Menopause and metabolic syndrome in the Middle East countries; a systematic review and meta-analysis study

Ozra Tabatabaei-Malazy^{1,2} · Shirin Djalalinia^{1,3} · Hamid Asayesh⁴ · Yalda Shakori⁵ · Mohammad Esmaeili Abdar⁶ · Morteza Mansourian⁷ · Armita Mahdavi Gorabi⁸ · Mehdi Noroozi⁹ · Mostafa Qorbani^{10,11}

Received: 28 August 2018 / Accepted: 15 November 2018 / Published online: 27 November 2018
© Springer Nature Switzerland AG 2018

Abstract

Introduction Metabolic syndrome (MetS) prevalence that is associated with increasing risk of diabetes and cardiovascular diseases (CVD) has accelerated with age. Since, menopause is known as a partial cause of CVD acceleration with ageing among women, determining the prevalence of MetS is important in this condition. We aimed to assess critically the prevalence rate of MetS among menopausal women in the Middle East Countries in this systematic review meta-analysis study.

Methods & Materials International webdata bases including Scopus, ISI web of Science and PubMed were systematically searched using Medical Subject Headings terms from January 2000 to February 2017. We included all cross-sectional conducted in the Middle East that reported prevalence of MetS in menopause status regardless of MetS definition. Quality assessment was considered for each included study. The pooled prevalence of MetS based on the Adult Treatment Panel III (ATP III) was estimated using random effect method due to between-study heterogeneity by STATA software, version 11.0 (StataCorp, USA).

Results Within 60 studies, 21 and 17 studies were included in qualitative synthesis and meta-analysis respectively. The prevalence of MetS among menopausal women was estimated 54.87% (95% CI: 53.76–55.97) in the Middle East countries. In subgroup analysis based on country the prevalence rate of MetS in Iran and Turkey was estimated 58.78% (95% CI: 57.54–60.02), and 39.02% (95% CI: 36.57–41.47), respectively.

Conclusions MetS was highly prevalent as an alarming sign among menopausal women in the Middle East countries. Thus, it is an emergency requirement to promote healthy lifestyle. Also, early detection and treatment of women who reach menopause and are at great risk of developing MetS is necessary for prevention of diabetes and CVD in the region.

Keywords Metabolic syndrome · Menopause · Prevalence · Middle East · Systematic review

✉ Mostafa Qorbani
mqorbani1379@yahoo.com

¹ Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

² Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

³ Development of Research and Technology Center, Deputy of Research and Technology, Ministry of Health and Medical Education, Tehran, Iran

⁴ Department of Medical Emergencies, Qom University of Medical Sciences, Qom, Iran

⁵ Student Research Committee, Alborz University of Medical Sciences, Karaj, Iran

⁶ Social Determinants of Health Research Center, Alborz University of Medical Science, Karaj, Iran

⁷ Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran

⁸ Department of Basic and Clinical Research, Tehran Heart Center, Tehran University of Medical Sciences, Tehran, Iran

⁹ Social Determinants of Health Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

¹⁰ Non-communicable Diseases Research Center, Alborz University of Medical Sciences, Karaj, Iran

¹¹ Chronic Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

Introduction

Metabolic syndrome (MetS) is a cluster of several components including central obesity, hypertension, dyslipidemia, and hyperglycemia [1]. Within several definitions of MetS, National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) definition is the most widely used [2]. MetS prevalence was reported 22% in the US in 2002 with an age dependent increasing manner [2]. Its prevalence was higher in women than in men. It was shown that the prevalence has continued to increase, particularly in women [3]. Third National Health and Nutrition Examination Survey (NHANES III) reported the MetS prevalence as 26.5% in women >20 years, 36.3% in aged 40–59 years, and 50.2% in aged >60 years [3]. Above figures were changed in NHANES 1999–2006 report as 34.1%, 36.3%, and 56.8%, respectively [3]. In addition to age, some other factors that are increased risk of MetS include race, weight, and menopausal condition [4]. Since, the MetS' components are associated with five or two folds increasing in the risk of type 2 diabetes mellitus (T2DM) or cardiovascular disease (CVD), respectively [5–7], its increased prevalence is likely to lead to future increases in these disorders. Menopause is known as a partial cause of CVD acceleration among ageing women [8]. Therefore, determining the prevalence of MetS is important in menopausal women. Some systematic review studies have been conducted to determine the prevalence of MetS in different population with and without considering menopause [3, 9–12]. Since the prevalence of MetS is not clear among menopausal women in the Middle East countries, we aimed to assess critically this topic in a systematic review with meta-analysis study.

Methods

Search strategy

To obtain all related studies, three international webdata bases including Scopus, ISI web of Science and PubMed were systematically searched according to preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline [13] from January 2000 to February 2017. The search terms were developed concentrating on “MetS and its components”, “prevalence” and “geographical domain of the Middle East region” including Bahrain, Cyprus, Egypt, Iraq, Iran, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirate, Yemen, and Middle East. The search term strategy is shown in supplementary file. We searched for English published cross-sectional studies conducted in human subject. Moreover, the references of selected citations were hand-searched. We sent at least 3 e-mails to corresponding authors in case of incomplete data.

Inclusion and exclusion criteria

We included all cross-sectional conducted in the Middle East on prevalence of MetS in new cases of menopause regardless of MetS definition. Menopause status was defined in all women above 40 years of age who missed menstrual period (spontaneous or surgical) of over 12 continuous months [14, 15]. If there were found multi-publications from the study, it was included the paper that consist more complete reported data. We included studies which assessed prevalence of MetS in menopausal women with specific groups.

Data management

The bibliographic information of searched studies was saved on Endnote software for further reference management. Through all processes of data refinement, including titles, abstracts and full texts review were followed by two independent experts. After exclusion of duplicated articles and irrelevant articles, the full texts and reference list of remained studies were assessed. In addition, the reference lists of the included articles were assessed to find further articles. Possible disagreements were resolved by discussion and consensus.

Quality assessment and data extraction

The quality assessment and data extraction of eligible remained papers has been conducted independently by two independent research experts and probable discrepancy between them was resolved through referencing the third expert opinion. The strengthening the reporting of observational studies in epidemiology (STROBE) statement was used for quality assessment of each included study [16]. It was considered the following STROBE items for quality assessment; study objectives, characteristics of the participants, data collection method, statistical methods, descriptive data, and main results. Non-qualified studies were excluded.

The extracted information from literature included the name of the first author, the year of publication, the study region (country), type of study, total sample size, sampling method, urban/rural location, age groups, menopausal condition, MetS definition criteria, reported prevalence of MetS and its 95% confidence interval (CI95%).

Ethical considerations

Present study was approved by the ethical committee of Alborz University of Medical Sciences. All of included studies in our review would be cited in all reports and all publications of our study. Whenever we needed more information about a certain study, for obtaining required information, we contacted the corresponding author.

Statistical analysis

Heterogeneity of reported prevalence was assessed by the Chi-square-based Q -test and was regarded to be statistically significant at $P < 0.1$. The degree of heterogeneity was estimated using I^2 statistic [17]. In order to estimate the pooled prevalence of MetS, it was used random effect method meta-analysis (using the DerSimonian and Laird method) due to heterogeneity between studies. Finally, the pooled prevalence and its 95% CI was presented in forest plot according to country. The analyses were conducted with STATA software, version 11.0 (StataCorp, USA).

Results

The number of the initial search results and included studies are shown in the Fig. 1. In the primary search, 60 full text articles

were related to our topic. After considering inclusion and exclusion criteria, 20 articles were included to qualitative analysis [8, 15, 18–35]. In each selected study, the prevalence of MetS was reported according to different criteria; 17 reports based on NCEP ATP III [8, 15, 18–29, 31, 33–35], 3 reports [22, 27, 32] based on IDF (2 reports were separately given prevalence data based on NCEP ATP III and IDF criteria), 2 reports based on World Health Organization (WHO) and the other based on American Heart Association (AHA) [26, 30]. The extracted data from these studies are shown in Table 1.

Due to report of MetS prevalence in most of studies (17 studies) was based on NCEP ATP III criteria, meta-analysis was performed according to this criteria. Severe heterogeneity was found between-studies in reported prevalence ($I^2 = 97.3\%$, $P < 0.001$). Thus, data was analyzed using meta-analysis random effect models. Overall, the prevalence of MetS in 17 meta-analyzed studies with a total sample size of 7514 menopausal

Fig. 1 Flow diagram of the study selection process

Table 1 Characteristics of included studies in qualitative synthesis

Ref.	Country	Sampling Method	Age(yr) (Mean $\pm$ SD)	Urban/ Rural	Sample Size	Definition of MetS	Quality assessment score	Prevalence % (n)/(95%CI)
Ainy et al. 2007 [18]	Iran	Random Sampling	45–66	U	1645	ATP III	33	66.14(1088)/(63.8–68.4)
Ozdemir et al. 2009 [19]	Turkey	Randomly admitted to clinic	>40/53.01 $\pm$ 4.8	U	95	ATP III	34	40 (38)/(30.1–50.6)
Ebrahimpour et al. 2010 [20]	Iran	Simple-stage cluster random sampling	25–64/56.5 $\pm$ 5.8	U	285	ATP III	33	60.0 (171)/(54.1–65.7)
Eshraghi et al. 2010 [8]	Iran	Consecutive recruitment	20–76/57.0 $\pm$ 7.3	U	215	ATP III	36	54.0 (116)/(47.0–60.8)
Heidari et al. 2010 [15]	Iran	Consecutive recruitment	>45/51.5 $\pm$ 5.8	U and R	1220	ATP III	34	63.07 (769)/(60.3–65.7)
Nabipour et al. 2010 [21]	Iran	Random Sampling	50–83/58.8 $\pm$ 7.8	U	382	ATP III	37	68.3 (261)/(63.4–73.0)
Akbulut et al. 2011 [22]	Turkey	Random Sampling	30–64/56.2 $\pm$ 4.19	U	286	ATP III	35	47.6 (136)/(41.6–53.5)
Ziaei et al. 2011 [23]	Iran	Consecutive recruitment	45–75/57.98 $\pm$ 5.56	U	140	IDF		54.5 (156)/(48.6–60.4)
Marjani et al. 2012 [24]	Iran	–	54.1 $\pm$ 5.3	–	100	ATP III	37	42.9 (60)/(34.5–51.5)
Yoldemir et al. 2012 [25]	Turkey	Randomly admitted to clinic	50–60/57.11 $\pm$ 6.07	U	180	ATP III	32	31.0 (31)/(22.1–41.0)
Aydin et al. 2013 [26]	Turkey	Randomly admitted to clinic	57.5 $\pm$ 13.9	U	45	WHO	37	19.44 (35)/(13.9–26.0)
Maharlouei et al. 2013 [27]	Iran	–	>40/58.6 $\pm$ 6.7	U	434	ATP III	36	26.7 (12)/(12.3–45.9)
Sarrafzadegan et al. 2013 [28]	Iran	Multi-stage cluster random sampling	59.8 $\pm$ 0.3	U and R	1199	ATP III	32	51.2 (222)/(46.3–55.9)
Sunbul et al. 2013 [29]	Turkey	Consecutive recruitment	>50	U	301	IDF	39	53.2 (231)/(48.4–58.0)
Caglar et al. 2014 [30]	Turkey	Randomly admitted to clinic	54.7 $\pm$ 5.3	U	87	ATP III	35	56.3 (675)/(53.4–59.1)
Yildiz et al. 2014 [31]	Turkey	Consecutive recruitment	40–73/55.9 $\pm$ 8.4	U	310	ATP III	35	60.5 (182)/(54.7–66.0)
Terzi et al. 2015 [32]	Turkey	Randomly admitted to clinic	45–65	–	230	AHA	36	29.8 (26)/(20.5–40.6)
Abbasi et al. 2017 [33]	Iran	Non-probability sampling	39–87	–	143	ATP III	37	31.3 (97)/(26.2–36.8)
Namazi et al. 2016 [34]	Iran	Randomly admitted to clinic	53.9 $\pm$ 5.6	U	264	IDF	35	27.4 (63)/(21.7–33.6)
Ozelci et al. 2016 (35)	Turkey	Consecutive recruitment	45–71/55.6 $\pm$ 6.1	–	315	ATP III	34	27.97 (40)/(20.8–36.1)
						ATP III	38	41.2 (109)/(35.3–47.5)
						ATP III	37	29.2 (92)/(24.2–34.6)

U urban; R rural; ATP III dult Treatment Panel III; IDF International Diabetes Federation; WHO World Health Organization; AHA American heart Association.

Fig. 2 Forest plot of MetS prevalence in Iranian and Turkish postmenopausal women

women were estimated 54.87% (95% CI: 53.76–55.97) in the Middle East countries. Since, the related studies were found just from two countries of the Middle East region; Iran and Turkey, sub-group analysis was performed based on these countries. Among 17 studies, 11 reports were from Iran [8, 15, 18, 20, 21, 23, 24, 27, 28, 33, 34], and others were from Turkey [19, 22, 25, 29, 31, 35]. Figure 2 shows pooled estimate of MetS in postmenopausal women in the Middle East countries. Prevalence of MetS in postmenopausal women of Iran and Turkey was 58.78% (95% CI: 57.54–60.02) and 39.02% (95% CI: 36.57–41.47) respectively.

Discussion

In our study, a relatively high prevalence rate of MetS was found in menopausal women in the Middle East countries according to NCEP ATP III definition (54.87%). In sub-group analysis, our included studies were conducted just in two countries of the Middle East region; Iran and Turkey. However, the prevalence rate in Iran was much

more than that found in Turkey; 58.78% versus 39.02%, respectively.

The observed prevalence rate of MetS in menopausal women of Middle East was noticeably different from its estimation in other countries. Our finding was higher than reports of MetS prevalence in Thailand that was 16.9% [36], in Korea as 21.8% [37], in Brazil as 22.2%–49.8% [38], in China as 37.1% [39], and in Tunis as 45.7% [40]. But our estimated prevalence rate was closer to that reported in some countries; 55.5%–65.7% in India [41], 57.8% in Nepal [42], and 61.7% in Spain [43]. Also our findings about high prevalence of MetS among menopausal women in Iran was concordant with current systematic review and meta-analysis in Iran [44]. The higher prevalence rate of MetS in our study than that estimated for other countries might be related to this fact that our participants were older (> 40–89 years old). The significant effect of age on the risk of MetS was shown from 6.7% in the third decade to 43.5% in the seventh decade [41]. In some of our included studies, subjects were selected from outpatient clinics [25, 26, 31, 34] which were not representative of the general population. Differences in socio-environmental and

genetic factors, lifestyles, type of menopause (natural/ surgical), time since menopause and criteria used for MetS definition could be some of the reasons for this variability.

In addition to the significant effect of age on the risk of MetS, urbanization was significantly associated with an increased risk of the MetS [40]. Other reasons that could be resulted in the variations in prevalence rate of MetS among menopausal women including inactivity, differences in dietary habits, abdominal obesity, rate of pregnancy, and high density lipoprotein cholesterol (HDL-C) level [39, 42, 45–47].

Our estimation was based on pooling data and meta-analysis of extracted data from the Middle East countries, but most of the studies in other countries were conducted in a small area that could not be generalized as prevalence rate in its country.

CVD risk is increased in menopausal women secondary to unfavorable changes during menopause. Menopausal women have prone to CVD with an unknown underlying mechanisms. Changes in body fat distribution from a gynaeoid pattern to an android pattern, abnormal lipid profiles, endothelial dysfunction, vascular inflammation, hypertension, insulin resistance, and high fasting glucose levels [38] are some of these variations. Some causes of these changes were established that included estrogen reduction secondary to ovarian failure, alteration of renin-angiotensin system due to an increased androgen/ estrogen ratio, increased endothelin levels, oxidative stress, obesity and stimulation of the sympathetic nervous system [38]. Since, it is shown that most of these components are preventable in postmenopausal women [38, 41], lifestyle modifications is recommended by moderate physical activity and consumption of a healthy diet.

In our sub-group meta-analysis, the prevalence rate of MetS in Iranian menopausal women was considerably higher than the Turkish. Part of this high prevalence rate might be explained by increasing in waist circumference values [45], high rate of lipid profile abnormalities, and growing in the mean age of Iranian population in recent years [48]. A significant changes in all components of MetS during menopausal period was observed in the most of previous studies in Iran [15, 18, 20, 27]. This finding was consistent with two systematic review studies that assessed the prevalence of lipid profiles abnormalities and mean serum level of lipid profiles in Iranian population [48, 49]. The prevalence of hypercholesterolemia (≥ 200 mg/dl), hypertriglyceridemia (≥ 150 mg/dl), high level of low density lipoprotein cholesterol (LDL-C: ≥ 130 mg/dl) and low HDL-C level (< 50 mg/dl among females) were 41.6%, 46%, 35.5%, and 43.9%, respectively in Iranian population compared to that reported in Turkish population as 37.5%, 30.4%, 44.5%, and 21.1%, respectively [48]. The reason of these findings might be related to dietary habits of Iranian population who consume more pieces of simple carbohydrates than complex carbohydrates [48]. Although the prevalence of diabetes in Iran has been reported higher than in Turkey, this difference has not been reported in hypertension prevalence. [50–52].

In a systematic review conducted in 6 countries of Persian Gulf (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates) prevalence of MetS was reported 20.7–37.2% among women based on ATP III definition which showed that prevalence of MetS in Middle East region is higher than other countries [3, 53].

Our study had some strengths and limitations. The main strength was pooling of available data in Middle East countries to perform meta-analysis. In addition, quality assessment of the most of included studies were scored as high quality by STROBE statement. Also we excluded studies which assessed prevalence of MetS in menopausal women with specific condition (diabetes, cancer,...).

The main limitation was lack of data from other countries than Iran and Turkey in the region. In addition, the lack of consensus on MetS definition was resulted in different reports of its prevalence and discrepancy in the data. Another limitation was the lack of rural/urban setting subgroup analysis in the included studies.

However, the prevalence rate of MetS among menopausal women in Middle East countries especially in Iran was considerably higher than that estimated prevalence rate in adults worldwide as 20–25% [54].

Conclusions

In conclusion, our study indicated that MetS was highly prevalent as an alarming sign among menopausal women in Middle East countries. Thus, it is an emergency requirement to apply an appropriate practical strategy for prevention of MetS through promoting healthy lifestyle, early detection and treatment of women who reaching menopause and are at great risk of developing MetS for prevention of non-communicable diseases such as type 2 diabetes mellitus and CVD in the region.

Acknowledgments The authors would like to express their appreciation to Deputy of Research and Technology, Alborz University of Medical Sciences, for financial support.

Funding Deputy of Research and Technology, Alborz University of Medical Sciences.

Compliance with ethical standards

Ethics approval and consent to participate The study was approved by the Research and Ethics Council of Alborz University of Medical Sciences.

Conflicts of interest There are no conflicts of interest.

Abbreviations MetS, Metabolic syndrome; NCEP ATP III, National Cholesterol Education Program Adult Treatment Panel III; NHANES III, National Health and Nutrition Examination Survey; T2DM, Type 2 diabetes mellitus; CVD, Cardiovascular disease

References

- National cholesterol education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III): third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adult final report. *Circulation* 2002; 106:3143–3421.
- Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, Fruchart JC, James WP, Loria CM, Smith SC Jr, International Diabetes Federation Task Force on Epidemiology and Prevention., National Heart, Lung, and Blood Institute., American Heart Association., World Heart Federation., International Atherosclerosis Society., International Association for the Study of Obesity.; International diabetes federation task force on epidemiology and prevention; National heart, lung, and blood institute; American Heart Association; world heart federation; international atherosclerosis society; International Association for the Study of obesity. Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; National Heart, Lung, and Blood Institute; American Heart Association; world heart federation; international atherosclerosis society; and International Association for the Study of obesity. *Circulation* 2009; 120(16): 1640–5. <https://doi.org/10.1161/CIRCULATIONAHA.109.192644>.
- Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and nutrition examination survey. *JAMA*. 2002;287(3):356–9.
- Mozumdar A, Liguori G. Persistent increase of prevalence of metabolic syndrome among U.S. adults: NHANES III to NHANES 1999–2006. *Diabetes Care*. 2011;34(1):216–9. <https://doi.org/10.2337/dc10-0879>.
- Meigs JB, Nathan DM, Wolfson JI, Mulder JE. The metabolic syndrome (insulin resistance syndrome or syndrome X). Available at: www.UpToDate.com. Last updated: Jan 13, 2017.
- Tabatabaei-Malazy O, Fakhrzadeh H, Sharifi F, Mirarefin M, Badamchizadeh Z, Larijani B. Gender differences in association between metabolic syndrome and carotid intima media thickness. *J Diabetes Metab Disord*. 2012;11(1):13. <https://doi.org/10.1186/2251-6581-11-13>.
- McNeill AM, Rosamond WD, Girman CJ, et al. The metabolic syndrome and 11-year risk of incident cardiovascular disease in the atherosclerosis risk in communities study. *Diabetes Care*. 2005;28:385–90.
- Eshtiaghi R, Esteghamati A, Nakhjavani M. Menopause is an independent predictor of metabolic syndrome in Iranian women. *Maturitas*. 2010;65:262–6. <https://doi.org/10.1016/j.maturitas.2009.11.004>.
- van Vliet-Ostapchouk JV, Nuotio ML, Slagter SN, Doiron D, Fischer K, Foco L, et al. The prevalence of metabolic syndrome and metabolically healthy obesity in Europe: a collaborative analysis of ten large cohort studies. *BMC Endocr Disord*. 2014;14:9. <https://doi.org/10.1186/1472-6823-14-9>.
- de Carvalho Vidigal F, Bressan J, Babio N, Salas-Salvadó J. Prevalence of metabolic syndrome in Brazilian adults: a systematic review. *BMC Public Health*. 2013;13:1198. <https://doi.org/10.1186/1471-2458-13-1198>.
- Amirkalali B, Fakhrzadeh H, Sharifi F, Kelishadi R, Zamani F, Asayesh H, et al. Prevalence of metabolic syndrome and its components in the Iranian adult population: a systematic review and meta-analysis. *Iran Red Crescent Med J*. 2015;17(12):e24723. <https://doi.org/10.5812/ircmj.24723>.
- Mendes KG, Theodoro H, Rodrigues AD, Olinto MT. Prevalence of metabolic syndrome and its components in the menopausal transition: a systematic review. *Cad Saude Publica*. 2012;28(8): 1423–37.
- Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. <https://doi.org/10.1136/bmj.b2535>.
- Lee CG, Carr MC, Murdoch SJ, Mitchell E, Woods NF, Wener MH, et al. Adipokines, inflammation, and visceral adiposity across the menopausal transition: a prospective study. *J Clin Endocrinol Metab*. 2009;94(4):1104–10. <https://doi.org/10.1210/jc.2008-0701>.
- Heidari R, Sadeghi M, Talaei M, Rabiei K, Mohammadifard N, Sarrafzadegan N. Metabolic syndrome in menopausal transition: Isfahan healthy heart program, a population based study. *Diabetol Metab Syndr*. 2010;2:59. <https://doi.org/10.1186/1758-5996-2-59>.
- von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Int J Surg*. 2014;12(12):1495–9. <https://doi.org/10.1016/j.ijsu.2014.07.013>.
- Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327:557–60.
- Ainy E, Mimran P, Zahedi Asl S, Azizi F. Prevalence of metabolic syndrome during menopausal transition Tehranian women: Tehran lipid and glucose study (TLGS). *Maturitas*. 2007;58(2):150–5.
- Ozdemir S, Celik C, Görkemli H, Kiyici A, Kaya B. Compared effects of surgical and natural menopause on climacteric symptoms, osteoporosis, and metabolic syndrome. *Int J Gynaecol Obstet*. 2009;106(1):57–61. <https://doi.org/10.1016/j.ijgo.2009.03.016>.
- Ebrahimpour P, Fakhrzadeh H, Heshmat R, Ghodsi M, Bandarian F, Larijani B. Metabolic syndrome and menopause: a population-based study. *Diabetes Metab Syndr*. 2010;4:5–9. <https://doi.org/10.1016/j.dsx.2008.04.014>.
- Nabipour I, Kalantarhormozi M, Larijani B, Assadi M, Sanjideh Z. Osteoprotegerin in relation to type 2 diabetes mellitus and the metabolic syndrome in postmenopausal women. *Metabolism*. 2010;59(5):742–7. <https://doi.org/10.1016/j.metabol.2009.09.019>.
- Akbulut G. Does the prevalence of metabolic syndrome in pre- and post-menopausal women differ by the ATP III and IDF criteria? *Turkiye Klinikleri J Med Sci*. 2011;31(6):1463–70.
- Ziaei S, Sayahi M, Faghihzadeh S. Relationship between reproductive aging, body composition, hormonal status and metabolic syndrome in postmenopausal women. *Climacteric*. 2011;14(6):649–53. <https://doi.org/10.3109/13697137.2011.570386>.
- Marjani A, Moghassemi S. The metabolic syndrome among postmenopausal women in Gorgan. *Int J Endocrinol*. 2012;2012:1–6. <https://doi.org/10.1155/2012/953627>.
- Yoldemir T, Erenus M. The prevalence of metabolic syndrome in pre- and post-menopausal women attending a tertiary clinic in Turkey. *Eur J Obstet Gynecol Reprod Biol*. 2012;164(2):172–5. <https://doi.org/10.1016/j.ejogrb.2012.06.021>.
- Aydin M, Koca C, Ozol D, Uysal S, Yildirim Z, Kavakli HS, et al. Interaction of metabolic syndrome with asthma in postmenopausal women: role of adipokines. *Inflammation*. 2013;36(6):1232–8. <https://doi.org/10.1007/s10753-013-9660-9>.
- Maharlouei N, Bellissimo N, Ahmadi SM, Lankarani KB. Prevalence of metabolic syndrome in pre- and postmenopausal Iranian women. *Climacteric*. 2013;16(5):561–7. <https://doi.org/10.3109/13697137.2012.727504>.
- Sarrafzadegan N, Khosravi-Boroujeni H, Esmaillzadeh A, Sadeghi M, Rafieian-Kopaei M, Asgary S. The association between hypertriglyceridemic waist phenotype, menopause, and cardiovascular risk factors. *Arch Iran Med* 2013;16(3):161–166. 013163/ AIM.008.
- Sunbul M, Eren F, Nacar C, Agirbasli M. Sex hormone binding globulin gene polymorphisms and metabolic syndrome in postmenopausal Turkish women. *Cardiol J*. 2013;20(3):287–93. <https://doi.org/10.5603/CJ.2013.0074>.

30. Caglar GS, Ozdemir ED, Kiseli M, Demirtas S, Cengiz SD. The association of osteocalcin and adiponectin with glucose metabolism in nondiabetic postmenopausal women. *Gynecol Obstet Investig*. 2014;77(4):255–60. <https://doi.org/10.1159/000358826>.
31. Yildiz S, Toprak H, Aydin S, Bilgin M, Oktay V, Abaci O, et al. The association of breast arterial calcification and metabolic syndrome. *Clinics (Sao Paulo)*. 2014;69:841–6. [https://doi.org/10.6061/clinics/2014\(12\)09](https://doi.org/10.6061/clinics/2014(12)09).
32. Terzi R, Dindar S, Terzi H, Demirtas O. Relationships among the metabolic syndrome, bone mineral density, bone turnover markers, and hyperglycemia. *Metab Syndr Relat Disord*. 2015;13:78–83. <https://doi.org/10.1089/met.2014.0074>.
33. Abbasi M, Farzam SA, Mamaghani Z, Yazdi Z. Relationship between metabolic syndrome and its components with bone densitometry in postmenopausal women. *Diabetes Metab Syndr* 2016; pii: s1871–4021 (16) 30230–2. <https://doi.org/10.1016/j.dsx.2016.12.008>.
34. Namazi Shabestari A, Asadi M, Jouyandeh Z, Qorbani M, Kelishadi R. Association of lipid accumulation product with cardio-metabolic risk factors in postmenopausal women. *Acta Med Iran*. 2016;54:370–5.
35. Ozelci R, Dilbaz B, Ozkaya E, Cirik DA, Zengin T, Mollamahmutoglu L. Association between bone mineral density and metabolic syndrome in Turkish women who were postmenopausal. *Int J Gynaecol Obstet*. 2016;133:370–4. <https://doi.org/10.1016/j.ijgo.2015.10.010>.
36. Indhavivadhana S, Rattanachaiyanont M, Wongvananurak T, Kanboon M, Techatrasak K, Leerasiri P, et al. Predictors for metabolic syndrome in perimenopausal and postmenopausal Thai women. *Climacteric*. 2011;14:58–65.
37. Joo JK, Son JB, Ju Eun Jung JE, Kim SC, Lee KS. Differences of prevalence and components of metabolic syndrome according to menopausal status. *J Korean Soc Menopause*. 2012;18:155–62. <https://doi.org/10.6118/jksm2012.18.3.155>.
38. Marchi R, Dell'Agnolo CM, Lopes TCR, Gravena AAF, Demitto MO, Brischiliari SCR, et al. Prevalence of metabolic syndrome in pre- and postmenopausal women. *Arch Endocrinol Metab*. 2017;61:160–6. <https://doi.org/10.1590/2359-3997000000253>.
39. Liang H, Chen X, Chen Q, Wang Y, Wu X, Li Y, et al. The metabolic syndrome among postmenopausal women in rural Canton: prevalence, associated factors, and the optimal obesity and atherogenic indices. *PLoS One*. 2013;8:e74121. <https://doi.org/10.1371/journal.pone.0074121>.
40. Ben Ali S, Belfki0Benali H, Aounallah-Skhiri H, Traissac P, Maire B, Delpeuch F, Achour N, Ben Romdhane H. Menopause and metabolic syndrome in Tunisian women. *Biomed Res Int* 2014; 2014: 457131. <https://doi.org/10.1155/2014/457131>, 1, 7.
41. Sharma S, Aggarwal N, Joshi B, Suri V, Badada S. Prevalence of metabolic syndrome in pre- and post-menopausal women: a prospective study from apex institute of North India. *J Midlife health*. 2016;7:169–74. <https://doi.org/10.4103/0976-7800.195695>.
42. Sapkota ASH, Sapkota A, Acharya K, Raut M, Jha B. Study of metabolic syndrome in postmenopausal women. *Ann Clin Chem Lab Med* 2015; 1: 6–11. <https://doi.org/10.3126/acclm.v1i1.12307>.
43. Orgaz Gallego MP, Bermejo Lopez P, Tricio Armero MA, Abellan Aleman J, Solera Albero J, Tarraga Lopez PJ. Metabolic syndrome and its components in postmenopausal women. *Nutr Hosp*. 2015;32:656–66. <https://doi.org/10.3305/nh.2015.32.2.9211>.
44. Ebtakar F, Dalvand S, Gheshlagh RG. The prevalence of metabolic syndrome in postmenopausal women: a systematic review and meta-analysis in Iran. *Diabetes Metab Syndr*. 2018;12(6):955–60. <https://doi.org/10.1016/j.dsx.2018.06.002>.
45. Delavari A, Forouzanfar MH, Alikhani S, Sharifian A, Kelishadi R. First nationwide study of the prevalence of the metabolic syndrome and optimal cutoff points of waist circumference in the Middle East: the national survey of risk factors for noncommunicable diseases of Iran. *Diabetes Care*. 2009;32(6):1092–7. <https://doi.org/10.2337/dc08-1800>.
46. Hajian-Tilaki KO, Heidari B. Prevalence of obesity, central obesity and the associated factors in urban population aged 20–70 years, in the north of Iran: a population-based study and regression approach. *Obes Rev*. 2007;8(1):3–10.
47. Dalvand S, Niksima SH, Meshkani R, Ghanei Gheshlagh R, Sadegh-Nejadi S, Kooti W, et al. Prevalence of metabolic syndrome among Iranian population: a systematic review and meta-analysis. *Iran J Public Health*. 2017;46:456–67.
48. Tabatabaei-Malazy O, Qorbani M, Samavat T, Sharifi F, Larijani B, Fakhrazadeh H. Prevalence of dyslipidemia in Iran: a systematic review and meta-analysis study. *Int J Prev Med*. 2014;5:373–93.
49. Qorbani M, Tabatabaei-Malazy O, Kelishadi R, Larijani B. Mean serum lipid levels in Iranian adult populations: a systematic review and meta-analysis. *Clin Lipidol*. 2015;10(5):449–64.
50. IDF diabetes atlas-7th edition. Available at: <http://www.diabetesatlas.org>. Last accessed: 21 Oct 2017.
51. Mirzaei M, Moayedallaie S, Jabbari L, Mohammadi M. Prevalence of hypertension in Iran 1980-2012: a systematic review. *J Tehran heart Cent*. 2016;11:159–67.
52. Sengul S, Akpolat T, Erdem Y, Derici U, Arici M, Sindel S, et al. Turkish Society of Hypertension and Renal Diseases. Changes in hypertension prevalence, awareness, treatment, and control rates in Turkey from 2003 to 2012. *J Hypertens*. 2016;34:1208–17. <https://doi.org/10.1097/HJH.0000000000000901>.
53. Mabry RM, Reeves MM, Eakin EG, Owen N. Gender differences in prevalence of the metabolic syndrome in gulf cooperation council countries: a systematic review. *Diabet Med*. 2010;27(5):593–7.
54. IDF consensus worldwide definition of the metabolic syndrome. Available at: <https://www.idf.org/e-library/consensus-statements/60-idfconsensus-worldwide-definition-of-the-metabolic-syndrome>. Last accessed: 21 Oct 2017.