REVIEW ARTICLE

Prevalence of osteoporosis in the Iranian population: a systematic review and meta-analysis

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Abstract

Purpose The prevalence of osteoporosis increases as the population ages. The aim of this study was to conduct a systematic review and meta-analysis to estimate the prevalence of osteoporosis among the general population ≥ 50 years old in Iran.

Methods Multiple databases including Scopus, WOS, Medline, Embase, and Persian databases (SID and Magiran) were systematically searched to identify relevant research papers. All population-based studies estimating the prevalence of osteoporosis in the Iranian population were included and imported into Endnote software. Two authors independently reviewed the articles. The Newcastle-Ottawa Scale was used to assess the risk of bias. Statistical analysis was performed using Stata software, and a significance level of 0.05 was applied to the analyses.

Results Totally 2117 documents were retrieved from the databases up until October 11, 2022. After reading the full texts, 10 documents were included in the study. Our results indicated that the pooled prevalence of osteoporosis in the femoral neck region was 0.19 (95%CI: 0.12–0.26) and 0.19 (95%CI: 0.13–0.25) for women and men, respectively. Pooled prevalence of spinal osteoporosis was 0.29 (95%CI: 0.21–0.38) among women and 0.16 (95%CI: 0.12–0.19) among men. The total pooled prevalence of osteoporosis was 0.38 (95%CI: 0.29–0.48) for women and 0.25 (95%CI: 0.22–0.29) for men.

Conclusion Our study highlights the elevated prevalence of osteoporosis among individuals aged 50 years and older, with females exhibiting higher rates. Notably, osteoporosis in the femoral neck region demonstrated the lowest prevalence in both sexes. The implementation of comprehensive strategies is imperative to address osteoporosis problems effectively.

Keywords Osteoporosis · Meta-analysis · Prevalence · Bone mineral density · Iran

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Introduction

Osteoporosis is a systemic skeletal disorder distinguished by diminished bone mass and deterioration of bone tissue structure, leading to increased vulnerability to fractures [1]. With the aging population, the incidence of osteoporosis and its associated complications is projected to significantly increase, becoming a major global healthcare burden [2]. Osteoporotic fractures, predominantly observed in the hip, spine, wrist, and femoral neck, result in substantial morbidity [3] and are a significant concern for both men and women and public health [4]. Osteoporosis is responsible for approximately 2 million fractures annually, which can severely impact the quality of life and contribute to disability and mortality [5]. The global prevalence of osteoporosis is challenging to estimate, because of variations in definitions and diagnostic criteria. Globally, 1 in 3 women and 1 in 5 men aged 50 years and above will experience osteoporotic fractures [6].

Within the Eastern Mediterranean Region, the overall combined prevalence of osteoporosis is 24.4% [7]. The findings of the Iranian Multicenter Osteoporosis Study (IMOS) revealed a high prevalence of bone loss among the Iranian population [8]. In the initial phase of IMOS conducted in five cities (2001), 78.2% of postmenopausal women and 77.3% of men aged ≥50 years exhibited osteopenia and/or osteoporosis. In the third phase of the IMOS in two cities (2011), the prevalence of osteoporosis was 37% for postmenopausal women and 44% for men aged ≥50 years [9]. In 2021, the prevalence of osteoporosis among the elderly population in Iran was estimated to be 62.7% in women and 24.6% in men [10]. Numerous studies conducted in different regions of Iran have reported the prevalence of osteoporosis. However, a comprehensive and reliable estimation of the overall prevalence of osteoporosis is necessary to provide substantial evidence for the control and prevention of this condition nationwide. Therefore, this study is a systematic review and meta-analysis to obtain a reliable estimate of the prevalence and understanding of the epidemiology of osteoporosis among the general population of Iran.

Methods

This study was conducted in accordance with the PRISMA guidelines. We systematically identified relevant studies using specified keywords, including Iran, osteoporosis, osteopenia, prevalence, and bone mineral density.

Literature search method

To identify relevant research papers, we conducted a systematic literature search on several databases, including Scopus, Web of Science (WOS), Medline, Embase, and Google Scholar, until October 11, 2022. In addition, we searched Persian databases, including the Scientific Information Database (SID) and Magiran, and retrieved relevant data. The selection of keywords was based on MeSH (Medical Subject Headings) terms. Furthermore, a manual search was conducted by screening the reference lists of related articles.

Eligibility criteria and the selection process

The PICO algorithms were used to establish the inclusion and exclusion criteria. The inclusion criteria encompassed articles focusing on the examination of osteoporosis prevalence among individuals aged 50 years and above in the general population of Iran. Furthermore, among studies that presented the prevalence of osteoporosis within different age categories, those encompassing individuals aged 50 years and older, were integrated into our investigation. The exclusion criteria involved articles that estimated the prevalence of osteoporosis in a specific group of individuals characterized by pre-existing medical conditions or patients seeking treatment in clinical centers. Case series and case reports, editorial materials, commentaries, case-control studies, reviews, and randomized clinical trials were excluded from the analysis. The search strategy was constructed in accordance with the PICO algorithm. Both text words and MeSH terms were incorporated to define the search keywords, and various combinations of these terms were employed to locate pertinent articles. Detailed information regarding the search strategy is provided in Appendix 1.

Study selection

By importing the related articles to EndNote X8, duplicates were removed. The retrieved documents underwent a two-step review. In the initial step, the titles and abstracts of the articles were examined, followed by an evaluation of the full texts. All population-based studies that estimated the prevalence of osteoporosis in the Iranian population, without any restrictions regarding the osteoporosis site, were included. Persian databases were also searched using relevant keywords of osteoporosis and its prevalence. The articles were initially screened on the basis of their titles and abstracts, and if they met the inclusion criteria, they were imported into EndNote software, and their full texts were reviewed. Two authors (E.H. and H.M.) independently conducted the article review. Disagreements were addressed by brainstorming with the third author (N.F.) to resolve inter-rater discrepancies. The level of inter-rater agreement was assessed using the Kappa coefficient, which was calculated as 88%.

Data extraction

General information from each study, such as authors' names, year of publication, study setting (i.e., geographic

location), sample size, sex composition, and age range, was extracted by two independent authors using a standardized data form in an Excel spreadsheet. Within the collection of articles that delineated the prevalence across various age groups, the data pertaining to the prevalence within the age group of 50 years and above was incorporated into our study. In addition, we collected data on details of anatomic locations of osteoporosis and calculated the corresponding prevalence rates.

Risk of bias assessment

The risk of bias in the included studies was assessed using the Newcastle-Ottawa Scale [11]. Two authors (E.H. and H.M.) reviewed the articles independently, and the total score of each article was calculated. In case of uncertainty or disagreement, a third-party investigator (N.F.) was consulted to reach a consensus. Subsequently, all selected studies were classified into three categories: good (score 8–9), satisfactory (score 4–7), or unsatisfactory (score 1–3), based on the consensus opinion of experts.

Effect measures

The prevalence rates reported in the conducted studies were used for combination or exposition of the outcome.

Data analysis and synthesis statistical analysis

The analysis was conducted using Stata software 14.0 (STATA Corporation, College Station, TX, USA). The "metan" command was used to assess the combined prevalence with a 95% confidence interval (CI). Statistical heterogeneity between studies was determined using Cochran's Q test and the I^2 statistic. If heterogeneity was present, a random-effects model was used. A meta-regression analysis was performed to identify potential sources of heterogeneity, such as publication year, age group, and city of sampling. A statistical significance level of 0.05 was considered statistically significant.

Result

Literature search and study selection

A total of 2274 documents were obtained from the databases until October 11, 2022. Among these, 793 documents were eliminated because of duplication. Of the remaining 1490 documents, 1315 were excluded based on title and abstract screening as they appeared irrelevant to the goal of this review. After this screening, there were 175 articles remaining. From this subset, 49 articles were selected for data extraction. However, 39 of these articles were excluded because they used the same data sets. Eventually, after thoroughly reading the full texts and conducting quality assessments, 10 documents were included in the study (Fig. 1).

The study included a population ≥ 50 years. Some studies focused on a specific province or city, whereas others covered multiple locations. In cases where a study covered multiple provinces and had separate articles for different cities or regions, only the data from the multi-provincial study were recorded to avoid redundancy. Because several papers have reported the prevalence of osteoporosis at a subnational level using the IMOS data sets, we chose to use an article that reported results from two national-level studies to prevent duplication [12]. The results from the Amirkola study [13] were not available at the time of writing this publication, therefore we obtained them by contacting the principal investigator of the study. Table 1 displays the locations of the studies included in our analysis.

We collected data on the prevalence of osteoporosis at the spinal and femoral neck sites for both females and males individually (Table 1). Initially, 2274 papers were identified from electronic databases, and ultimately, 10 articles containing data from 8923 individuals recruited in 11 regional or national studies were included in our meta-analysis.

Femoral neck osteoporosis

In general, 10 studies investigated the occurrence of osteoporosis in the femoral neck region, with 5 studies focusing on men and 9 studies concentrating on women. The prevalence of femoral neck osteoporosis varied across different regions, ranging from 2/9% in Tehran city to 66% in females in Kovar city. Among males, the prevalence ranged from 11% in Iran-Phase1 IMOS to 55% in Kovar city. Our findings revealed that the pooled prevalence of femoral neck osteoporosis was estimated to be 19% (95% confidence interval: 12–26; $p < 0.001$, $I^2 = 98.1\%$) in women and 19% (95% confidence interval: 13–25; $p = 0.001$, $I^2 = 93.1\%$) in men (Fig. 2A and B).

Spinal osteoporosis

In our investigation, we conducted a comprehensive analysis of 10 specific studies focusing on spinal osteoporosis. Among these studies, 5 were conducted on men and 9 on women. We observed that the prevalence of spinal osteoporosis was higher compared to femoral neck osteoporosis. In women, the prevalence ranged from 7% in the Iran-Phase3 IMOS study to 82% in the Kovar study, whereas in men, it ranged from 13/2% in the Kovar study to 21/3% in the Iran-Phase1 IMOS study. Additionally, we calculated the pooled prevalence of spinal osteoporosis to be 29% (95%CI: 21–38;

Fig. 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram for the studies included in the current meta-analysis
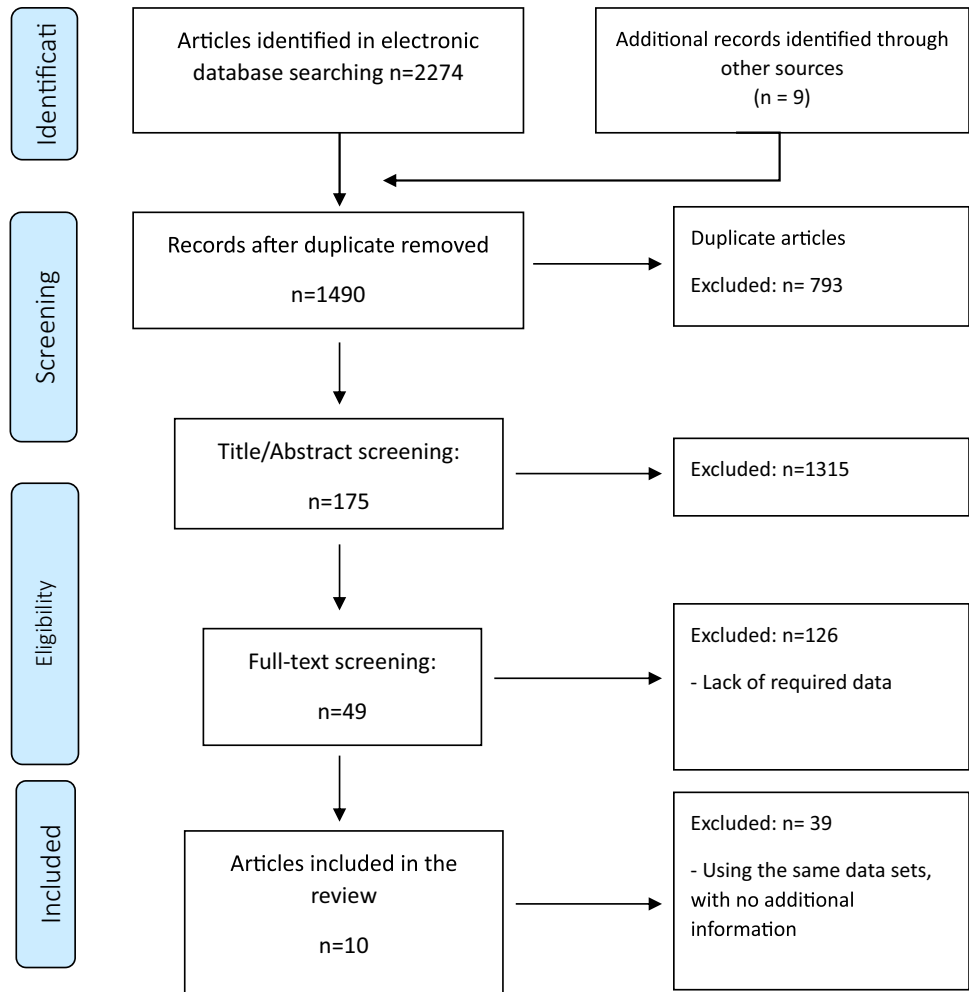

Table 1 Characteristics of the included studies in the meta-analysis

| Author	Sampling year	Published year	City	Age group	Sex	Spinal prevalence (SE), %	Femoral neck prevalence (SE), %	Total prevalence (SE), %
Jamshidian [12]	2001	2004	Tehran	≥50	Female	28 (2)	5 (1)	NA
Hadavi [13]	2002	2014	Iran-Phase1 IMOS	≥50	Female	3 (2)	12 (1)	35 (2)
Hadavi [13]	2002	2014	Iran-Phase1 IMOS	≥50	Male	21 (1)	0.11 (1)	28 (1)
Salehi [14]	2001–2005	2009	Tehran	≥50	Female	19 (1)	11 (1)	36 (1)
Salehi [14]	2001–2005	2009	Tehran	≥50	Male	14 (2)	12 (2)	24 (2)
Hosseinpanah [15]	NA	2008	Tehran	≥50	Female	25 (2)	11 (2)	NA
Adinehpour [16]	2008	2010	Fars-Kovar	≥50	Male	8 (2)	4 (4)	NA
Tohidi [17]	2008	2011	Fars-Kovar	≥50	Female	6 (4)	4 (4)	NA
Hadavi [13]	2011	2014	Iran-Phase3 IMOS	≥50	Female	7 (1)	24 (2)	34 (2)
Hadavi [13]	2011	2014	Iran-Phase3 IMOS	≥50	Male	16 (2)	25 (2)	32 (3)
Shahriarpour [18]	NA	2020	Tehran	≥50	Female	30 (3)	15 (2)	NA
Fahimfar [10]	2016	2021	Bushehr	≥60	Female	41 (1)	47 (1)	58 (1)
Fahimfar [10]	2016	2021	Bushehr	≥60	Male	15 (1)	14 (1)	23 (1)
Amirkola	2017	NA	Babol-Amirkola	≥60	Female	NA	NA	40 (1)
Amirkola	2017	NA	Babol-Amirkola	≥60	Male	NA	NA	20 (1)
Hemmati [19]	2018	2021	Tabriz	≥50	Female	23 (2)	3 (0.9)	24 (1)
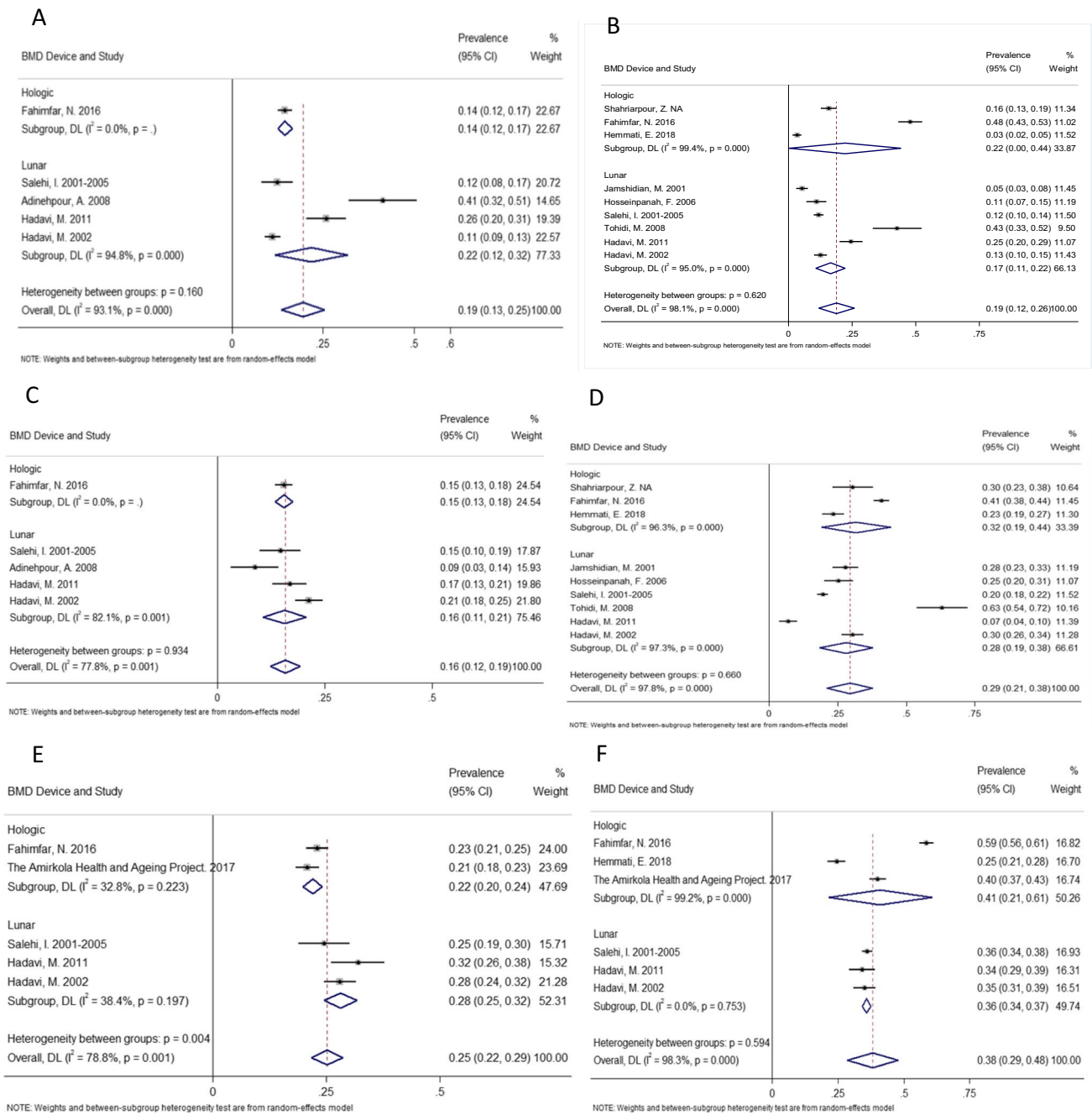
Fig. 2 The estimated prevalence of osteoporosis in men and women aged ≥50 years old in Iran (**A**: femoral neck in men, **B**: femoral neck in women, **C**: spinal site in men, **D**: spinal site in women, **E**: total osteoporosis in men, **F**: total osteoporosis in women)

$P < 0.001$, $I^2 = 97.8\%$) in women and 16% (95%CI: 12–19; $P = 0.001$, $I^2 = 77.8\%$) in men (Fig. 2C and D).

Total osteoporosis

A total of 7 studies were included in the analysis, with 5 focusing on men and 7 focusing on women. The pooled prevalence of osteoporosis was found to be 38% (95% confidence interval: 29–48; $p < 0.001$, $I^2 = 98.3\%$) in women and 25%

(95% confidence interval: 22–29; $p = 0.001$, $I^2 = 78.8\%$) in men (Fig. 2E and F). As anticipated, the prevalence of osteoporosis was higher in women compared to men, regardless of the specific site or overall osteoporosis.

Risk of bias assessment

Figure 3 shows the risk of bias of the included studies evaluated using the six-question NOS (Newcastle-Ottawa)

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checklist for cross-sectional studies. Each question has four possible responses: yes, no, unclear, and not mentioned. The NOS selection section contains three questions regarding sample's representativeness, response rate adequacy, and use of a validated exposure measurement tool. The NOS comparability section assesses whether confounding factors have been controlled. The NOS outcome section includes two questions regarding outcome assessment (blind assessment or record linkage) and appropriate statistical analysis.

Discussion

The objective of this meta-analysis was to determine the incidence of osteoporosis in individuals aged 50 years and older in Iran. Our findings revealed that the overall pooled prevalence of osteoporosis was 38% for females and 25% for males. When specifically considering the spine, the pooled prevalence was 29% for females and 16% for males. Consistent with expectations, the prevalence of osteoporosis was higher in women compared to men, both in terms of overall prevalence and at specific sites. Among females, the lowest and highest prevalence rates of femoral neck osteoporosis were reported as 5% (Jamshidian et al.) and 47% (Fahimfar et al.), respectively. In Jamshidian's study,

different techniques were employed to measure bone mass density in comparison to Fahimfar's study (specifically, dual photon X-ray technique vs. The Dual-energy X-ray technique). Undoubtedly, the prevalence of osteoporosis increases with age [20], and the utilization of different bone density measurement devices, each with varying sensitivity, affects the reporting of the osteoporosis prevalence [21, 22]. Among men aged over 20 years, the lowest prevalence of osteoporosis at the spine site was 8% and the highest prevalence at the neck of the femur site was 41%, as reported by Adinehpour et al. conducted in Kovar city in 2010.

In 2022, a meta-analysis estimated the global occurrence rates of osteoporosis and osteopenia to be 19.7% and 40.4%, respectively. Variations were observed across continents and nations. The prevalence was notably elevated in Turkey (52.0%), Palestine (40.6%), Iran (41.5%), and Jordan (36.3%). Conversely, the lowest occurrence rates were documented in the Netherlands (4.1%), Qatar (4.9%), Finland (6.0%), England (5.2%), and Brazil (6.4%). These findings reflect those developing countries exhibit higher prevalence compared with developed ones. Regardless of sex, the prevalence of osteoporosis increases with age [23]. In Iran, it has been estimated that the prevalence of osteoporosis is particularly high among women [10, 24].

Fig. 3 Risk of bias assessment using NOS tool
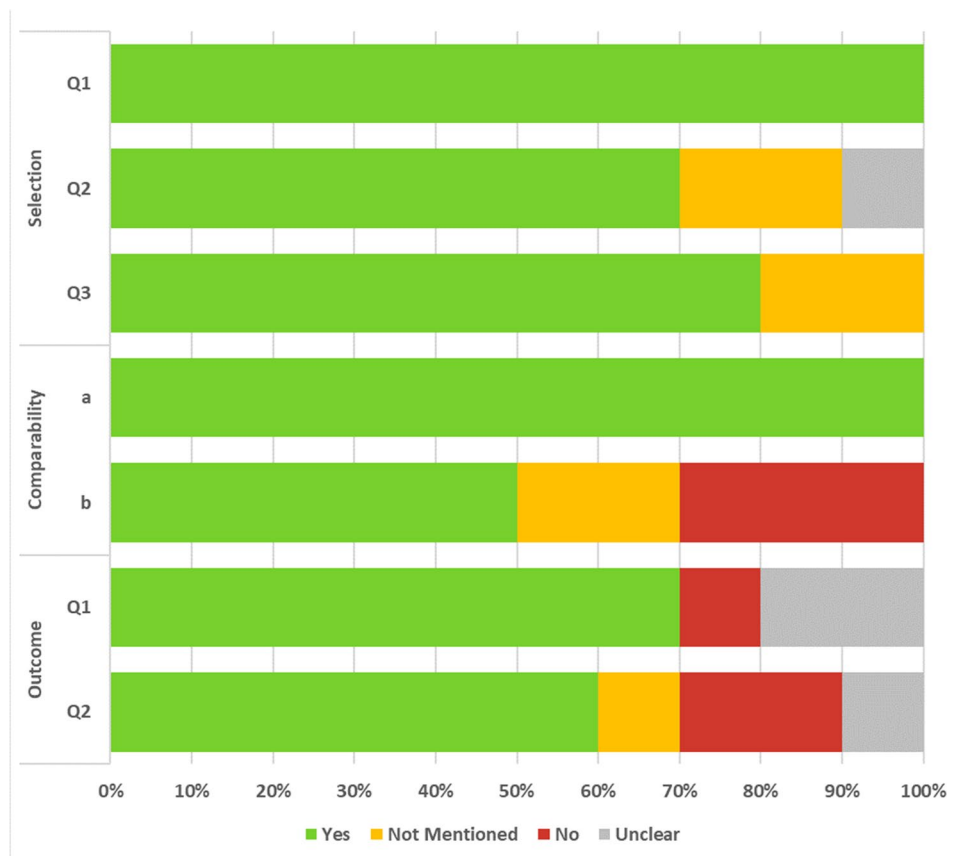
To date, there have been 7 meta-analyses examining the prevalence of osteoporosis in Iran. The initial meta-analysis, conducted in 2011, analyzed 21 eligible studies and found an osteoporosis prevalence of 18.9% in the femur and 18.91% in the spinal region [25]. In a 2013 meta-analysis study involving 31 studies, the overall prevalence of osteoporosis in the lumbar spine was found to be 0.17. The prevalence was higher among older age groups, women, and in the northern regions of the country [26]. Hemmati et al. conducted a meta-analysis in 2018, estimating a prevalence of 32% for osteoporosis in postmenopausal women in Iran. Additionally, the prevalence of low bone density was estimated to be 51% based on 50 studies. Specifically, the prevalence of osteoporosis has been reported to be32% in the lumbar spine, 21% in the spine, 25% in the femoral neck, and 21% in the hip [27]. Another meta-analysis performed in 2019 focused on postmenopausal women with type II diabetes. This study, consisting of four papers with a total sample of 562, found a prevalence of osteoporosis of 25.26% in the lumbar spine and 17.45% in the femoral neck [5]. A meta-analysis was performed in 2022 to assess the prevalence of osteoporosis in patients with multiple sclerosis (MS). The analysis included 29 original articles and 6 conference papers, and the results showed a pooled prevalence of osteoporosis of 17% [28]. Another meta-analysis conducted by Moshayedi et al. in 2022 focused on patients with rheumatoid arthritis and included 57 studies. The findings demonstrated a prevalence of osteoporosis of 27.6% [29].

In a meta-analysis study published by Nourmohammadi et al. in 2022, 30 studies were included to assess the prevalence of osteoporosis and low bone density in individuals over the age of 60 years in Iran. The results indicated a prevalence of osteoporosis of 34% and a prevalence of low bone density of 47%. The study also revealed that 34% of women and 41% of men over the age of 60 years in Iran suffer from osteoporosis. The prevalence of osteoporosis was found to be 25% in the spine and 35% in the hip [30].

In the most recent meta-analysis conducted in 2022 specifically in Iran, the prevalence of osteoporosis and osteopenia in postmenopausal Iranian women was reported to be 33.70% and 47.60%, respectively. The analysis also revealed a pooled prevalence of osteoporosis of 31.99% in the spine and 15.93% in the femur [31].

Numerous investigations have been conducted to assess the prevalence of osteoporosis in Iran. However, some of these studies were regional and part of a comprehensive national study, with their findings already incorporated into their primary nationwide article. This has implications for the process of meta-analysis, as the inclusion of these articles alongside the main study may lead to issues of duplication that have not been adequately addressed in previous meta-analyses. In addition, it is worth noting that the type of bone densitometry devices used in the studies is often not clarified, despite the fact that the outcomes can be influenced by the specific device employed. Furthermore, differences in the reference population used for the bone densitometry devices may contribute to heterogeneity in the results.

Limitations

There are several limitations to be acknowledged in our study. First, we observed a significant level of heterogeneity within our study. In order to address this concern, we implemented strategies to increase homogeneity, such as conducting subgroup analysis based on gender and the osteoporosis site. Second, certain studies included in our analysis reported the prevalence of osteoporosis without specifying the anatomical site. In addition, there has been a lack of comprehensive studies investigating the prevalence of osteoporosis in all regions of Iran, as we did not include some cities in our study. Moreover, numerous articles included in our meta-analysis failed to mention the reference population for the bone densitometry device used. It is worth noting that the reference population should ideally consist of Caucasian women aged 20–29 years, as per international recommendations. This failure to adhere to the recommended reference population may have contributed to the observed heterogeneity. Therefore, it is recommended that future research adhere to international guidelines to ensure more accurate results. In addition, we attempted to identify potential sources of heterogeneity based on variables such as study location, study year, and age groups. However, because of the limited sample size and resulting in low statistical power, we were unable to detect significant sources of heterogeneity.

Conclusion

The findings of our study revealed a significant occurrence of osteoporosis within the Iranian population, with approximately one-third of individuals aged ≥50 years experiencing osteoporosis in at least one anatomical location. Considering the escalating issue of population aging, it is imperative to develop comprehensive strategies aimed at effectively managing and mitigating this concern.

Declarations

References

1. Vandenbroucke A, Luyten FP, Flamaing J, Gielen E. Pharmacological treatment of osteoporosis in the oldest old. Clin Interv Aging. 2017;12:1065–77.
2. Trajanoska K, Rivadeneira F. The genetic architecture of osteoporosis and fracture risk. Bone. 2019;126:2–10.
3. Farrah Z, Jawad AS. Optimising the management of osteoporosis. Clin Med (London, England). 2020;20(5):e196–201.
4. Fuggle NR, Curtis EM, Ward KA, Harvey NC, Dennison EM, Cooper C. Fracture prediction, imaging and screening in osteoporosis. Nat Rev Endocrinol. 2019;15(9):535–47.
5. Parizad N, Baghi V, Karimi EB, Ghanei GR. The prevalence of osteoporosis among Iranian postmenopausal women with type 2 diabetes: a systematic review and meta-analysis. Diabetes Metab Syndr. 2019;13(4):2607–12.
6. Epidemiology of Osteoporosis and Fragility Fractures. 2022. Available from: https://www.osteoporosis.foundation/facts-statistics/epidemiology-of-osteoporosis-and-fragility-fractures. Accessed 12 Sept 2021.
7. Zamani M, Zamani V, Heidari B, Parsian H, Esmaeilnejad-Ganji SM. Prevalence of osteoporosis with the World Health Organization diagnostic criteria in the eastern Mediterranean region: a systematic review and meta-analysis. Arch Osteoporos. 2018;13(1):1–10.
8. Larijani B, Moayyeri A, Keshtkar AA, Hossein-Nezhad A, Soltani A, Bahrami A, et al. Peak bone mass of Iranian population: the Iranian multicenter osteoporosis study. J Clin Densitom. 2006;9(3):367–74.
9. Fahimfar N, Gharibzadeh S, Khashayar P, Rajabian R, Ranjbar Omrani G, Bahrami A, et al. Iranian multicenter osteoporosis studies (IMOS) during last decade: rationale, main findings, lessons learned and the way forward. J Diabetes Metab Disord. 2020:1–6.
10. Fahimfar N, Noorali S, Yousefi S, Gharibzadeh S, Shafiee G, Panahi N, et al. Prevalence of osteoporosis among the elderly population of Iran. Arch Osteoporos. 2021;16(1):1–10.
11. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa: Ottawa Hospital Research Institute. 2000;2(1):1–12.
12. Jamshidian Tehrani M, Kalantari N, Azadbakht L, Rajaie A, Hooshiar-rad A, Golestan B, et al. The prevalence of osteoporosis among women aged 40-60 in Tehran. Iran J Endocrinol Metab. 2003;5(4):271–6.
13. Hadavi M, Larijani B, Qorbani M, Eshrati B. Osteoporosis prevalence and t-score discordance between femur and lumbar spine in Iran and some related factors: imos study. Iran J Diabetes Metab. 2015;14(5):305–14.
14. Salehi I, Khazaeli S, Najafizadeh SR, Ashraf H, Malekpour M. High prevalence of low bone density in young Iranian healthy individuals. Clin Rheumatol. 2009;28(2):173–7.
15. Hosseinpanah F, Rambod M, Hossein-nezhad A, Larijani B, Azizi F. Association between vitamin D and bone mineral density in Iranian postmenopausal women. J Bone Miner Metab. 2008;26(1):86–92.
16. Adine Pour A, Tohidi M, Dabbaghmanesh M, Jafari P, Fattahi M, Ranjbar Omrani G. Prevalence of osteoporosis in rural men of fars based on both local and WHO reference data. Iran J Endocrinol Metabol. 2010;12(4):393–400.
17. Touhidi M, Adinehpour A, Dabaghmanesh M, JAFARI P, Fatahi M, Ranjbar OGH. Evaluation of bone mineral density in rural women of Kawar-Fars (Kawar cohort study). Iranian South Medical Journal. 2011;13(4):253–62.
18. Shahriarpour Z, Nasrabadi B, Shariati-Bafghi SE, Karamati M, Rashidkhani B. Adherence to the dietary approaches to stop hypertension (DASH) dietary pattern and osteoporosis risk in postmenopausal Iranian women. Osteoporos Int. 2020;31(11):2179–88.
19. Hemmati E, Mirghafourvand M, Mobasseri M, Shakouri SK, Mikaeli P, Farshbaf-Khalili A. Prevalence of primary osteoporosis and low bone mass in postmenopausal women and related risk factors. J Educ Health Promot. 2021;10:204.
20. Pietschmann P, Rauner M, Sipos W, Kerschan-Schindl K. Osteoporosis: an age-related and gender-specific disease–a mini-review. Gerontology. 2009;55(1):3–12.
21. Wanner HW, Riggs BL. Methods and application of bone densitometry in clinical diagnosis. CRC Crit Rev Clin Lab Sci. 1986;24(3):217–33.
22. Nelson DA, Brown EB, Flynn MJ, Cody DD, Shaffer S. Comparison of dual photon and dual energy X-ray bone densitometers in a clinic setting. Skelet Radiol. 1991;20(8):591–5.
23. Xiao P-L, Cui A, Hsu C-J, Jiang N, Xu X, Peng R, et al. Global, regional prevalence, and risk factors of osteoporosis in population-based studies: an analysis based with the World Health Organization diagnostic criteria. Preprint in The Lancet. 2022. Available at https://doi.org/10.2139/ssrn.4034473.
24. Larijani B, Resch H, Bonjour JP, Aghai Meybodi HR, Mohajery Tehrani MR. Osteoporosis in Iran, Overview and Management. Iran J Public Health. 2007;1(36):1–13.
25. Bagheri P, Haghdoost AA, Dortaj RE, Halimi L, Vafaei Z, Farhangnia M, et al. Ultra analysis of prevalence of osteoporosis in iranian women. A Systematic Review and Meta-analysis. Iranian Journal of Endocrinology and Metabolism. 2011;13(3):315–25.
26. Irani AD, Poorolajal J, Khalilian A, Esmailnasab N, Cheraghi Z. Prevalence of osteoporosis in Iran: a meta-analysis. J Res Med Sci. 2013;18(9):759.
27. Hemmati F, Sarokhani D, Sayehmiri K, Motadayen M. Prevalence of osteoporosis in postmenopausal women in Iran: a systematic review and meta-analysis. Iran J Obstet Gynecol Infertil. 2018;21(3):90–102.
28. Azadvari M, Mirmosayyeb O, Hosseini M, Vaheb S, Razavi SZE. The prevalence of osteoporosis/osteopenia in patients with multiple sclerosis (MS): a systematic review and meta-analysis. Neurol Sci. 2022;43(6):3879–92.
29. Moshayedi S, Tasorian B, Almasi-Hashiani A. The prevalence of osteoporosis in rheumatoid arthritis patient: a systematic review and meta-analysis. Sci Rep. 2022;12(1):15844.

30. Nourmohammadi H, Abdan Z, Hashemipour SMA, Sarokhani D, Abdan M, Fakhri M, et al. Prevalence of osteoporosis and osteopenia in people over 60 years in Iran: a systematic review and meta-analysis. Int J Prev Med. 2022;13(1):11.

31. Eghbali T, Abdi K, Nazari M, Mohammadnejad E, Gheshlagh RG. Prevalence of osteoporosis among Iranian postmenopausal women: a systematic review and Meta-analysis. Clin Med Insights Arthritis Musculoskelet Disord. 2022;15:11795441211072471.