, respectively) (Table 2, Figures 3 and 4).

The results of the meta-regression show that the main source of heterogeneity in findings was the mean age of participants. The results show that by each year increase in the mean age of individuals after the age of 18, the prevalence of MetS increased by 0.004% (coefficient: 0.0048792, P = 0.005).

Nine studies reported the prevalence of MetS components according to different criteria (Table 3). Among these studies, in six the prevalence of components was calculated in subjects with MetS. Most of the subjects with MetS had three components (54.7% - 95%). The prevalences of four and five components in MetS subjects were 0.6 - 34% and 0 - 11.8%, respectively.

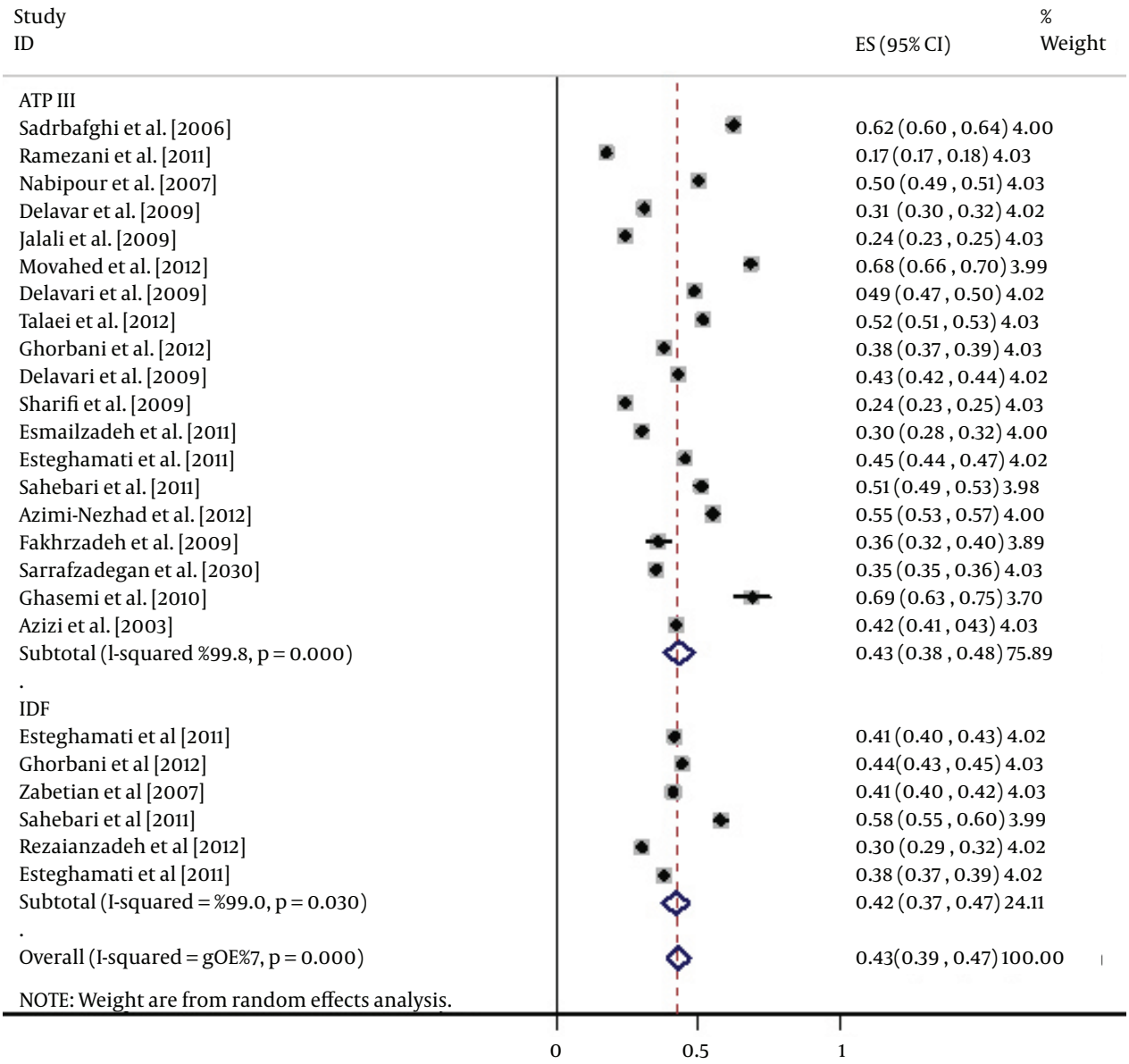

Figure 4. Forest Plot of the Prevalence of Metabolic Syndrome in the Iranian Female Adult Population

Table 3. Prevalence of Metabolic Syndrome Components in the Iranian Adult POPULATION in Population-Based Studies[a]

Reference	Location and type of study	Study population	Sampling method	Study date	Publication date	Age range (years)	Mean age (mean ± SD)	Sex	Urban/ rural	Sample size	Criteria	Prevalence of MetS components (%)
Tohidi et al. (44)	Ghazvin, Kermanshah, Golestan, and Hormozgan, multicity study	Healthy adults	Multistage random cluster sampling		2011	18 - 45		F	U	T: 914	Modified ATP III	3 components: 11.4; 4 components: 5.1; 5 components: 1

Fakhrzadeh et al. (54)	Isfahan (cohort study), local study	Healthy adults	Random stratified sampling		2011	43 - 82	56.42 ± 9.52	Both	Both	T: 468; M: 236; F: 232	ATP III	3 components: 55.2; 4 components: 34; 5 components: 10.8
Jalali et al. (46)	Akbar abad Koar Fars near Shiraz, local study	Healthy adults	Simple random sampling	2008 (1387)	2009	18 - 90	T: 38.7 ± 14.3; M: 40.5 ± 15.9; F: 37.4 ± 13.7	Both	R	T: 1,402; M: 360; F: 1,042	ATP III; Modified ATP III; IDF	Total, 3 components: 95; 4 components : 0.6; 5 components: 4.5; male, 3 components: 99; 4 components: 0; 5 components:1; female, 3 components: 93.4; 4 components: 0.6; 5 components: 6. Total, 3 components: 66.3; 4 components: 27.1; 5 components: 6.7; male, 3 components: 71.4; 4 components: 26.1; 5 components: 2.5; female, 3 components: 64.1; 4 components: 27.5; 5 components: 8.4. Total, 3 components: 54.7; 4 components: 33.4; 5 components: 11.8; Male, 3 components: 38.4; 4 components: 44.8; 5 components: 16.8; Female, 3 components: 59; 4 components: 30.5; 5 components: 10.5
Delavar et al. (47)	Babol, local study	Female adults	Systematic random sampling		2009	30 - 50	F: 40.2 ± 0.2	F	U	T: 944	ATP III	1 component: 30.8; 2 components: 28.9; 3 components: 22.6; 4 components: 7.4; 5 components: 0.8
Sharifi et al. (48)	Zanjan, local study	Healthy adults	Stratified, multistage random sampling	2002 - 2003	2009	> 20		Both	U	T: 2,941; M: 1,396; F: 1,545	Modified ATP III	3 components: 75.6; 4 components: 24.4; 5 components: 0
Nabipour et al. (52)	Bushehr, Genaveh, and Deilam, local study	Healthy adults	Random cluster sampling	2003 - 2004	2007	≥ 25		Both	Both	T: 3,723; M: 1,746; F: 1,977	ATP III	0 components: 4.0; 1 component: 15.1; 2 components: 28.7; 3 components: 30.8; 4 components: 17.7; 5 components: 3.6
Sadrbafghi et al. (53)	Yazd, local study	Healthy adults	Random cluster sampling	2004 (1383)	2006	20 - 74	T: 49 ± 18; M: 48.9 ± 15.4; F: 49.2 ± 21.4	Both	U	T: 1,110; M: 550; F: 557	ATP III	0 components: 19.2; 1 component: 21.1; 2 components: 27.6; 3 components: 20.8; 4 components: 9; 5 components: 2.3
Fakhrzadeh et al. (54)	Tehran, local study	Healthy adults	Single stage cluster sampling	2003	2006	25 - 64	T: 41.26 ± 12.06	Both	U	T: 1,480; M: 571; F: 909	ATP III	0 component: 12; 1 component: 29; 2 components: 29.1; 3 components: 22.7; 4 components: 7.1; 5 components: 0.2
Azizi et al. (16)	Tehran, (TLGS, phase 1), local study	Healthy adults	Multistage stratified random cluster sampling	1999 - 2001	2003	≥ 20		Both	U	T:10,368; M: 4,397; F: 5,971	ATP III	Total, 3 components: 58; 4 components: 33; 5 components: 9; Male, 1 component: 29; 2 components: 32; 3 components: 16; 4 components: 7; 5 components: 1; Female, 1 component: 28; 2 components: 23; 3 components: 20; 4 components: 14; 5 components: 4

[a]Abbreviations: F, female; M, male; T, total.

7. Conclusions

Our findings show that the prevalence of MetS is relatively high in Iran according to all three definitions (ATP III: 36.9%, IDF: 34.6%, and JIS: 41.5%). These observed prevalence rates are noticeably higher than the estimated prevalence around the world, which is between 20% and 25% (7). The mean prevalence of MetS in Iran was found to be higher than in many other countries (e.g., Portugal [27.6%], (55) Spain [26.6%], (56) France [25% in males and 15.3% in females], (57) and Italy [22% in males and 18% in females]) (3). It was also higher than in the United States of America (22.9%) (58). The prevalence of MetS in Iran is much closer to that in North Africa (30%), (59) Asia-China (33.9%), (60) Turkey (36.6%), (60) and some Latin American countries such as Colombia (34.8%) (61)and Venezuela (35.3%) (62). Therefore it can be assumed that some reasons other than urbanization and inactivity have resulted in this relatively high prevalence of MetS in Iran. In a study conducted by Delavari et al., greater waist circumference values and lower HDL cholesterol have also been reported in Iranian communities than in Western populations, which support the idea of an ethnic predisposition of the Iranian community to MetS (14).

It is noteworthy to acknowledge that comparisons between Iran and other countries must be made with caution. First, because most of these studies were conducted in a small area or a city, they cannot be representative of the entire country. Thus, generalizing the estimated prevalence to a country is a point of concern. Second, it has been shown that MetS is highly age-dependent (63). This was also found in our study; the prevalence of MetS in the Iranian population increased around 0.004% by each year of age increase after the age of 18. Therefore, even in a study with population-based sampling, comparing countries with different age pyramids might result in different prevalence rates, even with comparable risks of MetS. In recent years, the population of Iran has been growing older, and this might be one of the reasons for such a high prevalence of MetS in this country.

Another finding of this study was the significantly higher prevalence of MetS and its reverse sex distribution according to JIS compared to the other two definitions. According to the ATP III and IDF definitions, MetS prevalence was significantly higher in women (15.4% and 11.3% higher than the prevalence in men, respectively). However, based on the JIS criteria, MetS was 8.4% more prevalent in men, which was also significant. The lack of consensus on MetS definitions and the cutoff points used for its components, especially regarding waist circumference, has resulted in these differences. In the JIS definition, the cutoff point for waist circumference is usually higher than those of ATP III and IDF for women and lower for men, which may have resulted in a higher prevalence of MetS being measured in men according to the JIS definition, and contrary to the ATP III and IDF definitions. These differences influence health policies and clinical practice, in which underestimation or overestimation may result in inappropriate distribution of health services. Barbosa et al. performed a cross-sectional study on 1,439 adults in Brazil and concluded that NCEP-ATP III (64) underestimated the prevalence of MetS, particularly in men. This study showed that MetS is a public health problem in Iran. It has a high prevalence and it is expected to have an increasing trend in coming years as the mean age of the Iranian population grows. Therefore, by implementing an appropriate screening and treatment system, many metabolic diseases (such as diabetes and cardiovascular disease) that are costly to society can be prevented.

The main limitation of this study is that estimated prevalences were not adjusted based on the size of the target populations. Regarding this point, the results of a cluster analysis method are much more reliable, but cluster sampling is not practical because it is very difficult and expensive to perform. It seems that meta-analysis could be an efficient substitute strategy.

The prevalence of MetS is relatively high in the Iranian adult population. The lack of consensus on MetS definitions has resulted in different reports of its prevalence. However, even considering the lowest prevalence of 34.6%, the prevalence of MetS in Iran is considerably higher than the estimated prevalence around the world (20 - 25%). Therefore, applying an appropriate screening and treatment system for MetS could prevent many chronic diseases that are costly to society.

Footnotes

Authors' Contribution: Study concept and design: Mostafa Qorbani, Hossein Fakhrzadeh; acquisition of data: Bahareh Amirkalali, Tahereh Samavat; analysis and interpretation of data: Mostafa Qorbani, Bahareh Amirkalali; drafting of the manuscript: Bahareh Amirkalali; critical revision of the manuscript for important intellectual content: Roya Kelishadi, Farhad Zamani, Farshad Sharifi and Saeid Safiri; statistical analysis: Mostafa Qorbani; administrative, technical, and material support: Hossein Fakhrzadeh, Hamid Asayesh; study supervision: Hossein Fakhrzadeh.

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