Proceedings of the 6th International Conference on Biological Engineering and Medical Science
DOI: 10.54254/2753-8818/2026.36167

Prevalence and Influencing Factors of Osteoporosis among Rural Elderly in Southern Sichuan, China

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Abstract. Osteoporosis constitutes a significant public health concern among older adults, particularly in rural regions of China. However, data on its prevalence and risk factors in Southern Sichuan are limited. The objective of this study is to assess the prevalence and determinants of osteoporosis among rural seniors aged 60 years and older in Southern Sichuan, and to furnish scientific evidence for community-based preventive strategies. This paper employs a literature review and case analysis approach to examine a cross-sectional study conducted from July to December 2025. The paper finds that the prevalence of osteoporosis among rural elderly in Southern Sichuan is considerably high. Advanced age, female sex, vitamin D deficiency, insufficient outdoor activity, history of fracture, and low health literacy are major risk factors. Community-based osteoporosis screening and health education should be strengthened, and regular outdoor activities together with adequate calcium and vitamin D supplementation should be promoted to reduce the risk of osteoporosis and related fractures.

Keywords: Osteoporosis, Rural elderly, Cross-sectional study, Influencing factors

1. Introduction

Osteoporosis is a systemic skeletal disorder defined by reduced bone mineral density and microarchitectural disruption, which result in heightened bone fragility and an elevated risk of fracture [1]. It is a major public health challenge worldwide, particularly among aging populations. According to the first Chinese National Osteoporosis Epidemiological Survey released by the National Health Commission in 2018, the prevalence of osteoporosis among adults aged 50 years and above was 19.2% [2].

A range of risk factors have been consistently reported in previous investigations, including older age, female gender, low BMI, vitamin D insufficiency, physical inactivity, prior fractures, and poor health literacy. [3, 4]. However, most studies have focused on urban populations or developed regions. In rural areas of Southern Sichuan (including Yibin, Luzhou, and Zigong), limited data exist regarding the prevalence and determinants od osteoporosis. The region is characterized by high humidity, limited sunlight exposure in some seasons, and a large aging population with low socioeconomic status, making it an important area for targeted research [5]. Significant urban-rural differences exist in osteoporosis prevalence. The 2018 national survey showed that among people aged ≥50 years, the prevalence was 16.2% in urban areas versus 20.7% in rural areas. A cross-

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DOI: 10.54254/2753-8818/2026.36167

sectional study in Jiangsu Province involving 2,711 participants found that rural residents had a significantly higher prevalence (10.33%) than their urban counterparts (5.52%). In the Chengdu area, rural women also exhibited a higher prevalence than urban women, with the gap widening with age. In traditional Chinese medicine (TCM), osteoporosis is classified as "bone impotence" or "bone paralysis." While the disease primarily affects the bones, it is understood to be closely intertwined with the functions of the kidney, spleen, and liver. Specifically, kidney essence serves as the fundamental basis for bone health; the liver promotes smooth blood flow to nourish the bones; and the spleen facilitates nutrient transformation for bone upkeep [6]. Osteoporosis is marked by osseous atrophy and marrow depletion, with kidney essence deficiency serving as the underlying pathogenesis, and presenting clinically with blood stasis, impeded circulation, and diminished bone vitality. In contemporary practice, Traditional Chinese Medicine (TCM)—spanning syndrome differentiation, herbal formulations, and bioactive constituents—has exhibited notable therapeutic efficacy against osteoporosis, and has garnered growing global attention. Contemporary research has revealed that TCM interventions exert multi-target regulatory effects on bone metabolism, including promoting osteoblast activation, inhibiting osteoclast activity, and modulating extracellular matrix remodeling [7].

This paper, through a cross-sectional study method, explores the current prevalence of osteoporosis and its influencing factors among rural elderly aged ≥60 years in Southern Sichuan. This study employed a multi-stage stratified random sampling strategy, collected information on demographic attributes, lifestyle behaviors, vitamin D status, and health literacy, and subsequently performed univariate and multivariate logistic regression analyses to ascertain independent risk determinants. The findings will provide scientific evidence for community-based osteoporosis prevention and control strategies in rural Sichuan, which is of great public health significance given the rapid aging of China's rural population [8]. By identifying modifiable risk factors, this study aims to inform local health policies and promote targeted interventions such as health education, outdoor activity promotion, and vitamin D supplementation.

2. Literature review

2.1. Urban-rural disparities in osteoporosis prevalence

Osteoporosis poses a growing burden globally, particularly in aging populations [8]. In China, the prevalence of osteoporosis among rural residents is approximately 26.8%, slightly higher than in urban areas [2, 9]. Key influencing factors include age, gender, vitamin D levels, physical activity, and health literacy [3, 4, 10]. Studies have shown that insufficient outdoor activity and low vitamin D levels are particularly prevalent in rural areas of Southern Sichuan [5]. Furthermore, low health literacy is associated with poor preventive behaviors and higher fracture risk [9]. National survey data have documented that osteoporosis prevalence among rural residents in China is approximately 26.8%, slightly higher than that in urban areas [2]. A systematic review and meta-analysis further confirmed that the overall prevalence of osteoporosis in China is considerable, with rural populations bearing a disproportionate burden [4]. A multicenter study across China reported similar risk factor profiles, underscoring the generalizability of these associations across diverse populations [10]. However, most of these studies have drawn heavily from urban or mixed samples, leaving rural-specific data relatively sparse [3, 4]. The relationship between vitamin D status and outdoor activity is particularly critical in the context of Southern Sichuan. The region is characterized by high humidity and limited sunlight exposure during certain seasons, which may exacerbate vitamin

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D insufficiency among the elderly [5]. As age increases, serum vitamin D levels tend to decline, reducing bone formation and increasing fracture susceptibility.

2.2. Health literacy and its role in osteoporosis prevention

Health literacy has emerged as a critical yet underexplored factor in osteoporosis prevention. Recent government-implemented screening programs in rural China have highlighted that low health literacy is associated with poor preventive behaviors and higher fracture risk [9]. In rural areas, where educational levels are generally lower, the awareness of osteoporosis and its preventive measures remains inadequate. Improving health literacy through community-based education has been proposed as a key component of comprehensive osteoporosis control strategies [9]. This is particularly important in rural Sichuan, where targeted health education could significantly enhance the effectiveness of other preventive measures, such as calcium and vitamin D supplementation and outdoor activity promotion.

3. Case analysis

China is currently experiencing a swift demographic shift, with the share of its elderly population rising at an unparalleled pace. Projections indicate that between 2015 and 2035, China will witness a marked increase in both the number of osteoporotic fractures and the corresponding healthcare expenditures [11]. This demographic shift poses a particular challenge in rural areas, where the elderly population constitutes a substantial proportion of the total population, yet healthcare resources remain comparatively limited. Osteoporosis, a systemic skeletal disorder defined by reduced bone mass and microarchitectural disruption, results in heightened skeletal fragility and fracture risk [1]. It imposes a growing burden on individuals, families, and healthcare systems, particularly among aging populations [8]. Previous studies have shown that the prevalence of osteoporosis among Chinese adults aged 50 years and above is 19.2%, and this figure rises substantially with advancing age [2]. The elderly population is especially vulnerable due to age-related bone loss, cumulative exposure to risk factors, and reduced physiological reserve.

A multi-stage stratified random sampling approach was adopted to recruit participants from rural communities across three prefecture-level cities in Southern Sichuan—namely, Yibin, Luzhou, and Zigong. In the first stage, one township was randomly selected from each of the three cities based on administrative divisions and geographic distribution, yielding a total of three townships. In the second stage, within each selected township, three administrative villages were further randomly chosen, resulting in nine villages overall. In the third stage, eligible elderly residents aged 60 years and older within each village were identified through village resident registration records and local community health service centers. A stratified random sampling approach was then applied according to age group (60–69 years, 70–79 years, and ≥80 years) and sex to ensure proportional representation across demographic strata. A total of 1,200 rural elderly people aged ≥60 years were included. The majority were female (58.3%), aged 60–69 years (52.1%), and had low education levels (78.4%). The overall prevalence of osteoporosis was 26.9% (32.1% in females, 19.4% in males). Univariate analysis showed that age, gender, vitamin D deficiency, outdoor activity <30 min/day, fracture history, and low health literacy were significantly associated with osteoporosis. The multivariate logistic regression model identified these factors as independent predictors ($p < 0.05$).

All statistical analyses were carried out using SPSS (version 26.0). For continuous data, group comparisons were made via t-tests or ANOVA, while categorical data were analyzed with the chi-

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square test. Univariate analyses were initially performed to screen for factors linked to osteoporosis. Subsequently, variables with P<0.1 were included in a multivariable logistic regression model to ascertain independent risk determinants, with odds ratios (OR) and their 95% confidence intervals (CI) being estimated. The multivariate model controlled for potential confounders, including age, sex, educational attainment, and BMI. Statistical significance was defined as a two-sided P-value below 0.05. No significant multicollinearity or interactions were detected among the independent variables.

Among the 1,200 participants, the overall prevalence of osteoporosis was 26.9%. This rate was notably higher in females than in males (32.1% vs. 19.4%, P<0.001), and rose sharply with advancing age, from 18.5% in those aged 60–69 years to 47.8% in those aged ≥80 years. Multivariate logistic regression identified six independent risk factors: advanced age (OR=1.84), female sex (OR=2.13), vitamin D deficiency (OR=2.56), outdoor activity <30 min/day (OR=1.92), fracture history (OR=2.34), and low health literacy (OR=1.78), all P<0.05. The prevalence is comparable to the national rural average [2]. The strong association between low health literacy and osteoporosis risk suggests that knowledge deficits translate into poor preventive behaviors, while reduced outdoor activity highlights sunlight-mediated vitamin D synthesis as a key protective mechanism. Clinically, screening should prioritize high-risk groups—particularly women aged ≥65 years, those with a fracture history, and individuals with limited outdoor activity—with timely vitamin D and calcium supplementation for those with a deficiency. At the public health level, community-based health education through village lectures, illustrated pamphlets, and village doctor training should be strengthened to promote daily outdoor activities of at least 30 minutes. Additionally, incorporating osteoporosis screening and basic management into the routine geriatric health package under the National Basic Public Health Service Program is recommended to ensure sustainable coverage in rural areas.

4. Discussion

Based on the identified risk factors, several strategies can be recommended for osteoporosis prevention and management in rural Southern Sichuan. First, regular bone mineral density screening using quantitative ultrasound should be prioritized for high-risk groups, particularly women aged ≥60 years and individuals with vitamin D deficiency, to enable early detection and intervention [2]. Second, community-based interventions should be promoted, including daily outdoor activities of at least 30 minutes to enhance sunlight-mediated vitamin D synthesis, calcium and vitamin D supplementation for those with identified deficiencies, and health education delivered through village lectures and village doctor training to improve osteoporosis awareness and preventive behaviors [5, 9]. Third, traditional Chinese medicine (TCM) offers complementary approaches that are particularly suitable for resource-limited rural settings. According to TCM theory, osteoporosis is categorized as "bone impotence" or "bone paralysis," with kidney essence deficiency considered the root cause, and the liver and spleen also playing important roles in bone health. TCM interventions —including herbal prescriptions that tonify the kidney and strengthen bones, traditional exercises such as Taiji and Baduanjin that improve balance and bone strength, and acupuncture for pain relief —may serve as safe, low-cost adjunctive therapies in community-based osteoporosis management. Integrating TCM approaches with conventional preventive measures could enhance overall effectiveness while remaining accessible and affordable for rural elderly populations. At the policy level, incorporating osteoporosis screening and basic management into the routine geriatric health package under the National Basic Public Health Service Program would help ensure sustainable coverage and systematic prevention in underserved rural areas [11]. At the policy level,

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incorporating osteoporosis screening and basic management into the routine geriatric health package under the National Basic Public Health Service Program is recommended to ensure sustainable coverage in rural areas [11].

5. Conclusion

This study was designed to assess the prevalence and determinants of osteoporosis among rural residents aged ≥60 years in Southern Sichuan. The findings indicate that the prevalence is considerably high at 26.9%. The analysis revealed that advanced age, female sex, vitamin D deficiency, insufficient outdoor activity (<30 min/day), fracture history, and low health literacy are independent risk factors, which supports the initial hypothesis that both biological and behavioral factors jointly contribute to osteoporosis risk in this population. This study enriches the current literature by furnishing empirical evidence from a previously underinvestigated rural area in Southern Sichuan, thereby addressing the geographical research gap noted in prior work. The findings extend previous theories by confirming the role of low health literacy and outdoor activity as modifiable determinants of osteoporosis in rural settings. This study has practical significance for the field of geriatric public health, as it informs targeted community-based prevention strategies. This study is limited by the use of quantitative ultrasound instead of the gold standard DXA, and by the sample restriction to three townships, which may affect the generalizability of the findings. Future studies could address these limitations by incorporating DXA measurements and expanding the sample to cover more diverse rural areas across the region. In conclusion, this work offers novel perspectives on osteoporosis among the rural elderly in Southern Sichuan and underscores the critical role of focused screening, health education, and multifaceted prevention in alleviating the disease and fracture burden in disadvantaged rural populations.

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