

Prevalence of Hypertension in Cardiovascular Disease in Iran: Systematic Review and Meta-Analysis

Abstract

Background: Hypertension is a major cause of noncommunicable diseases such as cardiovascular disease. Therefore, this study aimed to estimate the prevalence of hypertension in cardiovascular patients in Iran by meta-analysis. **Methods:** The search was carried out using authentic Persian and English keywords in national and international databases including IranMedex, Scientific Information Database (SID), Magiran, IranDoc, Medlib, ScienceDirect, PubMed, Scopus, Cochrane, Embase, Web of Science, and Google Scholar search engine without any time limitation until 2017. Heterogeneity of studies was assessed using I² statistic. Data were analyzed using STATA 11.1. **Results:** In 66 reviewed studies with a sample of 111,406 participants, the prevalence of hypertension was 44% in Iranian patients with cardiovascular disease 67%(95%CI: 38%–49%) in women and 42% in men. The prevalence of systolic hypertension in cardiac patients was 25%, diastolic 20%, diabetes 27%, and overexposure 43%. The prevalence of hypertension was 44% in patients with coronary artery disease, 50% in myocardial infarction, 33% in aortic aneurysm, and 44% in cardiac failure. **Conclusions:** Hypertension has a higher prevalence in women with cardiovascular disease than men, and it increases with age. Among patients with cardiovascular disease, myocardial infarction patients have the highest levels of hypertension. The prevalence of systolic hypertension in cardiac patients is higher than diastolic hypertension.

Keywords: Cardiovascular disease, hypertension, Iran, meta-analysis

Introduction

Chronic illness has the greatest impact on psychological function, and subsequently, quality of life, self care, physical and social performance is also affected.^[1-3] Cardiovascular diseases are the most common chronic diseases among the middle-aged that affects the quality of life.^[4,5] High blood pressure is the increase in pressure from the bloodstream to the wall of the blood vessels.^[6] According to the World Health Organization, hypertension is systolic blood pressure greater than or equal to 140 mm Hg and diastolic blood pressure greater than or equal to 90 mm Hg.^[7] If not treated, the disease causes many complications in vital organs such as the kidneys, the brain, the eyes, and the heart.^[8] This study has shown that hypertension is one of the major causes of disability and mortality, and a relative reduction in blood pressure reduces the risk of cardiovascular disease, stroke, and renal failure.^[7] In fact, the higher the risk of hypertension, the greater the chance of

stroke, heart attack, heart failure, and renal failure.^[9] In 2000, the global prevalence of hypertension was 26.4%, and it is predicted that by 2025, about 1.54 billion adults would suffer from this disease.^[10]

With a prevalence of 39%, cardiovascular diseases are the first cause of death in Iran and are the most common cause of premature death in different societies, and about 138,000 deaths are reported every year.^[7,11] Considering that hypertension is a global problem, the relationship between the risk of cardiovascular disease and hypertension is a long-lasting relationship, and therefore, prevention and control of hypertension are considered as highly important public health goals.^[12] Overall, high blood pressure is one of the most important risk factors for coronary artery disease (CAD) and the most common cause of heart failure. Changes in epidemiological pattern of diseases in developed and developing countries, increased life expectancy, increase in psychological stress caused by urbanization, and changes

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Access this article online

Website:
www.ijpvmjournal.net/www.ijpvm.ir

DOI:
10.4103/ijpvm.IJPVM_351_18

Quick Response Code:



How to cite this article: Fakhri M, Sarokhani D, Ghiasi B, Hasanpour Dehkordi A. Prevalence of hypertension in cardiovascular disease in Iran: Systematic review and meta-analysis. *Int J Prev Med* 2020;11:56.

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in eating habits made this disease a major risk factor for cardiovascular disease.^[10,13-19] Considering that various studies in Iran reported different statistics ranging from 4%^[20] to 91%^[21] for the prevalence of hypertension in cardiovascular patients, the need for a meta-analysis study seems necessary.

Materials and Methods

Study protocol

The present study is a systematic review and meta-analysis study of the prevalence of hypertension in Iranian cardiovascular patients. This study was conducted based on the Preferred reporting items for systematic review and meta-analysis¹ statement, which is concerned with systematic review and meta-analysis studies. Based on this protocol, all stages of the research methodology such as search, selection of studies, qualitative assessment of studies, and data extraction from the studies were conducted by two researchers independently. If there was a difference in the report of the researchers, the third researcher investigated and resolved the dispute.^[22]

Search strategy

This is a systematic review and meta-analysis on the prevalence of hypertension in cardiovascular patients in Iran by reviewing existing articles from 1985 to 2017. To collect data, national and international databases including IranMedex, Scientific Information Database (SID), Magiran, IranDoc, Medlib, ScienceDirect, PubMed, Scopus, Cochrane, Embase, Web of Science, and the Google Scholar search engine were used.

The search was carried out independently by two researchers using Persian keywords and their English equivalent (“Iran,” “Meta-analysis,” “Cardiovascular,” and “Hypertension”). For the comprehensiveness of the search, the keywords were combined using “OR” and “AND” operators, and references to all articles related to the subject were also manually examined.

Inclusion and exclusion criteria

The main criteria for inclusion in this study were reference to the prevalence of hypertension in cardiovascular patients. Exclusion criteria included lack of relevance to the subject, inadequate data, statistical community other than cardiac patients, and non-random sample size.

After analyzing the inclusion and exclusion criteria and determining the related studies, the methodological quality of the studies was examined by two researchers. For this purpose, the standard STROBE checklist was used.^[23] This checklist consists of 22 different sections that assess various aspects of the methodology including sampling methods, variable measurement, statistical analysis, modification of confounding variables, validity

and reliability specifications of the tools used, and the objectives of the study.

Study selection

Based on the description presented in the first step, 354 possibly related articles were found on the prevalence of hypertension in cardiac patients. Out of these articles, 187 articles were removed due to duplication. Abstract of the remaining 167 articles was reviewed, and 49 other articles were omitted. The full text of 118 remaining articles was reviewed, and 52 articles were deleted due to meeting the exclusion criteria. Finally, 66 articles entered the meta-analysis process [Figure 1].

Data extraction

To reduce reporting bias and error in data collection, two researchers independently extracted data from articles and entered the data into a checklist containing the following items: name of the first author, title of study, sample size, year and place of research, the prevalence of hypertension in cardiovascular patients based on gender, the prevalence of systolic and diastolic blood pressure, prevalence of diabetes, overweight, body mass index (BMI) in cardiovascular patients, and so on.

Statistical analysis

To analyze and combine the results of various studies, the prevalence of hypertension in cardiovascular patients was considered as a binomial probability distribution, and its variance was calculated by binomial distribution in each study. Heterogeneity of studies was investigated using Q test and I² index. Regarding the heterogeneity of the studies, the random effect model was used to combine the results of various studies. The data were analyzed using STATA Ver. 11 and $P < 0.05$ was considered significant.

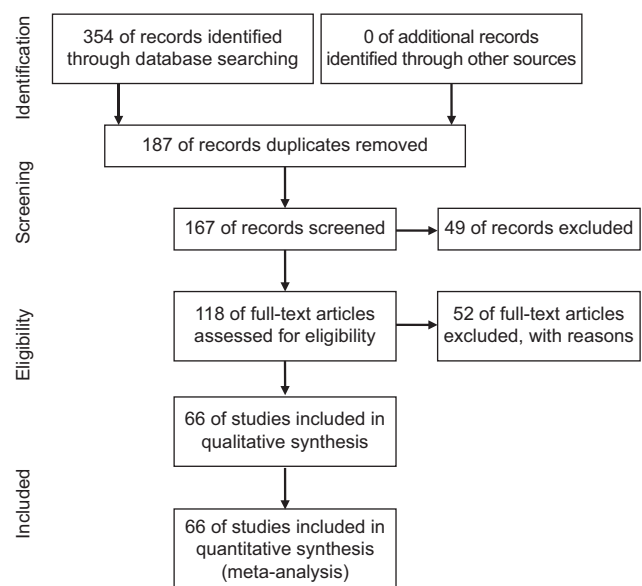


Figure 1: Diagram of the process of selecting studies for systematic review and meta-analysis

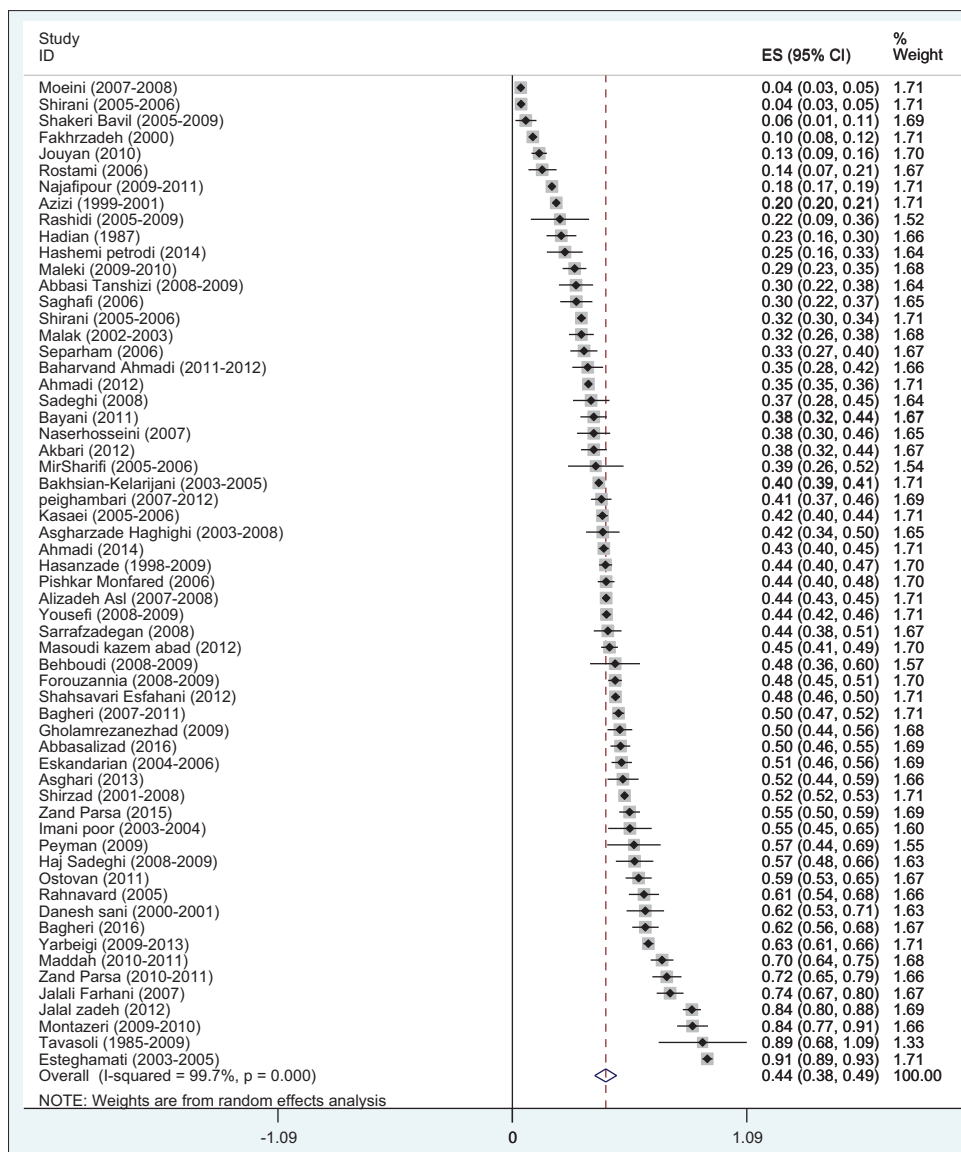


Diagram 1: The prevalence of hypertension in cardiovascular patients in Iran and its 95% confidence interval based on the author's name and year of research according to the random effects model. The midpoint of each section shows the prevalence of hypertension in cardiovascular patients in each study. The lozenge shows the prevalence of hypertension in cardiovascular patients in Iran for all studies

Meta-regression model was used to examine the relationship between the prevalence of hypertension in cardiovascular patients and the sample size and year of research. The sensitivity analysis was used to determine whether omitting one study would affect the final meta-analysis result.

Results

In systematic review of studies, 66 articles with a sample size of 111,406 entered the meta-analysis process. The characteristics of the reviewed articles are presented in Table 1.

The prevalence of hypertension in cardiovascular patients in Iran was 44% (95% confidence interval [CI]: 38%–49%) [Diagram 1]. The lowest and highest prevalence of

hypertension in cardiovascular patients were in the studies of Moeini (4%)^[20] and Esteghamati (91%),^[21] respectively.

The prevalence of hypertension was 67% in women with cardiovascular disease (95% CI: 53%–82%) and 42% in men with cardiovascular disease (95% CI: 39%–46%).

In addition, the prevalence of systolic hypertension was 25% (95% CI: 12%–39%), the prevalence of diastolic hypertension was 20% (95% CI: 8%–31%), the prevalence of diabetes was 27% (95% CI: 23%–31%), the prevalence of overweight was 34% (95% CI: 18%–50%), and the prevalence of BMI was 33% (95% CI: 9%–57%) in cardiovascular patients [Table 2].

The prevalence of hypertension was 44% in patients with CAD (95% CI: 37%–51%), 50% in patients with

Table 1: Specifications of the articles that entered the meta-analysis step

(References) Author	Age	Year of study	City	Type of cardiovascular disease	Sample size	Prevalence of hypertension in cardiovascular disease (%)	Prevalence of diabetes in cardiovascular disease (%)
[24]Separham	<45	2006	Isfahan	Coronary artery disease	216	33.4	-
[25]Tavasoli	2-16	1985-2009	Tehran	-	9	88.8	-
[26]Aghaei Shahsavari	59.6	2004-2005	Tabriz	Cardiovascular	476	---	-
[27]Azizi	>3	1999-2001	Tehran	Cardiovascular	15,005	20.4	58.4
[28]Saghafi	25-64	2006	Tehran	PCAD	144	29.9	9
[29]Ghaffari	61.3	2008-2013	Tabriz	Myocardial infarction	1017	---	6
[30]Shirzad	>7	2001-2008	Tehran	Undergone isolated coronary	15,550	52.3	-
[31]Masoudi kazem abad	56.9	2012	Mashhad	Coronary artery disease	609	45.3	-
[32]Haj Sadeghi	59	2008-2009	Tehran	Coronary artery disease	123	57	-
[33]Peyman	62.6	2009	Ilam	Cardiovascular	60	56.7	31.2
[34]Abbasalizad	59	2016	Tehran	Coronary artery disease	454	50.4	-
[35]Baharvand Ahmadi	58.1	2011-2012	Lorestan	coronary artery disease	170	35.2	-
[36]Bagheri	57.2	2016	Mazandaran	coronary artery disease	238	62.1	25.2
[37]Rashidi	50-70	2005-2009	Ahvaz	Aortic Aneurysm	36	22.2	-
[38]Zand Parsa	61.2	2015	Tehran	coronary artery disease	414	54.7	-
[39]Asghari	62.7	2013	Tabriz	Acute myocardial infarction	182	51.6	27.3
[40]Ostovan	62.24	2011	Shiraz	Coronary artery disease	246	58.9	-
[41]Montazeri	64.83	2009-2010	Tehran	Coronary artery disease	100	84	41.9
[42]Ahmadi	61.2	2012		Myocardial infarction	20750	35.5	34
[43]Hashemi petrodi	43.3	2014	Sari	Myocardial infarction	101	24.5	22.2
[44]Jalal zadeh	61.7	2012	Tehran & Zanjan	Coronary artery disease	300	83.7	-
[45]Baharvand Ahmadi		2011-2012	Khorramabad	Coronary artery disease	160	47	52
[46]peighambari	60.45	2007-2012	Tehran	Aortic valve stenosis	407	41.5	22
[47]Jouyan	46	1990	Shiraz	premature coronary artery disease	321	12.5	30.1
[48]Jahangiri	50-70	2013	Tehran	Coronary artery disease	300	---	17.4
[49]Bakhsian-Kelarijani	56.8	2003-2005	Tehran	Coronary artery disease	9709	40.3	6
[50]Abbasi Tanshizi	53.56	2008-2009	Mashhad	Coronary artery disease	128	29.7	16.6
[51]Pishkar Monfared	>15	2006	Sistan & Baluchestan	Coronary artery disease	614	43.7	-
[52]Najafipour	15-75	2009-2011	Kerman	Coronary artery disease	5900	18.4	32.5
[53]Maddah	58	2010-2011	Rasht	Coronary artery disease	288	69.8	-
[20]Moeini	60-99	2007-2008	Isfahan	Cardiovascular	2063	4	-
[54]Zand Parsa	59.9	2010-2011	Tehran	Coronary artery disease	165	72.1	-
[55]Hosseini	57.8	2003-2007	Tehran	Percutaneous coronary intervention	195	63	43
[56]Bagheri	58.7	2007-2011	Tehran	Coronary artery disease	1390	49.5	45.2
[57]Yarbeigi	60.39	2009-2013	Tehran	Coronary artery disease	1592	63.5	-
[58]Sadeghi	58.9	2008	Isfahan	Coronary artery disease	125	36.8	47.3
[15]Alizadeh Asl	59.9	2007-2008	East Azerbaijan	Cardiovascular	12,031	43.8	26.4
[59]Yousefi	58.4	2008-2009	Tehran	Coronary artery disease	2097	43.9	36.4
[60]Gholamrezanezhad	55.3	2009	Tehran	SPECT_MPI	291	50.2	28
[61]Rostami	60.53	2006	Isfahan	Coronary artery disease	107	14	21.6
[62]Eskandarian	60.9	2004-2006	Semnan	Coronary artery disease	433	51	11.2
[63]Bayani	54.4	2011	Mashhad	Cardiovascular	238	37.9	25.2
[64]Shirani	61.7	2005-2006	Tehran	Coronary artery disease	2819	4.1	-
[65]Shirani	60.9	2005-2006	Tehran	Coronary artery disease	2044	32.2	3

Contd...

Table 1: Contd...

(References) Author	Age	Year of study	City	Type of cardiovascular disease	Sample size	Prevalence of hypertension in cardiovascular disease (%)	Prevalence of diabetes in cardiovascular disease (%)
[66]Fakhrzadeh	47.1	2000	Qazvin	Coronary artery disease	846	9.6	28.9
[67]Sarrafzadegan	59.9	2008	Isfahan	Coronary artery disease	226	44.5	12.8
[68]Behboudi	60.8	2008-2009	Tehran	Coronary artery disease	71	47.9	-
[69]Naserhosseini	57	2007	Mazandaran	Coronary artery disease	153	37.9	35.2
[70]Kasaei	56.47	2005-2006	Tehran	Coronary artery disease	1533	42	-
[71]MirSharifi	62.5	2005-2006	Tehran	Patients with severe peripheral vascular disease	54	38.9	24
[72]Forouzannia	61	2008-2009	Yazd	Coronary artery disease	923	47.9	27.8
[73]Shakeri Babil	58.2	2005-2009	Tabriz	Patients with peripheral arterial disease	95	6.3	-
[21]Esteghamati	62	2003-2005	Tehran	Patients with unstable angina or myocardial infarction	514	91	10.5
[74]Shahsavari Esfahani	60 (12.5)	2012	Jahrom	Cardiovascular	2392	48.2	30
[75]Jalali Farhani	-	2007	Tehran	-	194	73.6	-
[76]Maleki	60.7	2009-2010	Bojnord	-	260	29	42.8
[77]Jamshidi	-	2013	Hamedan	Cardiovascular	550	---	11
[78]Akbari	60.75 (9.78)	2012	Sari	Heart surgery patients	250	38	-
[79]Rahnavard	58.25	1395	Tehran	Congestive heart failure	184	61.4	22
[80]Hadian	68	1987-88	Sari	Heart failure	140	22.9	-
[81]Danesh sani	66.15 (1.5)	2000-2001	Mashhad	Heart failure	117	62	-
[82]Ahmadi	-	2014		Heart failure	1691	42.7	21
[83]Asgharzade Haghghi	75.01 (6.20)	2003-2008	Karaj	Systolic Heart Failure	154	42.2	-
[84]Malak	-	2002-2003	Semnan	Heart failure	248	32.2	31.1
[85]Hasanzade	58.6 (10.2)	1998-2009	Mashhad	Coronary artery disease	1000	43.5	-
[86]Imani poor	-	2003-2004	Tehran	Coronary artery disease	93	54.8	31

Table 2: Prevalence of hypertension in patients with cardiovascular diseases in the studied subgroups

Subgroups	Number of study	Sample size	Prevalence of hypertension (95% CI)	Minimum prevalence of hypertension (95% CI)	Maximum prevalence of hypertension (95% CI)
Prevalence of hypertension in women with cardiovascular diseases	4	1996	67% (53%-82%)	50% (47%-53%)	76% (63%-89%)
Prevalence of hypertension in men with cardiovascular diseases	4	2985	42% (38%-46%)	39% (35%-43%)	46% (43%-49%)
Prevalence of systolic hypertension in patients with cardiovascular diseases	3	1326	25% (12%-39%)	14% (10%-18%)	38% (34%-42%)
Prevalence of diastolic hypertension in patients with cardiovascular diseases	3	1326	20% (8%-31%)	9% (6%-12%)	28% (24%-32%)
Prevalence of diabetes in patients with cardiovascular diseases	33	74251	27% (23%-31%)	3% (3%-4%)	58% (54%-63%)
Prevalence of overweight in patients with cardiovascular diseases	4	17256	34% (18%-50%)	18% (17%-19%)	42% (38%-46%)

myocardial infarction (95% CI: 8%–93%), 33% in patients with aortic aneurysm (95% CI: 14%–52%), and 44% in patients with heart failure (95% CI: 34%–54%). The highest prevalence of hypertension was in patients with myocardial infarction.

In an analysis based on age group, the prevalence of hypertension was 14% in cardiovascular patients aged 40 to 49 years old (95% CI: 8%–20%), 46% in patients aged 50 to

59 years old (95% CI: 42%–49%), and 48% in patients aged 60 to 69 years old (95% CI: 37%–59%); there was only one study in the age group of 70 years old and above, and the prevalence of hypertension in other age groups was 39% (95% CI: 28%–50%). In fact, the prevalence of hypertension in cardiovascular patients has increased with increasing age.

In the analysis of the geographical regions, the prevalence of hypertension in cardiovascular patients was 49% in the

north of Iran (95% CI: 42%–57%), 32% in the center (95% CI: 22%–42%), 33% in west (95% CI: 17%–49%), 43% in east (95% CI: 36%–49%), and 29% in the south (95% CI: 0%–67%) in just one study. The highest and lowest prevalence of hypertension in cardiovascular patients was in the north and south of Iran, respectively.

In Diagram 2, meta-regression showed no significant relationship between the prevalence of hypertension in cardiovascular patients and sample size ($P = 0.271$). In addition, there was no significant relationship between the prevalence of hypertension in cardiovascular patients and the year of study in Diagram 3 ($P = 0.675$).

Discussion

The prevalence of hypertension in cardiovascular patients in Iran was 44%, which was 67% in women and 42% in men. Asmar *et al.* reported the prevalence of hypertension in French men and women to be 37.9 and 22.2, respectively.^[87] In this study, the prevalence of hypertension in women was higher, which is consistent with the results of this study.

Across the WHO regions, the prevalence of raised blood pressure was highest in Africa, where it was 46% for both sexes combined. Both men and women have high rates of raised blood pressure in the Africa region, with prevalence rates over 40%. The lowest prevalence of raised blood pressure was in the WHO region of the Americas at 35% for both sexes. Men in this region had higher prevalence than women (39% for men and 32% for women). In all WHO regions, men have slightly higher prevalence of raised blood pressure than women. This difference was only statistically significant in the Americas and Europe.^[88]

Several meta-analysis have been conducted on blood pressure in different countries, which we will mention later. Results from 23 analyses in 2016 were excluded from main analyses owing to high risks of confounding.

Increased long-term variability in systolic blood pressure was associated with risk of all-cause mortality (hazard ratio: 1.15, 95% CI: 1.09–1.22), cardiovascular disease mortality (1.18, 95% CI: 1.09–1.28), cardiovascular disease events (1.18, 95% CI: 1.07–1.30), coronary heart disease (1.10, 95% CI: 1.04–1.16), and stroke (1.15, 95% CI: 1.04–1.27). Increased mid-term and short-term variability in daytime systolic blood pressure were also associated with all-cause mortality (1.15, 95% CI: 1.06–1.26, and 1.10, 95% CI: 1.04–1.16, respectively).^[89] In a research, 42 studies with 402,282 participants were included. We estimated prevalence of hypertension in Iran during 1980–2012 ($I^2 = 99\%$). The overall pooled prevalence of hypertension was 22% (95% CI: 20.2–23.8). The prevalence of hypertension was 23.6% (95% CI: 21.1–26.1) in men and 23.5% (95% CI: 20.2–23.8) in women. In urban areas, the prevalence of hypertension was 22.1% (95% CI: 19.4–24.7).^[90] In this study, there was no difference in the prevalence of hypertension between men and women. In other research, from 100 articles in 2017 in Iran which were found in the searched references, 22 of them were finally analyzed. Among the selected final articles from 1999 to 2012, 96,689 participants participated in this study. The prevalence of hypertension was 17%. The prevalence rate of hypertension among the people aged above 20 years was between 10% and 32% and its mean was 24% (95% CI: 23%–24%).^[91] As we see, the prevalence of hypertension in heart patients in Iran is higher than normal people, which is evident.

In a study, a total of 242 studies, comprising data on 1,494,609 adults from 45 countries, met our inclusion criteria. The overall prevalence of hypertension was 32.3% (95% CI: 29.4–35.3), with the Latin America and Caribbean region reporting the highest estimates (39.1%, 95% CI: 33.1–45.2).^[92] In other research of a total of 1240 articles, 18 studies comprising 42,618 participants met the eligibility criteria. The overall pooled prevalence of

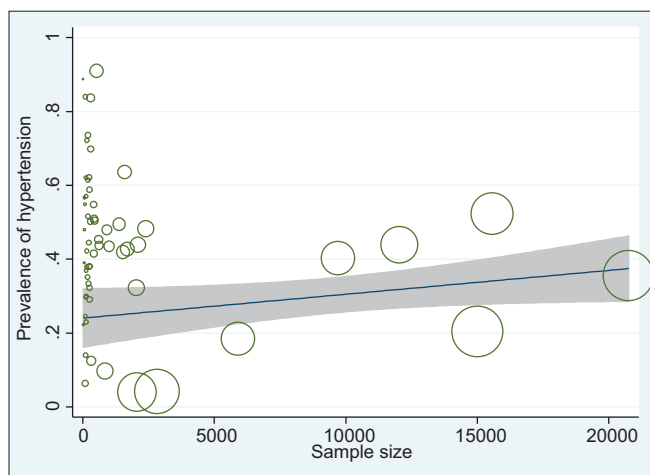


Diagram 2: Relationship between the prevalence of hypertension in cardiovascular patients in Iran and the research sample size using meta-regression

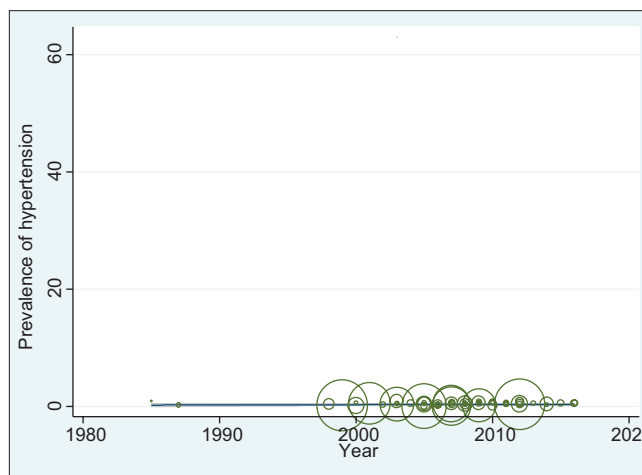


Diagram 3: Relationship between the prevalence of hypertension in cardiovascular patients in Iran and the year of the study using meta-regression

hypertension in Pakistani adolescents was 26.34% (25.93%, 26.75%).^[93] Prevalence of hypertension in Pakistani adolescents is lower than that of cardiovascular patients in Iran.

Overall prevalence of hypertension was 17%, with 21.4% in the urban population and 14.8% in the rural population.^[94] Prevalence of hypertension in cardiovascular patients in India is lower than that of cardiovascular patients in Iran. Overall prevalence for hypertension in India was 29.8% (95% CI: 26.7–33.0).^[95] Prevalence of hypertension in Indian populations is lower than that of cardiovascular patients in Iran. In 32 reviewed studies with a sample of 34,714 participants, the prevalence of hypertension in Iranian diabetic patients was 51% (95% CI: 43%–60%).^[96] Therefore, the prevalence of hypertension in Iran is higher in patients with heart disease than in diabetic patients.

Meta-regression showed no significant relationship between the prevalence of hypertension in cardiovascular patients and the research sample size ($P = 0.271$); that is, in studies with larger sample sizes (larger circle), the prevalence of hypertension in cardiovascular patients increased, but this increase is not statistically significant [Diagram 2]. There was no significant relationship between the prevalence of hypertension in cardiovascular patients and the year of study ($P = 0.675$); according to Diagram 3, during the years 1985–2017, the prevalence of hypertension in cardiovascular patients in Iran was almost constant, but this is not statistically significant. Sensitivity analysis showed that the prevalence of hypertension in cardiovascular patients in Iran after omitting the study of Esteghamati^[21] decreased to 42.66 (95% CI: 37.83%–47.50%), and after omitting the study of Moeini^[20] increased to 44.18 (95% CI: 39.35%–49.01%), and these two studies are the most effective studies in the final meta-analysis.

According to a study, the prevalence of heart failure in England was 7.79%.^[97] In a study among American people aged 18 to 74 years based on the definition of hypertension (hypertension over 140/90), the prevalence of hypertension was 29.2%.^[98] In another study published by Vasan in Framingham in 2001, 14.7% of people with high blood pressure suffered from cardiovascular events over the course of 10 years.^[99] In United States, 83.6 million people have at least one type of CAD. According to the International Center for Health Statistics, in 2012, 6.8% of people over the age of 18 in Asia had heart disease, 4.5% had CAD, and 21.2% had high blood pressure.^[100] Studies in Spain show that the prevalence of cardiovascular risk factors such as high blood pressure (37.6%) and diabetes (6.2%) is high.^[101] In a study titled “Cardiovascular Risk Factors in Children in the United States” by Barton *et al.*, 22.3% of them had systolic and diastolic blood pressures above the 90th percentile.^[102]

The limitations of the study include insufficient information in some articles, the lack of uniform distribution of studies

in different regions of Iran, since only two studies were conducted in the south Iran; some studies were conducted on cardiovascular patients and healthy participants, and the prevalence of hypertension was not reported separately for each group.

The benefits of the study: This article, for the first time in Iran, studies the prevalence of hypertension in cardiovascular patients with a systematic and meta-analytic review. It also expresses the prevalence of hypertension in cardiovascular patients, in terms of men and women, and the severity of systolic and diastolic hypertension.

Conclusions

The prevalence of hypertension in cardiovascular patients is high in Iran and is higher among women, and the problem increases with age. Among patients with cardiovascular disease, myocardial infarction patients have the highest levels of hypertension. The prevalence of systolic blood pressure in cardiac patients is more than diastolic hypertension, and cardiac patients in the north of Iran are more likely to have hypertension than patients in other regions of Iran.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Received: 01 Aug 18 **Accepted:** 12 Feb 19

Published: 30 Apr 20

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