Review Article

Metabolic syndrome and chronic diseases in Iran; A case - control meta-analysis

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Abstract

Background: To quantify the frequency of metabolic syndrome amongst individuals suffering from some chronic diseases and to compare them with the data obtained from healthy population. Methods: Manuscripts published on the prevalence of metabolic syndrome between 2000 and 2016 were identified through the following databases; Magiran, SID, and Iran Medex as well as PUBMED, EMBASE, MEDLINE, Web of Science, Scopus, and Google scholar using related MESH terms. Studies included if they had published quantitative estimates and measure of variability and/or confidence limits in the individual with the following diseases: diabetes, cardiovascular disease, cancer, periodontal, arthritis, polycystic ovary syndrome, Non-alcoholic fatty liver, psychiatric disorder, kidney and chronic disease. Data were analyzed with Stata, version 11. Results: A total of 62 articles selected for the final stage of this meta-analysis. The pooled prevalence of metabolic syndrome among diabetes, those with cardiovascular diseases, cases with renal failure, patients with NAFLD, periodontal subjects and individuals by arthritis were significantly higher than healthy population ($P < 0.05$). The risk of aforementioned diseases was found to be two to six times higher in those with metabolic syndrome than the normal population. Comparably, there was an inverse association between metabolic syndrome and mental disorders. Conclusions: Our findings suggest the early recognition, control and prevention of the metabolic syndrome and its individual components in the general population.

Keywords: Metabolic Syndrome, Prevalence, Chronic disease

Introduction

Metabolic syndrome (MetS) is a set of metabolic disorders including central obesity, insulin resistance or glucose absorption and metabolism disorder, lipid disorders, and hypertension. [1] There are several criteria for diagnosing metabolic syndrome based on which a person having three of the above-mentioned factors is considered as having metabolic syndrome. [2]According to the available statistics, 25% of the world population on average suffer from metabolic syndrome [3] which varied across different regions of the world. [1] Nevertheless, studies showed that the frequency of metabolic syndrome is higher in certain diseases compared to the normal population including diabetes, [3] cardiovascular diseases,[4] renal failure [5] and non-alcoholic fatty liver (NAFLD). [6]

Accordingly, studies estimated that individuals with metabolic syndromes have six-fold greater risk of diabetes compared with individuals without metabolic syndrome. [7] Data also suggests that Subjects with identified MetS have more than 3 times higher statistically significant probability to get cardiovascular and NAFLD diseases. [4, 8] Moreover, the available evidence reported more than 30% increased risk for periodontal disease, chronic renal failure and colorectal cancer [9-11] incidence amongst people suffering from MetS than those without MetS. There has been some association between mental disorders and MetS as well. [12] In comparison, contradictory results are reported for some diseases such as arthritis (inverse association) in which the frequency of metabolic syndrome is lower compared to healthy population. [13]

On the other hand, no study has quantified the pooled prevalence of MS amongst unhealthy population of Iran systematically. Therefore, the purpose of the current study was two folds; firstly, to estimate the frequency of metabolic

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syndrome within these individuals and secondly, to compare it with the healthy population through a systematic review and meta-analysis. To our knowledge, this is the first case-control study in which representative and comparable sample of cases and controls selected systematically from the general and unhealthy population of different areas of a nation.

Methods

Search strategy & Data sources:

Relevant published articles in English or Persian between 2000 to 2016 were identified through national databases (manuscripts published in Persian i.e. Magiran, SID, and Iran Medex) as well as PUBMED, EMBASE, MEDLINE, Web of Science, Scopus, and Google Scholar databases using MOOSE guidelines and MESH heading search strategy with the terms metabolic syndrome, diabetes, cardiovascular disease, cancer, periodontal, arthritis, polycystic ovary syndrome, Non-alcoholic fatty liver, psychiatric disorder, kidney and chronic disease. Additionally, references from identified manuscripts also scanned to find out any other relevant articles.

Study selection and Data extraction:

All cross-sectional and cohort studies on the Iranian population included if they used the three criteria of standard measurement, including NCEP-ATPIII, IDF, and ATPIII to estimate the prevalence of metabolic syndrome. Studies were also included if they had published quantitative estimates and measure of variability and/or confidence limits. Articles were excluded if they reported only one estimate of frequency, with no information by which to estimate the confidence intervals. In addition, in case of duplicate articles, more recent ones or those with a larger sample size were included. In the case of studies lacking sufficient information, researchers contacted the corresponding authors via telephone or email address in some cases.

Using this approach, a total of 62 articles determined for the final stage of the meta-analysis. The full text of selected articles were reviewed independently by two researchers and information was extracted and recorded in a checklist in Excel including: name of the author, year of publication, location of study, age and sex of participants, sample size, criterion for measuring metabolic syndrome, the general prevalence of metabolic syndrome and its confidence interval (CI).

Data synthesis and statistical analysis:

Pooled estimates and their 95% confidence intervals (CI) obtained for the prevalence of MS by means of a 'random effects' method and each report weighted according to an estimate of its 'statistical size' defined as the inverse of the variance of the log MS. Heterogeneity was estimated using the I^2 statistic and tested using the Q statistic. To maintain consistency across studies, the CI for all reports calculated using the exact method in Stata. Figures obtained from the published systematic review [14] on the prevalence of MS among healthy population of Iran in the same period of time used as the control group to estimate the odds ratio (OR) and CI. Data analysis implemented using Stata, version 11.

Results

The initial search of electronic databases produced 1313 records during time period of 2000 to 2016, of which 1193 were irrelevant. Twenty- seven were excluded from this meta-analysis as did not met inclusion criteria and 31 additional studies contained duplicate information. Then, a total 62 manuscripts with information on 22350 individuals with the published estimates of the prevalence of MetS among unhealthy population of Iran were eligible for inclusion in these analyses. The summary characteristics of selected studies, including authors, year of publication, province, place of residence, sample size, sex, age, criterion of measurement, as well as prevalence and 95% CI for MetS are shown in Table 1.

The pooled prevalence of reports on metabolic syndrome amongst unhealthy population of Iran are shown in Table 2. Consequently, Figure 1 displays the link between Mets and some chronic diseases in Iran through Odds ratios which obtained from the comparison of aforementioned frequencies with the combined prevalence of MetS in healthy population of Iran [14]. These figures and relationships are described in more detail in the following sections.

Diabetes and metabolic syndrome

A total of 21 reports with information on 9615 individuals with diabetes were included in these analyses. The pooled prevalence of metabolic syndrome among diabetes was 74.07% (95% CI: 69.39 - 79.07). Individuals with MetS were 6.54 times more likely to get diabetes compared with unaffected ones: OR = 6.54 (95% CI: 6.24 - 6.85).

Cardiovascular diseases and metabolic syndrome

From the identified studies, a total of 16 reports with information on 6211 subjects with cardiovascular diseases met inclusion criteria for these analyses. The summary estimates of metabolic syndrome in patients with cardiovascular disease was 46.58% (95% CI: 41.00 - 52.92). The risk of developing cardiovascular disease was approximately two times greater in persons who were categorized as metabolic syndrome compared with those classed as health/normal population: OR = 1.99 (95% CI: 1.89 - 2.10).

Renal failure and metabolic syndrome

Overall, 8 of the included studies identified frequency of metabolic syndrome in 922 cases with renal failure in which the combined estimate was 57.03% (95% CI: 49.52 - 65.67). The probability of renal failure's occurrence was three-fold higher in MetS patients than normal counterparts; OR = 3.04 (95% CI: 2.66 - 3.46).

Non-alcoholic fatty liver and metabolic syndrome

Only, one study examined the prevalence of metabolic syndrome in sample of 864 patients with NAFLD. The frequency of metabolic syndrome in cases with Non-alcoholic fatty liver was estimated 65.03% (95% CI: 61.85 - 68.38). There was a significant association between metabolic syndrome and occurrence of NAFLD; OR = 4.26 (95% CI: 3.70 - 4.90).

Periodontal disease and metabolic syndrome

Reviewing literature ascertained one report (n = 278) in which 53.6% (95% CI: 47.54 – 59.57) of periodontal subjects were suffering from MetS. The study also demonstrated a significant relationship between metabolic syndrome and the occurrence of periodontal disease; OR = 2.64 (95% CI: 2.08 - 3.34).

Arthritis and metabolic syndrome

The pooled prevalence of MetS was 46.81% (95% CI: 42.53 - 51.53) in a sample of 3 reports including 523 individuals by arthritis. There has been a significant association between metabolic syndrome and arthritis [OR = 2.01; 95% CI: 1.69 - 2.39] in the present study. In other words, compared to the healthy population, those with MetS were at two-fold increased risk of developing arthritis.

Mental disorders and metabolic syndrome

Ten studies examined frequency of MetS in a total of 1495 people with mental disorders. The summary estimate of this study was 25.75% (95% CI: 20.60 - 32.19). Accordingly, an inverse association was observed between metabolic syndrome and mental disorders; OR=0.79 (95% CI: 0.70 - 0.89).

Polycystic Ovary syndrome (PCOS) and metabolic syndrome

From the studies identified in the preliminary search, and a total of 9 studies involving 2242 subjects with PCOS were included. The combined frequency of MetS in patients with PCOS was found to be 29.06% (95% CI: 23.16 - 36.46). The risk estimate (OR) of metabolic syndrome among PCOS individuals was 0.93 (95% CI: 0.85 - 1.02) compared to healthy controls.

Colorectal cancer and metabolic syndrome

There was one study with a sample size of 200 patients with colorectal cancer in which frequency of metabolic syndrome was found to be 36% (95% CI: 29.35 - 43.07). The association between metabolic syndrome and colorectal cancer was not statistically significant [OR=1.28; 95% CI: 0.96-1.71] in this analysis.

Heterogeneity

There was no evidence of heterogeneity (P > 0.05) across the pooled prevalence's obtained using three different diagnostic criteria for each disease except for kidney (P = 0.012). Therefore, a subgroup analysis was carried out to show the association between metabolic syndrome and renal failure using various diagnostic criteria. The prevalence varied from 48.2 (95% CI: 39.90 – 56.71) in IDF to 65.57 (95% CI: 57.17 - 75.19) in NCEP-ATPIII as shown in Table 2. Consequently, the strength of the association also differed according to the definition of MetS used which were as follow: IDF [OR = 2.13; 95% CI: 1.54 - 2.90]; ATPIII [OR = 2.20; 95% CI: 1.79 - 2.70]; NCEP-ATP III [OR = 4.35; 95% CI: 3.65 - 5.18].

Table 1: Prevalence of metabolic syndrome among unhealthy population of Iran by study.

First Author/ Year (Reference Number)	Setting	Sample		**Metabolic syndrome**	
	Province(District)	No. (Sex)	Age	Diagnostic criteria	**P (95% CI)**
Mohagheghi, 2011 [15]	Tehran (Tehran)	495 (MF)	58.01 ± 10.43	ATPIII	**17.4 (14.1 - 21.0)**
Hadaegh, 2008 [16]	Tehran (Tehran)	840 (MF)	≥ 30	ATPIII IDF	**59.1 (55.6 - 62.3)** **51.4 (47.9 - 54.8)**
Assali, 2011 [17]	Khorasan (Mashhad)	309 (MF)	<50 - ≥60	IDF ATPIII	**41.7 (26.3 – 41.3)** **41.3 (23.5 – 38.1)**
Ghanei –Gheshlagh , 2016 [18]	Kurdistan (Saqqez)	200 (MF)	70.7 ± 8.6	ATPIII	**48 (40.9 - 55.1)**
Ardeshiri, 2014 [19]	Tehran (Tehran)	235 (MF)	59 ± 9.3	ATPIII	**77 (71.1 - 82.2)**
Anvari , 2009 [20]	Tehran (Tehran)	531 (MF)	58.95 ± 9.91	NCEP-ATPIII	**39.7 (35.5 – 44.0)**
Sadeghian, 2007 [21]	Tehran (Tehran)	637 (MF)	45.25 ± 6.40	NCEP-ATPIII	**59.8 (55.8 - 63.6)**

Mahdavi Anari,2015 [22]	Yazd (Yazd)	108 (MF)	58.25 ± 9.83	IDF	**78.7 (69.7 - 85.9)**
Harandi, 2016 [23]	Isfahan (Najafabad &Arak Isfahan)	564 (MF) 141 (MF)	≥ 35	ATPIII	**51 (46.8 - 55.2)** **56 (47.4 – 64.3)**
Kabir, 2012 [24]	Isfahan (Isfahan)	547 (MF)	57.1 ± .6	NCEP-ATPIII	**42.8 (38.5 - 47.0)**
Parizadeh, 2014 [25]	Khorasan (Mashhad)	234 (M) 132 (F)	18 - 75	IDF	**23.1 (17.8 – 29.0)** **46.2 (37.5 – 55.0)**
Dehghani, 2016 [26]	West-Azerbaijan (Urmia)	331 (MF)	60 ± 12.5	NCEP-ATPIII	**62.2 (56.7 – 67.4)**
Sarrafzadegann, 2009 [27]	Isfahan (Isfahan)	78 (F)	< 55	ATPIII	**74.4 (63.2 – 83.5)**
Sadrebafghi, 2005 [28]	Yazd (Yazd)	47 (F) 153 (M) 219 (F) 404 (M)	45 ± 5 68 ± 9	NCEP-ATPIII	**52.3 (38.0 – 67.8)** **25.7 (18.7 – 33.1)** **31.3 (25.4 - 38.1)** **26.1 (21.7 – 30.5)**
Saeidi, 2009 [29]	Isfahan (Nagafabad)	66 (MF)	58.36 ± 11.46	ATPIII	**69.7 (57.1 - 80.4)**
Nakhjavani, 2014 [30]	Tehran (Tehran)	639 (F)	43.33 ± 0.47 and 60.35 ± 0.38	NCEP-ATPIII	**88.3 (85.5 - 90.6)**
Marjani, 2011[31]	Golestan (Gorgan)	293 (MF)	53.11 ± 10.15	IDF modified ATPIII	**76.79 (71.5 - 81.5)** **75.42 (70.0 - 80.2)**
Rashidi, 2012 [32]	khozestan (Ahvaz)	350 (MF)	54.08 ± 10.53	NCEP-ATPIII IDF	**73.1 (68.1 - 77.7)** **64.9 (59.6 - 69.8)**
Foroozanfar, 2015 [33]	kerman (kerman)	950 (MF)	56.0 ± 11.6	NCEP-ATPIII IDF	**73.4 (70.4 - 76.1)** **64.9 (61.8 - 67.9)**
Ziaee, 2012 [34]	Qazvin (Qazvin)	23 (MF) 23 (MF)	30 - 70	IDF	**95.7 (78.0 - 99.8)** **78.3 (56.2 - 92.5)**
Derakhshan, 2010 [35]	kerman (Rafsanjan)	1392 (MF)	30 - 83	ATPIII	**94.8 (93.5 - 95.9)**
Hosseinpanah, 2006 [36]	Tehran (Tehran)	76 (MF)	59.7 ± 8.8	ATPIII	**89.5 (80.3 - 95.3)**
Arash, 2016 [37]	Tehran (Tehran)	1534 (MF)	54.3 ± 11.2	ATPIII	**71 (68.6 - 73.2)**
Sharifi, 2013 [38]	Zanjan (Zanjan)	123 (MF)	21 - 75	modified NCEP III	**48 (38.8 – 57.1)**
Baeis, 2016 [39]	khozestan (Ahvaz)	514 (MF)	20 - 60	NCEP-ATPIII	**75.1 (71.1 – 78.7)**
Veissi, 2016 [40]	khozestan (Ahvaz)	157 (MF)	28 - 75	IDF	**84.1 (77.3 – 89.4)**
Vafaeimanesh, 2016 [41]	Qom (Qom)	139 (MF) 72 (MF)	47.72 ± 5.72 47.06 ± 5.88	ATPIII IDF ATPIII IDF	**90.4 (84.5 – 94.9)** **76.6 (68.3 – 83.0)** **87.2 (77.5 - 94.1)** **69.8 (57.4 – 79.7)**
NAKHJAVANI, 2011 [42]	Tehran (Tehran)	132 (MF)	57.5 ± 1	ATPIII	**39.4 (31.0 – 48.2)**
Janghorbani, 2016 [43]	Isfahan (Isfahan)	282 (MF)	30 - 70	NCEP-ATPIII	**55.3 (49.3 – 61.2)**
Sbohani, 2016 [44]	Isfahan (Isfahan)	300 (MF)	30 - 64	ATPIII	**69.6 (64.1 – 74.8)**

Bonakdaran, 2009 [45]	Khorasan (Mashhad)	1962 (MF)	52.47 ± 10.20	NCEP-ATPIII	**64.6 (62.4 – 66.6)**
Azizi, 2007 [46]	Tehran (Tehran)	588 (MF)	54.2 ± 11.6	IDF ATPIII	**79.5 (75.9 – 82.6)** **84.3 (81.1 - 87.1)**
Pourteymour, 2013 [47]	Tabriz (Tabriz)	200 (F)	20 - 40	ATPIII	**39.5 (32.6 - 46.6)**
Moini, 2012 [48]	Tehran (Tehran)	282 (F)	15 - 40	ATPIII	**22.7 (17.9 - 28.0)**
Shahbazian, 2012 [49]	khozestan (Ahvaz)	53 (F)	24 ± 6.8	ATPIII	**13.5 (5.4 - 25.3)**
Mehrabian, 2011 [50]	Isfahan (Isfahan)	539 (F)	18 - 42	ATPIII	**24.9 (21.2 - 28.7)**
Madani, 2016 [51]	Tehran (Tehran)	624 (F)	28.6 ± 4.3	NCEP-ATPIII	**19.7 (16.6 - 23.0)**
Zahiri, 2016 [52]	Guilan (Rasht)	215 (F)	15 - 35	ATPIII	**28.8 (22.8 – 35.3)**
Layegh, 2016 [53]	Khorasan (Mashhad)	115 (F)	16 - 45	NCEP-ATPIII	**39.4 (30.1 – 48.6)**
Ebrahimi-Mamaghani, 2015 [54]	Tabriz (Tabriz)	23 (F) 40 (F)	17 - 37	ATPIII	**43.5 (23.1 – 65.5)** **20 (9.0 - 35.6)**
Moradi, 2009 [55]	Tehran (Tehran)	151 (F)	16 - 48	ATPIII	**46.4 (38.2 – 54.6)**
Forootan, 2012 [56]	Tehran (Tehran)	200 (MF)	57.1 ± 13.9	ATPIII	**36 (29.3 - 43.0)**
Saadatian, 2012 [57]	Khorasan (Mashhad)	103 (F)	27 - 75	NCEP-ATPIII	**39.8 (30.2- 49.9)**
Rezaei, 2009 [58]	Tehran (Tehran)	372 (MF)	23 - 70	IDF ATPIII NCEP-ATPIII	**38.7 (33.7 - 43.8)** **27.4 (22.9 - 32.2)** **37.6 (32.6 - 42.7)**
Khalili, 2015 [59]	Hormozgan (Bandar Abbas)	200 (MF)	> 18	IDF NCEP-ATPIII	**9.5 (5.8 - 14.4)** **10 (6.2 - 15.0)**
Shakeri, 2016 [60]	Kermanshah (Kermanshah)	280 (MF)	20 - > 40	ATPIII	**30.4 (25.0 - 36.1)**
Kamkar, 2016 [12]	Golestan (Gorgan)	267 (MF)	18 - 73	ATPIII	**20.6 (15.9 - 25.9)**
Moayedi, 2015 [61]	Hormozgan (Bandar Abbas)	100 (MF)	18 - 60	NCEP-ATPIII	**15 (8.6 – 23.5)**
Goughari, 2015 [62]	Kerman (Kerman)	68 (MF)	18 - 65	NCEP-ATPIII	**48.5 (36.2 – 60.9)**
Ghoreishi, 2016 [63]	Zanjan (Zanjan)	105 (MF)	18 - 74	NCEP-ATPIII	**25.7 (17.6 – 35.1)**
Ghaneei –gheshlagh, 2011 [64]	West Azerbaijan (Uromeah)	132 (MF)	18 - 76	ATPIII	**57.6 (48.6 - 66.1**
Marjani, 2013 [65]	Golestan (Gorgan)	142 (MF)	20 - > 70	ATPIII	**56.33 (47.7 – 64.6)**
Mortazavi, 2012 [66]	Isfahan (Isfahan)	170 (MF)	> 20	NCEP-ATPIII	**67 (59.4 - 74.0)**

Razeghi, 2011[67]	Tehran (Tehran)	91 (MF)	54 ± 17.4	ATPIII	**31.8 (22.4 – 42.4)**
Shahrokh, 2012[5]	Tehran (Tehran)	153 (MF)	58.3	NCEP-ATPIII	**59.5 (51.2 - 67.3)**
Maleki, 2015[68]	Khorramabad (Borujerd)	89 (MF)	> 35	NCEP-ATPIII	**57 (46.3 - 67.7)**
Edalat-Nejad, 2015[69]	Markazi (Arak)	145 (MF)	≥ 18	IDF NCEP-ATPIII	**48.2 (39.9 - 56.7)** **77.2 (69.5 – 83.7)**
Fattahi, 2016[70]	Fars (Kavar)	285 (M) 579 (F)	≥ 18	ATPIII	**65.9 (60.1 – 71.4)** **64.6 (60.5 – 68.4)**
Safavi 2015[71]	Kerman (Kerman)	278 (MF)	15 - 75	NCEP-ATPIII	**53.6 (47.5 - 59.5)**
Tehrani, 2015[72]	Zanjan (Zanjan)	323 (MF)	57.2 ± 9.4	ATPIII	**46.1 (40.5 – 51.7)**
Goshayeshi, 2012[73]	Khorasan (Mashhad)	120 (MF)	45.49 ± 14.21	ATPIII	**45.2 (33.5 - 51.8)**
Shirani, 2016[74]	Tehran (Tehran)	80 (MF)	> 20	ATPIII	**51.3 (39.8 – 62.5)**

Abbreviations: ATPIII, Third Adult Treatment Panel; IDF, International Diabetes Federation; NCEP-ATPIII, National Cholesterol Education Program—Third Adult Treatment Panel; MF, Male &Female.

Table 2: Prevalence of Metabolic syndrome among unhealthy population of Iran by type of disease.

Disease	Diagnostic criteria	No. of reports	Prevalence of metabolic syndrome (95% CI)	P for heterogeneity
Psychiatric Disorders				**0.91**
	ATPIII	3	26.19(21.39 –32.06)	
	NCEP-ATPIII	5	26.79 (18.54 – 38.72)	
	IDF	2	19.51 (4.92 – 77.25)	
	Pooled	**10**	**25.75(20.60 – 32.19)**	
Polycystic Ovary Syndrome				**0.85**
	ATPIII	7	29.67 (23.27 – 37.84)	
	NCEP-ATPIII	2	27.69 (14.04 -54.63)	
	Pooled	**9**	**29.06 (23.16 -36.46)**	
Cancer (Colorectal)				-
	ATPIII	**1**	**36 (29.35 – 43.07)**	
Arthritis				**0.67**
	ATPIII	**3**	**46.81 (42.53 – 51.53)**	
Cardiovascular				**0.23**
	ATPIII	7	53.01 (42.92-65.47)	
	NCEP-ATPIII	5	40.72(32.77 -50.59)	
	IDF	4	45.40 (33.15 – 62.19)	
	Pooled	**16**	**46.58(41.00 -52. 92)**	
Periodontal				**-**
	NCEP-ATPIII	**1**	**53.6 (47.54 - 59.57)**	

Kidney				**0.012**
	ATPIII	3	48.87 (37.41 – 63.83)	
	NCEP-ATPIII	4	65.57 (57.17 -75.19)	
	IDF	1	48.2 (39.90 – 56.71)	
	Pooled	**8**	**57. 03 (49.52 – 65.67)**	
Non-alcoholic fatty liver				-
	ATPIII	**1**	**65.03 (61.85-68.38)**	
Diabetes				**0.34**
	ATPIII	6	76 .07 (68.21 -84.85)	
	NCEP-ATPIII	8	69.14 (62.15 – 76.91)	
	IDF	7	75.94 (69.90 -82.51)	
	Pooled	**21**	**74.07 (69.39 -79.07)**	

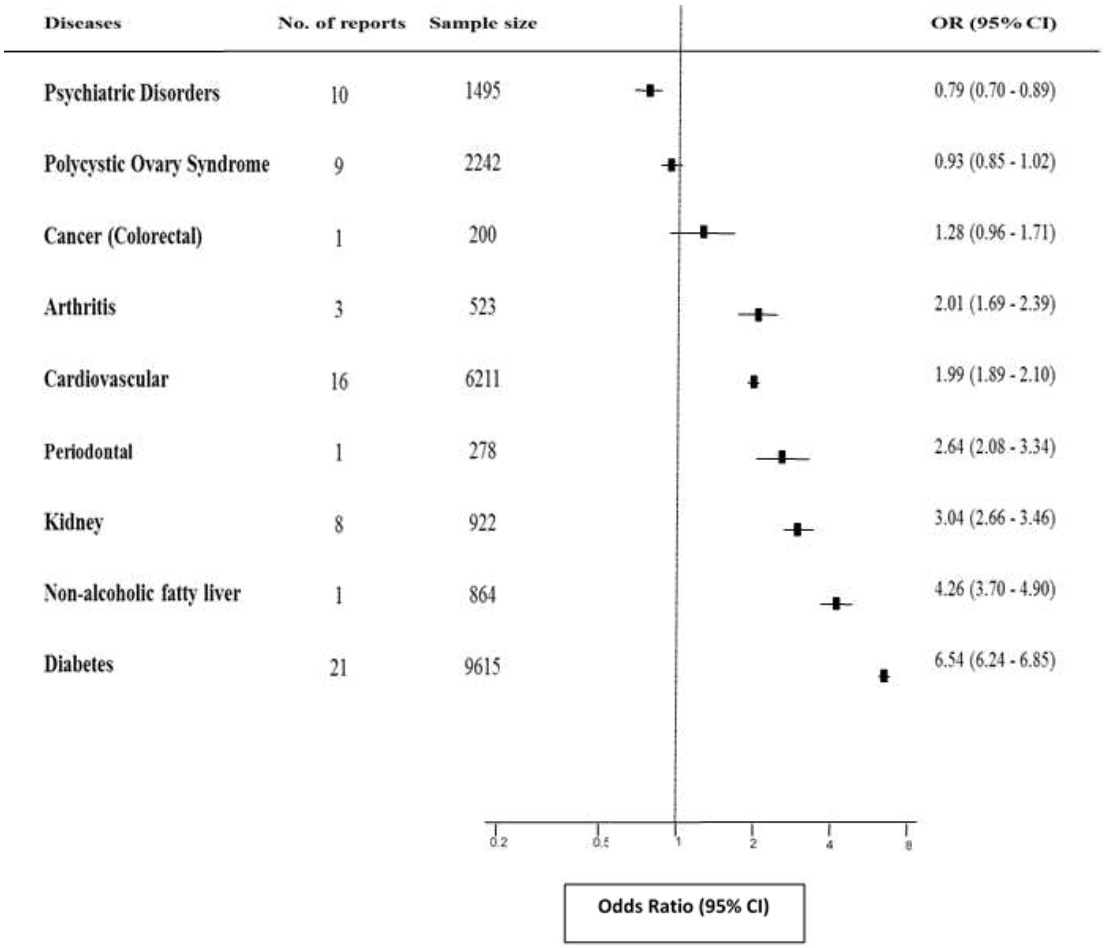

Figure 1. ORs and 95% CIs for metabolic syndrome comparing unhealthy (above-mentioned diseases-Cases) with healthy individuals of Iran (Controls). Black square, pooled point estimate; horizontal line, 95% CI for observed effect in each disease.

Discussion

The synthesis of available articles in this systematic review and meta-analysis provides persuasive evidence of increased prevalence of metabolic syndrome among patients with type 2 diabetes, non-alcoholic fatty liver, renal failure, periodontal, cardiovascular disease and arthritis compared with general population. Accordingly, data suggests that the presence of MetS is a significant predictor of aforementioned diseases. In contrast, individuals with mental disorders had an overall decreased prevalence of metabolic syndrome than those of controls. Moreover, there were no evidence of association between metabolic syndrome with polycystic ovary syndrome and colorectal cancer in the present study.

In this study, the risk of diabetes was found to be six times higher in those with metabolic syndrome than the healthy population. The estimated odds ratio was in line with the findings from other studies in which the measure of association (RR) between the metabolic syndrome and incident of diabetes reported from 2 to 10. In the EPIC and the Framingham offspring studies, the hazard ratios were very close to the present study (4.59 and 6.90, respectively). [75] It seems that increased insulin resistance plays a significant role in the development of metabolic syndrome. [41] Moreover, impaired fasting glucose and abdominal obesity were the most significant component of MetS that predict incident of diabetes in these studies. [76] Nevertheless, the above-mentioned reports demonstrated that the absence of MetS strongly predict the development of diabetes regardless of other risk factors, including IGT and insulin resistance .[77]

Available data from epidemiologic studies supports the assumption that metabolic syndrome is a cluster of important etiologic factors for the development cardiovascular disease. [3] A meta-analysis of these reports revealed that the metabolic syndrome increase the risk of CVD and stroke by two-fold Similarly, this systematic review demonstrated that MetS is prevalent in approximately 47% patients with cardiovascular disease. Data also showed that patients with MetS have two times higher risk of developing CVD as well. Metabolic syndrome is the concurrent of multiple metabolic risk factors including IFG/IGT, obesity, hypertension, diabetes and dyslipidemia which any of them might predispose people to develop CVD. Then, there might be multiple mechanisms by which MetS could increase the risk of CVD.[78]

In the present review, approximately two-third of NAFLD patients were suffering from metabolic syndrome. In line with the previous reports, individuals with MetS were 4 times more likely to develop non-alcoholic fatty liver disease compared to those without MetS. [79] It seems that the increased level of ALT in patients with NAFLD is associated with the risk of metabolic syndrome. On the other hand, risk-factors of metabolic syndrome such as BMI, insulin resistance, abdominal obesity, increased blood glucose and TG, and reduced level of HDL-C are effective in increasing the level of ALT in those with NAFLD.[80] Furthermore, at least one of the MetS characters there might be presence amongst NAFLD cases.

A meta-analysis of 62 studies demonstrated that MetS and its individual traits independently increased the risk of chronic kidney disease. Likewise, this study strongly revealed a significant association between metabolic syndrome and renal failure. This might be explained by the fact that there is a relationship between the incidence of obesity [81] and hypertension [82] with renal failure. Moreover, in those with metabolic syndrome, urinary protein secretion is increased as a result of increased TG. Insulin resistance can also disrupt the function of mitochondrion and further damage the renal tissue cells by sodium retention, over-production of LDL cholesterol, and hypertriglyceridemia.[83]

The frequency of MetS in patients with arthritis in current study was about 46% which in accordance to some of previous studies [84] showed that presence of metabolic syndrome highly increased the risk of arthritis. Increased insulin resistance, [85] BMI, and subcutaneous and visceral fat in the first stages of arthritis [13] could possibly describe this relationship.

The available documents suggests a significant association between MetS and colorectal cancer. [86] The link between colorectal cancer and metabolic syndrome can be probably justified by the increased BMI, blood pressure and glucose [11] in these patients as well as the role of total cholesterol and TG in creating colon adenoma and differentiating colon polyps into cancerous types upon increasing insulin resistance. [87] Nevertheless, inconsistent with this data, there were no significant association between metabolic syndrome and colorectal cancer in this study. The existence of one report with small number of participants may explain this difference.

Another finding of the present study was a significant positive relationship between periodontal disease and metabolic syndrome. Then, the study supports the overall results of a meta-analysis, in which the existence of metabolic syndrome was linked to the occurrence of periodontal disease. [88] Some investigations have reported an association between periodontal diseases with specific components of MetS. Moreover, periodontal disease is one of the complications of diabetes and insulin resistance, which is in turn exacerbated by glucose disorder and incidence of diabetes. [89] These might be explanations for connection between two conditions.

The overall prevalence of metabolic syndrome among women with PCOS was found to be 29% in the present study that was not differed according to the definition used. Comparing to the healthy controls, no association was found between PCOS and the odds of being diagnosed with MetS. This contrasts the findings of a recently published meta-analysis in which individuals with PCOS were two times more likely to be diagnosed with MetS than individuals without PCOS. Principally, the combined frequency of MetS in this review was about 3% lower than our findings (26.30% vs. 29%) [90] Therefore, the reason for the paradox in reported risk may be differences in the reference group used for estimation of OR in two studies. For example, about one-third of general population (reference group) in Iran suffering from MetS [14] while occurrence of metabolic syndrome amongst general population is much lower in some reports.

Our findings suggest a lower prevalence of metabolic syndrome in patient with mental/psychological disorders compared to the healthy population which is in contrast to the other studies. [91] This difference may be due to the characteristics of patients, treatment methods, or the dosage of medications across studies. For example, the majority of patients were treated with first-generation antipsychotics

drugs in the current study. In comparison, second generation drugs were used to treat these patients in other parts of the world. [59]

The current study is subject to several limitations. Firstly, there has been some methodological heterogeneity across studies. Secondly, the pooled ORs is obtained based on cross-sectional reports rather than on longitudinal data. Thirdly, there were inadequate data on confounders by which we were unable to adjust for some potential confounders. Nevertheless, there are some advantages which robust the findings and estimates. The main strength of the present study is its large pooled representative sample size from different areas of a nation that enabled us to find out vigorous estimation of frequency of diseases and their relationship with metabolic syndrome in Iran. In addition, in our knowledge this is the first meta-analysis with the nature of case-control examining the risk of some chronic diseases among patients with MetS in which both cases and controls are approximately proper representative sample of patients and general healthy population. Moreover, the sub-analysis conducted on different criteria used for classification of MetS yielded similar results and enhance our certainty regarding interpretation of results.

In conclusion, this meta-analysis supports the association between metabolic syndrome and some chronic diseases including diabetes, cardiovascular disease, renal failure, non-alcoholic fatty liver, periodontal, and arthritis. On the other hand, thes disease are now major global public health problems with high frequency and high morbidity that emphasize the early recognition, control and prevention of the metabolic syndrome and its individual components in the general population. Lifestyle interventions including healthy diet and physical activity can decrease the risk of metabolic syndrome to a great extent. Moreover, appropriate medical treatment of hyperglycemia, hypertension and dyslipidemia could be another important approach for the reduction of MetS consequences.

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Authors' contributions

The overall implementation of conception and study design, data collection including systematic review, critical appraisal of articles, extraction of information, synthesis, analysis and their interpretation as well as drafting and preparation of manuscript were the results of cooperative efforts by multiple individuals who has been listed as co-authors of this paper. All authors read and approved the final version of submitted article.

Conflict of Interest

There is no conflict of interest to be declared.

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