



Original Article

Prevalence of Osteoporosis and Associated Factors Among Older Adults: Findings from the Neyshabur Longitudinal Study on Ageing

Ali Hadinfar^{1,2}, Salimeh Jamali³, Fatemeh Zoorghi Bomeri³, Sara Saljoughi^{4*} 

¹ Noncommunicable Diseases Research Center, Neyshabur University of Medical Sciences, Neyshabur, Iran

² Workplace Health Research Center, Neyshabur University of Medical Sciences, Neyshabur, Iran

³ Department of Psychology, Birjand University, Birjand, Iran

⁴ Department of Operating Room, Zahedan University of Medical Sciences, Zahedan, Iran

Corresponding Author

Sara Saljoughi, Ph.D

Department of Operating Room,
Zahedan University of Medical
Sciences, Zahedan, Iran

✉ mahboubesaljoughi@gmail.com

☎ +985433450016

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ABSTRACT

Background: Osteoporosis is a common and clinically important condition in older adults. This study aimed to determine its prevalence and associated factors among older adults in Neyshabur, Iran.

Methods: This cross-sectional study used baseline data from the Neyshabur Longitudinal Study on Ageing (NeLSA). Of 7,462 participants, 7,217 with available osteoporosis status were included. Demographic, socioeconomic, lifestyle, clinical, functional, and psychological characteristics were assessed using standardized questionnaires and clinical measurements. Multivariable logistic regression was used to identify factors associated with osteoporosis.

Results: Osteoporosis was identified in 885 participants (12.30%); 89.80% were women. Participants with osteoporosis differed from those without osteoporosis in lifestyle, sleep, depression, cognition, and handgrip strength. In logistic regression, sex, age, hypertension, sleep quality, depressive symptoms, and handgrip strength were significantly associated with osteoporosis. Men had lower odds than women (OR = 0.16). Each one-year increase in age increased the odds by 3% (OR = 1.03). Hypertension was associated with higher odds (OR = 1.29). Each one-unit increase in PSQI and depression scores increased odds by 6% and 4%, respectively. Greater handgrip strength was associated with lower odds (OR = 0.98).

Conclusion: Osteoporosis was significantly associated with female sex, older age, hypertension, poorer sleep quality, greater depressive symptoms, and lower handgrip strength. These findings highlight the importance of considering demographic characteristics, chronic diseases, psychological status, and functional indicators concurrently when identifying older adults at increased risk of osteoporosis. Given the cross-sectional nature of the study, these associations should not be interpreted as causal relationships.

Introduction

Population aging is one of the most significant demographic transformations of the twenty-first century and has major implications for public health. According to the World Health Organization (WHO), individuals aged 60 years or older are considered older adults, and the global population of older adults is projected to exceed two billion

by 2050 (1). The rapid growth of the aging population has substantially increased the burden of chronic and disabling diseases in this age group. Among these conditions, musculoskeletal disorders, particularly osteoporosis, have emerged as major challenges for healthcare systems due to their insidious and progressive nature (2).

Osteoporosis is a systemic metabolic bone disorder characterized by reduced bone mass and deterioration of bone



microarchitecture, ultimately resulting in increased bone fragility and susceptibility to fragility fractures (3). According to the diagnostic criteria established by the WHO, osteoporosis is defined as a bone mineral density (BMD) value of ≤ -2.5 standard deviations (SD) below the mean BMD of healthy young adults (4). Osteopenia refers to a condition in which BMD ranges from -1.0 to -2.5 SD and is considered a precursor to osteoporosis (1). The disease often progresses asymptotically, and its first clinical manifestation may be a disabling fracture; therefore, osteoporosis is commonly referred to as the “silent disease” (5).

The prevalence of osteoporosis varies considerably worldwide and is substantially influenced by geographical, racial, cultural, and socioeconomic factors. In a comprehensive systematic review and meta-analysis involving 108 studies and 343,704 participants, the global prevalences of osteoporosis and osteopenia were reported to be 19.7% and 40.4%, respectively (6). The study demonstrated that the prevalence of osteoporosis was significantly higher in developing countries (22.1%) than in developed countries (14.5%), with estimates ranging from 4.1% in the Netherlands to 52% in Turkey (6). In addition, Salari et al. (2021), in a global meta-analysis of older adults, estimated the overall prevalence of osteoporosis at 21.7%, with the highest prevalence observed in Asia (24.3%) (2).

Substantial variations in the prevalence of osteoporosis have also been reported across different continents and countries. Studies conducted in Asia have reported osteoporosis prevalences of 18.2% among older Chinese adults (5), 34.8% among older Korean adults (4), 29.7% in Thailand (7), and 8.2%–11.8% in Saudi Arabia, depending on the measurement site, including the hip and lumbar spine (8). In Africa, relatively few studies have investigated osteoporosis. Ugwu and Ene (2025) reported a high prevalence of osteoporosis and osteopenia among individuals aged over 60 years in Nigeria (9). These differences indicate that demographic characteristics, lifestyle factors, dietary patterns, and access to diagnostic services may influence the prevalence patterns of osteoporosis across different populations.

Osteoporosis is particularly prevalent among postmenopausal women, as the decline in estrogen levels following menopause accelerates bone loss. Salari et al. (2021) reported that the prevalence of osteoporosis among older women (35.3%) was substantially higher than that among older men (12.5%) (2). Similarly, Lyu et al. (2024) reported a prevalence of primary osteoporosis of 23.4% among women and 11.5% among men in a Chinese population (5). These sex-related differences may be attributed to factors such as the decline in sex hormones among women, differences in baseline bone mass between men and women, and differences in the rate of bone loss (4).

In Iran, several studies have reported a high prevalence of osteoporosis among older adults. Nourmohammadi et al. (2022), in a systematic review and meta-analysis of 30 studies involving 13,347 participants, estimated the prevalence of osteoporosis among Iranian individuals aged 60 years and older at 34%, while the prevalence of osteopenia was 47% (1). The study reported that 34% of women and 41% of men aged over 60 years in Iran had osteoporosis. Furthermore, the highest prevalence of osteoporosis was observed at the hip

(35%), whereas the highest prevalence of osteopenia was reported in the lumbar spine (41%) (1). In another study conducted by Fahimfar et al. (2023), the overall prevalence of osteoporosis among Iranian women and men aged over 50 years was estimated at 38% and 25%, respectively (10). The same study reported osteoporosis prevalences of 19% at the femoral neck among both women and men, whereas the prevalence in the spine was 29% among women and 16% among men (10).

The consequences of osteoporosis extend beyond reduced bone density and can substantially affect the quality of life of older adults. Osteoporotic fractures, particularly hip fractures, are associated with increased mortality, disability, hospitalization, and loss of functional independence (2). One study reported that approximately one-third of patients with hip fractures die within the first year following the fracture, while only one-third regain their pre-fracture functional status (4). In addition, the economic burden of osteoporosis and related fractures on healthcare systems is substantial; the annual healthcare cost of osteoporosis in the U.S. has been estimated at approximately 5–10 billion US dollars (2).

Identifying factors associated with osteoporosis among older adults is particularly important because many of these factors are potentially modifiable and preventable. Previous studies have demonstrated that age, sex, educational level, socioeconomic status, body mass index (BMI), physical activity, calcium and vitamin D intake, smoking and alcohol consumption, and chronic diseases such as diabetes and hypertension are among the factors associated with osteoporosis in older adults (5). Choi et al. (2021), in a study of postmenopausal Korean women, reported that the odds of osteoporosis among women aged 70 years and older were 8.47 times higher than among those aged 50–59 years, while low household income was associated with a 1.63-fold increase in the odds of osteoporosis (4). Similarly, Lyu et al. (2024) reported that the prevalence of primary osteoporosis increased significantly with age, ranging from 1.2% among individuals aged 30–39 years to 53.9% among those aged 80 years and older (5).

Despite the growing body of national and international research, the prevalence of osteoporosis among older adults in Neyshabur has not been adequately investigated, and information regarding the factors associated with osteoporosis is limited in this geographical region. Given that the prevalence patterns of osteoporosis vary across regions of Iran and worldwide, and that its risk factors are influenced by the demographic, cultural, and socioeconomic characteristics of each population (1,10), region-specific studies are essential for the development of appropriate preventive and therapeutic interventions. Therefore, the present study was designed and conducted to determine the prevalence of osteoporosis and identify factors associated with osteoporosis among older adults in Neyshabur. The findings of this study may provide a basis for health policy development, the design of screening programs, and the implementation of preventive interventions in this region.

Methods

Study Design and Population

This study was conducted using data from the Neyshabur



Longitudinal Study on Ageing (NeLSA), one of the aging study centers within the Prospective Epidemiological Research Studies in Iran (PERSIAN)/Iranian Longitudinal Study on Ageing (IRLSA). NeLSA is a population-based longitudinal study conducted in Neyshabur, Razavi Khorasan Province, Iran, designed to investigate health status and demographic, social, behavioral, and clinical factors associated with aging. At baseline, eligible participants were selected from the population registry of six health centers using a stratified random sampling method. The inclusion criteria were Iranian nationality, residence in Neyshabur for at least three years, and the ability to participate in the study. Individuals with dementia, major depressive disorder, or disabilities that limited their ability to participate in the study were considered ineligible at enrollment.

For the present study, data from older adults participating in NeLSA who had complete information required to assess osteoporosis status and the study variables were analyzed. The primary outcome variable was osteoporosis status. Demographic, social, lifestyle, chronic disease, functional, and psychological variables were examined as potential factors associated with osteoporosis.

Data Collection

Demographic and socioeconomic information, including age, sex, educational level, marital status, occupation, and economic status, as well as lifestyle-related information, including cigarette smoking, opium use, and alcohol consumption, was collected using standardized questionnaires and face-to-face interviews conducted by trained interviewers. A history of chronic diseases, including hypertension and diabetes mellitus, was also recorded. In the NeLSA study, anthropometric and clinical measurements were performed according to the study protocol by trained staff.

Measurement Instruments

Sleep Quality. Sleep quality was assessed using the Persian version of the Pittsburgh Sleep Quality Index (PSQI). The PSQI consists of seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The total score ranges from 0 to 21, with higher scores indicating poorer sleep quality (11). The Persian version of the PSQI has demonstrated acceptable validity and reliability among Iranian older adults, with a Cronbach's alpha coefficient of 0.81 (12).

Depressive Symptoms. Depressive symptoms were assessed using the 10-item version of the Center for Epidemiologic Studies Depression Scale (CES-D-10). The total score ranges from 0 to 30, with higher scores indicating greater severity of depressive symptoms (13). In a validation study of the Persian version of the CES-D-10 among Iranian older adults, a Cronbach's alpha coefficient of 0.85 was reported. A cutoff score of 5 was also suggested for identifying clinically significant depressive symptoms (14).

Physical Activity. Physical activity was assessed using the Physical Activity Scale for the Elderly (PASE). The total PASE score typically ranges from 0 to 400 or higher, with higher scores indicating greater levels of physical activity

(15). The Persian version of this instrument has been validated among Iranian older adults, with a Cronbach's alpha coefficient of 0.94 reported for the total scale. In addition, a validation study conducted within the NeLSA center confirmed the construct validity of the Persian version of the PASE (16).

Cognitive Function. Cognitive function was assessed using the Mini-Mental State Examination (MMSE). The total MMSE score ranges from 0 to 30, with higher scores indicating better cognitive function (17). The Persian version of the MMSE has demonstrated acceptable psychometric properties in the Iranian population, with a reported Cronbach's alpha coefficient of 0.81 (18).

Statistical Analysis

The data were entered into SPSS and analyzed. First, continuous variables were assessed for their distribution. Normally distributed continuous variables were described using the mean and standard deviation (mean $\pm$ SD), whereas non-normally distributed variables were summarized using the median and interquartile range (IQR) or range, as appropriate. Categorical variables were presented as frequencies and percentages. Continuous variables were compared between older adults with and without osteoporosis using the independent-samples *t*-test or the Mann-Whitney *U* test, depending on the distribution. Categorical variables were compared using the chi-square test or Fisher's exact test when the assumptions of the chi-square test were not met. Multivariable logistic regression analysis was performed to identify independent factors associated with osteoporosis. The dependent variable was the presence of osteoporosis. Independent variables included age, sex, body mass index (BMI), educational level, occupation, marital status, economic status, cigarette smoking, opium use, alcohol consumption, history of hypertension and diabetes mellitus, sleep quality, depressive symptoms, physical activity, cognitive function, and handgrip strength. The results of the logistic regression model were reported as odds ratios (ORs) with 95% confidence intervals (CIs) and *p*-values. For categorical variables, the appropriate reference category was used as the baseline category. A two-sided *p*-value < 0.05 was considered statistically significant.

Results

Of the 7,462 participants enrolled in the study, osteoporosis status was unavailable for 245 individuals, who were therefore excluded from the analysis. Consequently, 7,217 older adults were included in the analysis, and assessed them for osteoporosis. Among them, 885 participants (12.3%) had osteoporosis, whereas 6,332 participants (87.7%) did not. Therefore, the prevalence of osteoporosis in the study population was 12.3%.

Table 1 compares the demographic, clinical, lifestyle, and functional characteristics of participants according to osteoporosis status. The results showed that the mean age of participants with osteoporosis was significantly higher than that of those without osteoporosis (62.45 vs. 60.82 years, respectively; $p < 0.001$). Similarly, the mean body mass index (BMI) was significantly greater among participants with osteoporosis than among those without osteoporosis (29.04



vs. 27.66 kg/m², respectively; $p < 0.001$).

Regarding functional and cognitive measures, participants with osteoporosis had significantly lower mean handgrip strength and MMSE scores than those without osteoporosis (15.34 vs. 23.11 kg and 22.56 vs. 23.96, respectively; both $p < 0.001$). Significant differences were also observed between the two groups for physical activity, sleep quality score, and depression score (all $p < 0.001$).

With respect to demographic characteristics, the proportion of women was substantially higher among participants with osteoporosis than among those without osteoporosis (89.8% vs. 48.3%). In addition, participants with osteoporosis were less likely to be literate or married than those without osteoporosis. Significant differences were also observed between the two groups in occupational and economic status (both $p < 0.001$).

Regarding lifestyle-related factors and medical history, significant differences were found between participants with and without osteoporosis regarding cigarette smoking, opium use, and alcohol consumption (all $p < 0.001$). Furthermore,

the prevalence of hypertension was significantly higher among participants with osteoporosis than among those without osteoporosis (50.3% vs. 37.4%, respectively; $p < 0.001$). A statistically significant difference was also observed in the prevalence of diabetes between the two groups ($p = 0.020$).

The results presented in Figure 1 demonstrated that sex, history of hypertension, age, sleep quality score, depression score, and handgrip strength were significantly associated with osteoporosis. Men had 84% lower odds of osteoporosis than women (OR = 0.16, 95% CI: 0.11–0.24; $p < 0.001$). In addition, each one-year increase in age was associated with a 3% increase in the odds of osteoporosis (OR = 1.03, 95% CI: 1.02–1.04; $p < 0.001$). Each one-point increase in sleep quality score and depression score was associated with a 6% and 4% increase in the odds of osteoporosis, respectively. In contrast, each one-unit increase in handgrip strength was associated with a 2% reduction in the odds of osteoporosis.

Table 1. Comparison of Demographic, Clinical, Lifestyle, and Functional Characteristics Between Older Adults With and Without Osteoporosis in the Neyshabur Longitudinal Study on Ageing (NeLSA)

Variable	Osteoporosis (n = 885)	No Osteoporosis (n = 6,332)	P-value
Age (years), mean $\pm$ SD	62.45 $\pm$ 8.25	60.82 $\pm$ 8.07	< 0.001
Body mass index (kg/m ²), mean $\pm$ SD	29.04 $\pm$ 4.78	27.66 $\pm$ 4.75	< 0.001
Physical activity, median (IQR)	45.75 (33.57–79.00)	65.98 (35.82–149.00)	< 0.001
Handgrip strength, mean $\pm$ SD	15.34 $\pm$ 6.86	23.11 $\pm$ 10.29	< 0.001
MMSE score, mean $\pm$ SD	22.56 $\pm$ 3.70	23.96 $\pm$ 3.77	< 0.001
PSQI score, median (IQR)	7 (5–11)	5 (3–8)	< 0.001
Depression score, mean $\pm$ SD	10.87 $\pm$ 2.53	10.30 $\pm$ 2.14	< 0.001
Female sex, n (%)	795 (89.8)	3,056 (48.3)	< 0.001
Literate, n (%)	531 (60.0)	4,817 (76.1)	< 0.001
Married, n (%)	714 (80.7)	5,712 (90.2)	< 0.001
Smoking, n (%)	31 (3.5)	717 (11.3)	< 0.001
Opium use, n (%)	78 (8.8)	1,213 (19.2)	< 0.001
Alcohol consumption, n (%)	21 (2.4)	684 (10.8)	< 0.001
History of hypertension, n (%)	445 (50.3)	2,366 (37.4)	< 0.001
History of diabetes, n (%)	258 (29.2)	1,615 (25.5)	0.020
Job status			
Unemployed	31 (3.5)	524 (8.3)	
Retired	97 (11.0)	1,675 (26.5)	< 0.001
Homemaker	699 (79.0)	2,546 (40.2)	
Employee	58 (6.6)	1,587 (25.1)	
Economic Status			
Poor	193 (21.8)	1,280 (20.2)	
Moderate	563 (63.6)	3,790 (59.9)	
Good	129 (14.6)	1,262 (19.9)	< 0.001

Abbreviations: SD, standard deviation; IQR, interquartile range; MMSE, Mini-Mental State Examination; PSQI, Pittsburgh Sleep Quality Index



Adjusted odds ratios for osteoporosis

Multivariable-adjusted odds ratios (95% CI) for each risk factor



Figure 1. Factors associated with osteoporosis among the older adults included in the study

Discussion

The findings of the present study showed that the prevalence of osteoporosis among older adults in Neyshabur was 12.3%. This prevalence falls within a relatively low-to-moderate range compared with prevalences reported in some comparable studies. For example, Zarinfar et al. (2024) reported an osteoporosis prevalence of 59% among older women and 23% among older men in Bushehr, Iran (19). Similarly, Jin et al. (2024) estimated the prevalence of osteoporosis at 22.64% among women and 14.07% among men in a rural Chinese population (20). Gu et al. (2026), using data from the ELSA and HRS longitudinal cohorts, reported osteoporosis prevalences of 6.3% and 14.1%, respectively, which are more comparable to the findings of

the present study (21). Park et al. (2023) also reported osteoporosis prevalences of 27.6% among individuals with strong handgrip strength and 15.16% among those with weak handgrip strength in a Korean population (22). Differences in prevalence across studies may be attributable to variations in diagnostic criteria, measurement methods, age and sex composition of the study populations, and regional differences in lifestyle and exposure to risk factors (23,24). Accordingly, the relatively lower prevalence observed in the present study may partly reflect differences in diagnostic methodology, the higher proportion of men in the study population, or differences in dietary patterns and physical activity levels.

One of the major findings of the present study was the significant difference in osteoporosis prevalence between



women and men. Women accounted for 89.8% of participants with osteoporosis, and the odds of osteoporosis were 84% lower among men than among women. This finding is consistent with evidence from several international studies. Zarinfar et al. (2024) reported that the prevalence of osteoporosis among older women in Bushehr (59%) was substantially higher than that among older men (23%) (19). Similarly, Jin et al. (2024) estimated the prevalence of osteoporosis at 22.64% among women and 14.07% among men in a Chinese population (20). Falaschi et al. (2021) also emphasized the higher prevalence of osteoporosis among women in their review of osteoporosis and frailty in older adults (24). This sex difference may be attributed to the decline in estrogen levels following menopause and the consequent acceleration of bone resorption, differences in baseline bone mass between men and women, and differences in the rate of bone loss (23,24). In addition, cultural and lifestyle factors, such as clothing practices and reduced exposure to sunlight among women, which may be more common in certain populations including Iran, may contribute to lower vitamin D levels and an increased risk of osteoporosis (20,23).

Age was also identified as an important risk factor in the present study. Each additional year of age was associated with a 3% increase in the odds of osteoporosis, and the mean age was significantly higher among participants with osteoporosis than among those without osteoporosis. This finding is consistent with the findings of previous studies. Falaschi et al. (2021) demonstrated that the prevalence of osteoporosis increases significantly with advancing age, with the disease predominantly affecting individuals entering their eighth decade of life (24). Das et al. (2025) also identified age as one of the strongest factors associated with osteoporosis in their review of bone health management among older adults (23). Similarly, Gu et al. (2026) identified age as an important determinant of osteoporosis risk and reported a significant increase in risk with advancing age (21). The mechanisms underlying this association include age-related loss of bone mass, reduced calcium absorption, decreased vitamin D levels, increased osteoclast activity, and the greater prevalence of chronic diseases and medications that may affect bone metabolism among older adults (23,24).

Interestingly, the mean body mass index (BMI) was significantly higher among participants with osteoporosis than among those without osteoporosis. At first glance, this finding may appear inconsistent with the traditional view that higher body weight has a protective effect against osteoporosis. However, accumulating evidence suggests that the relationship between adiposity and bone health is more complex. Wu et al. (2022) reported that although higher body weight may be associated with a modest reduction in the prevalence of osteoporosis, this protective effect is limited and is accompanied by a significant increase in the risk of hypertension (25). Gu et al. (2026) also considered BMI an important confounding variable in the association between physical activity and osteoporosis, indicating that BMI may influence the observed relationship between these factors (21).

The present study also demonstrated that a history of hypertension was significantly more prevalent among participants with osteoporosis than among those without osteoporosis (50.3% vs. 37.4%), and hypertension was

identified as an associated factor in the regression model. This finding is consistent with recent evidence. Huang and Ye (2024), in a population-based cross-sectional study of 37,807 NHANES participants, reported an independent association between hypertension and osteoporosis (OR: 1.183, 95% CI: 1.055–1.327), which remained significant after adjustment for multiple potential confounders (26). Wu et al. (2022) also reported a significantly higher prevalence of osteoporosis among patients with essential hypertension than among healthy controls and suggested that activation of the renin–angiotensin–aldosterone system may contribute to increased bone resorption and reduced bone formation (25). Jin et al. (2024), in a rural Chinese population, found that higher systolic blood pressure and pulse pressure were associated with a higher prevalence of osteoporosis among women, with this association observed specifically among postmenopausal women (20). Potential mechanisms underlying this association include the role of the renin–angiotensin–aldosterone system in bone metabolism, increased urinary calcium excretion, reduced vitamin D and osteocalcin levels, and increased oxidative stress (20,25,26).

Similarly, diabetes was more prevalent among participants with osteoporosis, although the difference reached statistical significance at $p = 0.02$. Das et al. (2025) and Falaschi et al. (2021) suggested that diabetes may increase osteoporosis risk through mechanisms involving hyperglycemia, the formation of advanced glycation end products, oxidative stress and chronic inflammation, as well as deterioration of bone quality (23,24). Wu et al. (2022) also identified diabetes as a factor associated with osteoporosis among patients with essential hypertension (25).

Sleep quality and depressive symptoms were also identified as factors associated with osteoporosis in the present study. Participants with osteoporosis had higher, and therefore poorer sleep-quality scores, and each one-point increase in the sleep-quality score was associated with a 6% increase in the odds of osteoporosis. This finding is consistent with Bevilacqua et al. (2020), who reported that poor sleep quality (PSQI > 5) was associated with unfavorable changes in bone mineral density and bone microarchitecture among older adults (27). They found that, among men, poor sleep quality was associated with reduced trabecular and cortical bone density and increased cortical porosity, whereas among women, poor sleep quality was associated with reduced cortical thickness and density at the radius. Potential mechanisms underlying this association include disruption of circadian rhythms and bone metabolism, increased systemic inflammation, and alterations in the secretion of hormones involved in bone metabolism (27).

Depression scores were also higher among participants with osteoporosis, and each one-point increase in the depression score was associated with a 4% increase in the odds of osteoporosis (28). Yardimci et al. (2021) proposed that depression and osteoporosis may be interconnected through shared pathways involving reduced serotonin levels, increased cortisol concentrations, and systemic inflammation. They suggested that the simultaneous management of insomnia, depression, and osteoporosis may help interrupt the potential vicious cycle linking these conditions (29). Zarinfar et al. (2024) also reported that osteoporosis was associated with poorer health-related quality of life, particularly in the physical domain, and that



this association was stronger among women than men (19).

Another important finding of the present study was the significant association between handgrip strength and osteoporosis. Mean handgrip strength was lower among participants with osteoporosis, and each one-unit increase in handgrip strength was associated with a 2% reduction in the odds of osteoporosis. This finding is consistent with Gu et al. (2026), who, using data from the ELSA and HRS longitudinal cohorts, reported that handgrip strength partially mediated the association between physical activity and osteoporosis and was significantly associated with a lower risk of osteoporosis (21). In their mediation analysis, handgrip strength accounted for 28.3% of the effect of physical activity on osteoporosis in the ELSA cohort. Park et al. (2023) also reported that Korean individuals with osteoporosis and weak handgrip strength had the lowest health-related quality of life (EQ-5D = 0.87) compared with the other groups, with significantly greater impairment in mobility, self-care, usual activities, pain/discomfort, and anxiety/depression (22).

Handgrip strength is considered a general indicator of muscle strength and may influence bone health through several mechanisms, including increased mechanical loading of bone, stimulation of bone formation through myokines, improved balance, and reduced risk of falls (21). In addition, low handgrip strength is a major diagnostic criterion for sarcopenia, which is closely associated with osteoporosis. The term “osteosarcopenia” has therefore been introduced to describe the coexistence of these two conditions (22,23).

Significant differences were also observed between the two groups in cigarette smoking, opium use, and alcohol consumption. These findings are consistent with the broader evidence demonstrating the role of lifestyle factors in osteoporosis risk. Das et al. (2025) and Falaschi et al. (2021) identified cigarette smoking, alcohol consumption, and physical inactivity as modifiable risk factors for osteoporosis (23,24). Gu et al. (2026) further demonstrated that regular physical activity, particularly resistance exercise, may reduce osteoporosis risk by increasing mechanical loading and strengthening muscles (21). Cigarette smoking may contribute to reduced bone mass through decreased calcium absorption, reduced estrogen levels, and increased oxidative stress, whereas alcohol consumption may increase osteoporosis risk by inhibiting bone formation and promoting bone resorption (23).

In addition, participants with osteoporosis had lower proportions of literate and married individuals, and significant differences were observed between the two groups in occupational and economic status. These findings are consistent with those of Zarinfar et al. (2024), who reported an association between osteoporosis and poorer health-related quality of life and suggested that this relationship may be partly explained by reduced access to healthcare services, inadequate nutrition, reduced physical activity, and psychological stress associated with socioeconomic difficulties (19). Marengoni et al. (2020), in their study of multimorbidity patterns among older adults, also demonstrated that socioeconomic and lifestyle factors play an important role in the clustering of chronic conditions, including osteoporosis (30).

Strengths and Limitations

The findings of the present study have potential implications for public health policy and clinical practice. Given the observed prevalence of osteoporosis among older adults in Neyshabur and its association with multiple risk factors, regular screening programs may be warranted to identify individuals at increased risk. Particular attention may be given to women, older individuals, those with comorbid chronic diseases, and individuals with poor sleep quality or depressive symptoms (19,23). Preventive interventions should be multidimensional and may include lifestyle modification, such as smoking and alcohol cessation, increased physical activity, improvement of sleep quality, management of comorbid chronic diseases, and psychological support for individuals experiencing depressive symptoms (21,29). Given the observed association between handgrip strength and osteoporosis, handgrip strength assessment may also represent a simple, inexpensive, and noninvasive approach for identifying individuals at increased risk of osteoporosis in clinical and community settings (21,22). Furthermore, educational and awareness programs for older adults and healthcare providers concerning bone health, adequate nutrition, particularly calcium and vitamin D intake, and regular physical activity may be warranted (23,24).

This study has several strengths. It used baseline data from a large, population-based cohort (NeLSA) of 7,217 older adults, providing substantial statistical power and allowing multivariable adjustment for a wide range of potential confounders. The study assessed a comprehensive set of demographic, socioeconomic, lifestyle, clinical, functional, and psychological variables, including sleep quality, depressive symptoms, physical activity, cognitive function, and handgrip strength, using standardized and validated instruments. The use of multivariable logistic regression with adjusted odds ratios strengthens the identification of factors independently associated with osteoporosis. In addition, the study addresses an important evidence gap regarding osteoporosis among older adults in Neyshabur, Iran, and its findings may inform local screening, prevention, and health policy initiatives. Finally, the concurrent evaluation of chronic diseases and functional indicators, such as hypertension and handgrip strength, adds clinical relevance and supports a multidimensional approach to osteoporosis risk assessment in older adults.

Several limitations of the present study should be considered when interpreting the findings. First, the cross-sectional design precludes causal inference and allows only for the identification of associations between variables. Therefore, prospective longitudinal studies and clinical trials are required to establish temporal and causal relationships (21,22). Second, osteoporosis status in the present study was based on participants' self-reported physician diagnosis, which may be subject to recall and reporting bias. The use of objective diagnostic methods, such as dual-energy X-ray absorptiometry (DXA), could improve the accuracy of osteoporosis classification (23). Third, although the present study included a relatively large sample, some potentially important factors, including serum vitamin D levels, dietary calcium intake, and previous fracture history, were not assessed, which may have resulted in residual confounding.



(19,24). Fourth, the study population was limited to older adults living in Neyshabur; therefore, the findings should be generalized to other regions of Iran or to other age groups with caution (19,30). Finally, because the study was conducted exclusively among older adults, some risk factors, such as BMI and handgrip strength, may have been influenced by age-related physiological changes, potentially complicating the interpretation of these associations (21,22).

Conclusion

In conclusion, the present study found that the prevalence of osteoporosis among older adults in Neyshabur was 12.3%. Osteoporosis was associated with several factors, including female sex, older age, comorbid chronic conditions, poorer sleep quality, greater depressive symptoms, lower handgrip strength, and lower socioeconomic status. These findings highlight the importance of a comprehensive and multidimensional approach to osteoporosis prevention and management among older adults. Given the rapidly growing older population in Iran and worldwide, implementation of regular screening programs, lifestyle-based preventive interventions, and appropriate management of comorbid chronic conditions may contribute to reducing the burden of osteoporosis and improving the quality of life of older adults. Future prospective longitudinal studies using objective diagnostic measures are warranted to confirm these findings and further elucidate the underlying mechanisms.

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Ethical approval

The Neyshabur Longitudinal Study on Ageing (NeLSA) was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval for this study was obtained from the Ethics Committee of Neyshabur University of Medical Sciences (Approval No. IR.NUMS.REC.1405.026). Written informed consent was obtained from all participants prior to enrollment.

Conflict of Interests

The authors declare no conflicts of interest.

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