International Journal of General Medicine

Dovepress
Taylor & Francis Group

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REVIEW

A Systematic Review of Research Tools, Research Status and Improvement Measures for Osteoporosis Awareness in Chinese and International

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Objective: Osteoporosis, a prevalent degenerative bone disorder, and its associated complications can have a substantial impact on patients. To enhance osteoporosis prevention, it is imperative to explore the public's awareness of this condition.

Methods: In this paper, literature related to osteoporosis awareness, which was published from October 2020 to October 2023, was searched in the CNKI, Wanfang, and PubMed databases. After the establishment of volume exclusion criteria, 16 articles were ultimately included in the analysis. Two reviewers independently extracted the study methods, tools, and results.

Results: Currently, most international research tools are questionnaires that have undergone rigorous reliability and validity testing and are extensively applied in clinical research. In contrast, in China, there is a paucity of research tools and cases, with most relying on translations of international questionnaires. The findings indicate that the awareness of osteoporosis among the general population in China and other countries is relatively low, and the awareness level in China is generally lower than that in developed countries. Currently, there are diverse measures to enhance awareness, including traditional media and online education via the Internet. All results suggest that active education can significantly boost awareness.

Conclusion: The area of osteoporosis awareness research remains relatively under - explored, and research tools need to be tailored to the characteristics of populations in different regions. Currently, there are few relevant studies, and their results consistently show that the public's awareness of osteoporosis is relatively low. Existing evidence demonstrates that health education can improve awareness, so healthcare professionals should place greater emphasis on bone health education.

Keywords: osteoporosis, awareness, osteoporosis knowledge, systematic review, health education

Introduction

Osteoporosis is a systemic skeletal disorder characterized by decreased bone mass and deterioration of bone micro-architecture, leading to increased bone fragility and a heightened susceptibility to fractures.[1] This condition can be classified based on etiology into primary osteoporosis and secondary osteoporosis.[2]

Following the World Health Organization's identification of osteoporosis risk indicators, the predicted prevalence values in subsequent epidemiological studies have significantly increased compared to earlier estimates[3]. The prevalence of osteoporosis is closely linked to age;[4] the most recent data from China in 2018 revealed that the prevalence of osteoporosis among individuals aged over 50 was 19.2%, while the prevalence in those over 65 was 32.0%. International researchers often consider hip fractures as critical epidemiological data to assess the severity of osteoporosis, given that nearly all hip fractures can be attributed to this disease.[3]

Osteoporosis is accompanied by various complications, including pain, height loss, kyphosis, and fractures, which have a detrimental impact on patients' health. Among these complications, fractures are the most severe. They significantly reduce the quality of life of patients. Moreover, the subsequent treatment and care for fractures can impose a substantial burden on families, society, and the economy.[4] The current management of osteoporosis patients encompasses both pharmacologic and non-

Received: 24 November 2024
Accepted: 6 February 2025
Published: 15 February 2025

pharmacologic interventions. Pharmacological approaches involve the use of agents that inhibit bone resorption and promote bone formation, while non-pharmacological strategies focus on modifying patients' lifestyle habits.[5] According to China's 2011 guidelines, osteoporotic fractures are preventable and treatable, underscoring the importance of disseminating knowledge about osteoporosis to facilitate early diagnosis, timely assessment of fracture risk, and the implementation of standardized preventive and therapeutic measures.[6]

In this paper, we will focus on osteoporosis cognition research and analyze the research tools, the current status of the research, and the impact of cognitive differences, so as to provide a basis for the subsequent development of related cognitive research.

Method

Literature Search Strategy for This Paper

Literature retrieval was conducted in databases such as the China National Knowledge Infrastructure (CNKI), WanFang and PubMed. The search time span was set from October 2020 to October 2023. Chinese search terms encompassed "骨质疏松症", "骨质疏松", "认知度", "认知", "知识", and "意识", while English search terms included "osteoporosis", "awareness", "knowledge", and "health concept".

The study was registered in the International Platform of Registered Systematic Review and Meta-analysis Protocols (INPLASY) (INPLASY202510067, doi: 10.37766/inplasy2025.2.0067).

Inclusion and Exclusion Criteria

Inclusion criteria: 1) Studies on the awareness of osteoporosis that were published between October 2020 and October 2023. 2) Studies with clearly defined inclusion and exclusion criteria.

Studies in which the research tools employed are questionnaires that have been tested for reliability or have been proven through research. 3) Studies that correctly utilize statistical methods to analyze the results and provide detailed data descriptions.

Exclusion criteria: 1) Recognition analyses conducted by medical practitioners. 2) Studies in which the research tools used are self-designed questionnaires without mentioning reliability and validity tests. 3) Literature that has not been repeatedly published. 4) Review articles, case reports, editorials, conference abstracts, letters, unpublished reports, or literature consisting of only abstracts.

5) Literature not published in core Chinese journals or in the Science Citation Index (SCI).

Data Extraction and Quality Assessment

Two evaluators (Ran and Yang) independently assessed the full-text articles and extracted data from all eligible publications. The extraction encompassed information such as the author's name, year of publication, country, number of participants, gender, age, research tools, and study results.

Literature Search Result

Figure 1 illustrates the retrieval process of the study. Firstly, 14 duplicates were removed, and subsequently, 175 articles were excluded based on the inclusion criteria, with the exception of 2 articles for which the original text could not be retrieved. Finally, 16 articles were included in the study in accordance with the exclusion criteria.

Research Tools

Research on osteoporosis awareness has predominantly utilized questionnaires, which often cover various facets of osteoporosis including general knowledge, risk factors, and preventative measures. The lack of a standardized questionnaire for large-scale awareness studies stems from the varying characteristics of populations across different countries and regions. Consequently, researchers tend to tailor questionnaire designs to local community demographics, resulting in a diverse array of osteoporosis awareness questionnaires characterized by differing types, standards, and contextual relevance.

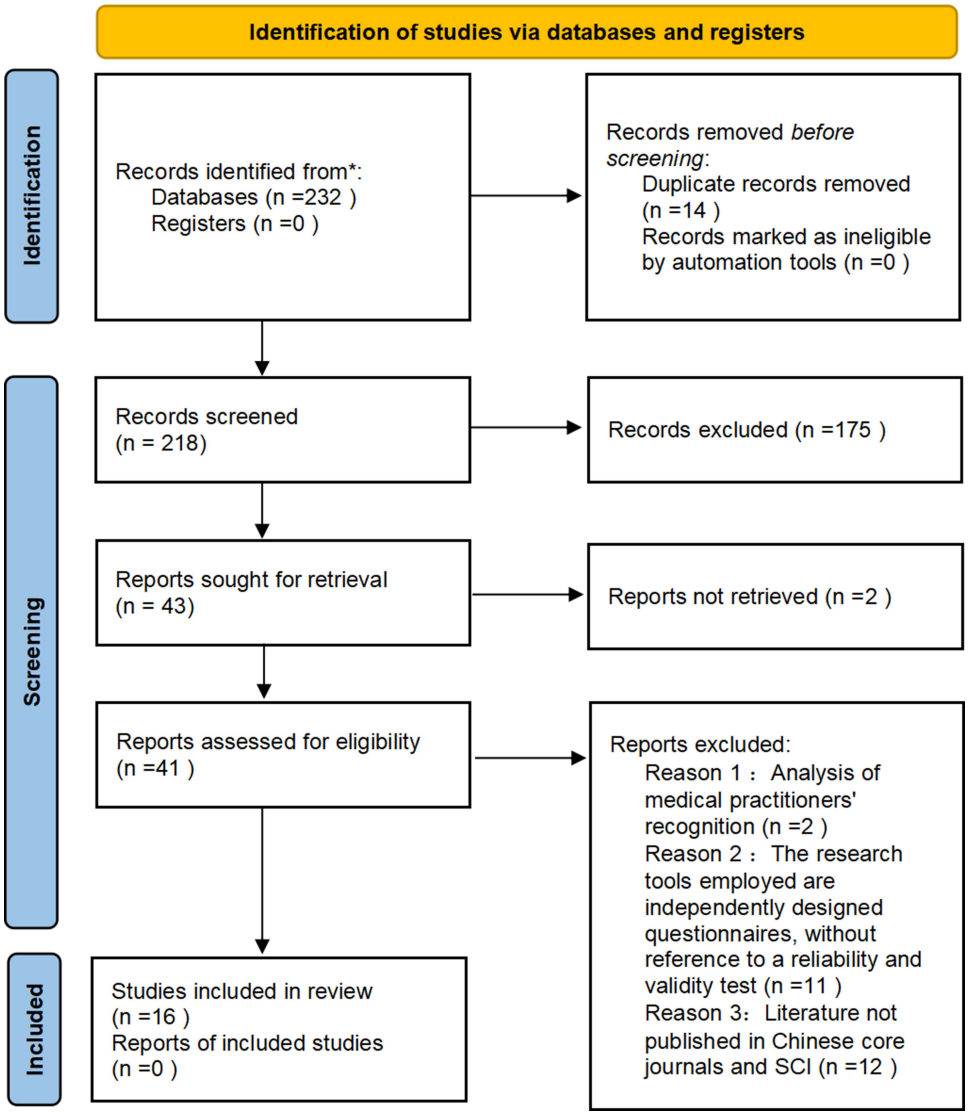

Figure 1 Retrieval process of the study. PRISMA 2020 flow diagram for updated systematic reviews for the present project.

Foreign Research Tools

Most of the widely utilized cognitive research tools have been developed and implemented by foreign researchers, including instruments such as OKAT, OPQ, OKT, and various related questionnaires that have been revised and enhanced based on these original tools. Table 1 provides a brief overview of the content and characteristics of different commonly used questionnaires.

Domestic Research Tools

The number of self-developed osteoporosis questionnaires in China is relatively limited. In actual research endeavors, the questionnaires that have undergone reliability and validity testing are predominantly imported from abroad. Given the significant regional and demographic differences in osteoporosis awareness, some scholars in China have attempted to design assessment questionnaires that are more tailored to the Chinese population. However, most of these instruments have not been widely adopted in clinical practice, and there is a notable lack of data to support their applicability.

https://doi.org/10.2147/IJGM.S508268

Table 1 Introduction to Foreign Research Tools

Questionnaire Name	Designer	Year	Questionnaire Content	Limitations
OHB*	KATHERINE.K[7]	1991	A 35-item questionnaire, grounded in the Health Belief Model and encompassing seven subscales, was utilized to evaluate participants' beliefs concerning exercise and calcium intake. These subscales include "Osteoporosis severity", "Susceptibility", "Health motivation", "Calcium benefits", "Calcium barriers", "Exercise benefits", and "Exercise barriers."	The research and development are limited to older adults, resulting in insufficient population coverage; it predominantly focuses on exercise behavior and calcium intake, without exploring other related beliefs.
FOOQ*	RITA.[8]	1998	A 25-item questionnaire designed to assess the population's knowledge regarding "general understanding of osteoporosis", "health preventive behaviors", and "risk factors."	Tailored for postmenopausal women, the questionnaire exhibits limited generalizability due to its omission of subjects' height, weight, and family history details, hindering the evaluation of cognitive distinctions among populations with varying baseline characteristics.
OPQ*	KERAN.[9]	2000	A 20-item questionnaire encompassing four domains: "general information", "risk factors", "consequences of osteoporosis", and "treatment options", designed to ensure high readability, an appropriate difficulty index, and substantial discriminatory power.	Tailored for specialized referral units, the overall questionnaire difficulty may not capture the nuanced associations between osteoporosis awareness levels and factors such as patient education, socioeconomic status, limiting its applicability in community survey settings.
OKAT*	TANIA.[10]	2003	A 20-item questionnaire was developed based on the demographic profile of Australian women aged 25–44. The survey evaluated participants' understanding of concepts such as "osteoporosis definition", "prevalence", "adverse effects, and prevention." Additionally, variables including height, weight, number of children, family medical history, education level, and other pertinent basic information were incorporated into the assessment.	The questionnaire exhibits a high degree of population specificity, necessitating further research to determine its applicability beyond the target demographic for which it was originally designed.
OKAT-S-short	Ivana[11]	2012	9 questionnaires, 9 questionnaires, streamlined version based on OKAT.	The selection of pharmacy students as subjects for the questionnaire's development mainly restricted the broad dissemination of the survey[11]
OPAAT*	LI[12]	2015	A 30-item questionnaire was developed to assess knowledge levels regarding "Osteoporosis in General", "Consequences of Untreated Osteoporosis", and "Prevention of Osteoporosis", with distinct focus on the perspectives of patients and professionals	This questionnaire is specifically designed for postmenopausal women and has limited population coverage.

Notes: *OHB (the Osteoporosis Health Belief Scale); FOOQ (the Facts on Osteoporosis Instrument); OPQ (osteoporosis questionnaire); OKAT (the Osteoporosis Knowledge Assessment Tool); OPAAT (the Osteoporosis Prevention and Awareness Tool).

South China Osteoporosis Knowledge Assessment Questionnaire (OKAQ)

The questionnaire was collaboratively designed by Cheng Zhi-an and Song Jiaming[13] et al in 2011. It was formulated taking into account the distinctive features of the regional climate and human environment in South China, comprising three sections and a total of 58 questions. The OKAQ integrates the regional and humanistic characteristics of our country, effectively addressing language barriers, which enhances the scale's local adaptability. Following a formal

survey, it was confirmed to exhibit strong structural validity.[13] However, the dissemination and implementation of the OKAQ currently encounter challenges due to the lack of sufficient clinical data for further validation.

Osteoporosis Knowledge, Attitude, and Behaviors Questionnaire (OKABQ)

The OKABQ is a set of scales independently developed by Huang[14] et al and their research team in 2023.Employing the KAP (Knowledge, Attitude, and Practice) model, the study aimed to examine the hypothesis posited in the text that patients' attitudes serve as mediators of their knowledge and behavior. The questionnaire demonstrated robust construct validity and reliability, revealing statistically significant direct effects of knowledge on behavior, as well as indirect effects of attitude on knowledge and behavior.

Translated and Revised Osteoporosis Knowledge Questionnaire

In addition to the two self-developed scales mentioned above, several classic osteoporosis knowledge questionnaires have been introduced in China.Examples include the OKT translated by Yuping Chen and Xueqin Liu, as well as the OPAAT-C translated by Yaqiong Tan and Bihua Luo.[15] These translations underwent further modification under the guidance of professionals and translators to ensure greater adaptability through selective deletions and preservation of the original questionnaire content. The final versions were refined to better suit Mandarin-speaking populations.

Status of Research

As economic development and health awareness continue to grow, individuals are increasingly focused on the prevention of osteoporosis. Research examining osteoporosis awareness within the population can provide valuable guidance for researchers and clinicians in their subsequent prevention strategies. Numerous regional awareness studies have been conducted across various countries, and this section will describe and analyze the findings from these published studies. Table 2 shows a brief overview of the international study of osteoporosis recognition in the last 3 years.

Foreign Studies

Over the past three years, several countries have undertaken relevant studies within local communities and hospitals, revealing a low level of awareness regarding osteoporosis among the population, as well as a significant gap in knowledge related to basic information, preventive care, and susceptibility to the condition. A total of ten high-quality papers were included in this analysis, and the following section provides a brief overview of the research subjects, methodologies employed, and key findings.

Subject of the Study

There is a consensus in the academic community that postmenopausal women face a heightened susceptibility to osteoporosis, supported by evidence indicating that peak bone mass occurs between 25–30 years of age followed by a gradual decline post-40 years.[2] Consequently, research studies often predominantly feature menopausal women as subjects. While it is indisputable that postmenopausal women represent a pivotal demographic for osteoporosis health

Table 2 Current Status of Research Abroad

Researcher	Research subjects	Research tools
Lulla[16]	≥ 65 years old female residents	Self-administered questionnaires
Shaki[17]	Postmenopausal women	OHBS
Ahmed[18]	≥18 year old female residents	OPAAT
Tan[19]	410 hospitalized patients	OPAAT
Ibrahim[20]	Residents aged 20–65	OPB+OKAT+PHBS
Nohra[21]	≥ 20 years of age	Self-administered questionnaires
Mujamammi[22]	17–30 years old	Self-administered questionnaires
Jehle-Kunz[23]	Patients and physicians	Self-administered questionnaires
Alhouri[24]	≥18 years old female	Self-administered questionnaires
Barańska[25]	Osteoporosis patients	Self-administered questionnaires

education initiatives, in the context of universal healthcare, it is imperative to expand our focus to encompass a broader spectrum of community members. Moreover, there is a dearth of research exploring the impact of other illnesses on cognition, suggesting a potential avenue for future investigations into the intricate relationship between other diseases and cognitive aspects of osteoporosis.

Research Methodology

As a cross-sectional study examining the current situation, all researchers opted to utilize questionnaires for data collection, although the research instruments and survey formats employed across different studies exhibited considerable variability. The majority of studies selected questionnaires that have undergone extensive testing in prior research, with their reliability and validity well established. However, it is noteworthy that these questionnaires were not specifically designed to reflect the characteristics of local populations. Consequently, their application may yield divergent results influenced by environmental factors such as demographic variations, geographic regions, and cultural contexts, thereby raising concerns regarding their overall applicability.

Another study integrated multiple questionnaires and extracted items from them to construct a novel scale that supplements aspects not captured by existing scales. This approach offers the benefit of creating a comprehensive questionnaire that encompasses a wide range of dimensions to effectively evaluate participants' cognitive processes. Nevertheless, the reliability of this newly developed scale has yet to be empirically verified.

Findings

Although the studies were conducted across diverse populations using various tools, their findings collectively indicate a low level of awareness regarding osteoporosis among these groups. Consequently, enhancing health promotion initiatives within the population emerges as a critical issue for future considerations.

In examining the correlation between the baseline characteristics of the population and cognitive levels, all aforementioned studies indicated a significant and positive correlation between cognitive levels and the educational attainment of the subjects.[16,17,19,20] This finding aligns with several prior studies. This correlation may be attributed to the interaction between educational level and the economic and social status, as well as the living conditions of the subjects. Moreover, individuals with higher education tend to exhibit a greater awareness of the importance of acquiring health-related knowledge and engaging in health-promoting behaviors.

Several studies have also established a link between diabetes and low levels of health awareness,[19] with findings indicating that women exhibit higher awareness than men.[21] A recent meta-analysis demonstrated that individuals with diabetes face an elevated risk of hip fractures compared to the general population.[26] Researchers have posited that this increased risk may be attributed to lower health literacy levels within this population, coupled with a lack of awareness regarding their susceptibility to and the severity of the disease.[19] This prompts speculation regarding whether health literacy is equally deficient among patients with other chronic conditions, such as hypertension, coronary heart disease, and chronic kidney disease, suggesting that their levels of awareness may also warrant similar concern.It is often assumed that younger people are more receptive to information and should have higher levels of cognition than their older counterparts. However, the correlation between age and cognition in the above study yielded different results. In this regard, it is important that the age of the participants should be normally distributed in order to minimize the sampling error.

Chinese Studies

In comparison to international research, studies examining osteoporosis awareness in China demonstrate significant gaps, characterized by a limited analysis of relevant factors and uneven quality across the existing literature. This section presents a review of higher-quality studies conducted within the last three years for further analysis. Table 3 shows a brief overview of the Chinese study of osteoporosis recognition in the last 3 years.

As illustrated in Table 3, when researching osteoporosis awareness in China, the selection of research subjects parallels that in other countries. It predominantly focuses on high - risk groups, particularly postmenopausal women. Simultaneously, the scope of focus has been expanded to include men, diabetic patients, those with osteopenia or

Table 3 Current Status of Domestic Research

Researcher	Research subjects	Research methodology
Sue Seen Tsing Lo[27]	≥ 20-year-old male patient	FOOQ+MOKQ+OHBS+OSES
Zijiao Yuan[28]	Bone loss/ Osteoporosis patients	Refer to OKAQ design questionnaire
Jing Gou[29]	≥ 60 years old urban residents	Self-administered questionnaires
Ruijie Liang[30]	Type 2 diabetics	Self-administered questionnaires
Shunu Tang[31]	Residents aged ≥60 years in 11 provinces	Self-administered questionnaires
Chunyan Chen[32]	Peri-menopausal women	Self-administered questionnaires

osteoporosis, and younger populations. This comprehensive sampling strategy enables a more extensive comparative analysis regarding the influence of gender, age, and disease status on awareness levels.

Research Methodology

The research instruments employed in relevant studies conducted in China can be categorized into two primary types: self-designed questionnaires and translated questionnaires. In addition to gathering general demographic information such as gender, age, and BMI, the majority of studies utilized a single questionnaire to assess awareness levels. However, some studies implemented multiple questionnaires concurrently to explore various dimensions of the subjects' knowledge regarding osteoporosis in a more targeted manner.

The optimal survey instrument should consist of a questionnaire customized to the specific attributes of the research participants, allowing for inherent scalability and possessing qualities of high readability and applicability. Nevertheless, self-constructed questionnaires come with significant drawbacks that hinder widespread adoption, and given the constrained dataset in the study, their reliability and validity remain unverified. It is our aspiration that moving forward, a questionnaire tailored to the unique characteristics of our target population can be devised and subjected to rigorous testing for reliability across a broader scope of studies.

Research Findings

Research on osteoporosis awareness in China indicates that the general population possesses a low level of understanding regarding osteoporosis. While there exists a basic comprehension of the condition, significant deficiencies persist in terms of preventive healthcare knowledge. Consistent with international findings, studies within China have underscored a positive association between education levels and osteoporosis awareness. Specifically, individuals with higher educational attainment exhibit heightened awareness of osteoporosis, consequently influencing their health-related behaviors[26–31].

All studies within the last three years cited in this paper have consistently reported a significant correlation between gender and osteoporosis awareness, with women demonstrating higher levels of awareness compared to men, and this difference was found to be statistically significant.[28,29,31] This aligns with findings from numerous international and previous studies. Hui-Qin Zhong's[33] analysis suggested that this gender disparity could be attributed to women's heightened concern regarding their health issues. However, some studies have indicated no gender-cognition correlation, with instances where men exhibited greater awareness than women. It is plausible that regional factors and the selection of study populations may influence these differing outcomes.

In the study conducted by Yuan and Gou,[28,29] it was suggested that osteoporosis awareness varies significantly across different age groups, with older adults demonstrating markedly lower levels of awareness compared to their younger counterparts. This disparity can be attributed to the current era of highly developed information networks, which facilitates greater access to and acceptance of health-related knowledge among younger individuals, thereby enhancing their overall health awareness.

Osteoporosis Awareness and Other Diseases

Osteoporosis, characterized by reduced bone mass and increased bone fragility, is intricately linked to other bone disorders like osteoarthritis and fractures. Furthermore, given its prevalence in postmenopausal women, hormonal fluctuations associated with osteoporosis may also contribute to certain gynecological conditions.

Bone-Related Diseases

The most common and serious complication of osteoporosis is fractures; indeed, nearly all hip fractures can be attributed to this disease.[3] Although osteoporotic fractures are now recognized as preventable and treatable, only a small percentage of patients receive appropriate intervention.[6] In a 2022 awareness study conducted by Kraus.[34] The findings revealed that patients undergoing elective surgery demonstrated significantly greater knowledge regarding osteoporosis, including its severity and susceptibility, compared to those undergoing emergency surgery for fractures. Furthermore, emergency patients were found to be at a substantially higher risk of sustaining subsequent fractures.

The second condition of concern is chronic bone diseases, notably osteoarthritis. Osteoarthritis is characterized by degenerative changes in articular cartilage and is frequently associated with secondary osteoporosis, representing a prevalent and irreversible chronic joint disease. There exists a bidirectional relationship between osteoarthritis and osteoporosis in their pathophysiological development: on one hand, patients with osteoarthritis exhibit a significantly heightened risk of developing osteoporosis; on the other hand, the presence of osteoporosis can adversely influence the progression of osteoarthritis[35].

Historically, it was largely accepted that osteoarthritis and osteoporosis rarely coexisted within the same individual, leading most research efforts to focus on the inverse relationship between the two conditions. However, recent studies have increasingly highlighted the overlap in the pathogenesis and management of these diseases. For instance, Bijlsma[36] et al noted that excessive bone resorption occurs in the early stages of osteoarthritis, a crucial characteristic often observed in postmenopausal osteoporosis. Furthermore, Bultink[37] et al proposed that obesity accelerates the progression of osteoarthritis, while low body weight is associated with an elevated risk of osteoporosis; intriguingly, many osteoporotic fractures also occur in individuals who are overweight or obese.Therefore, raising awareness of osteoporosis is not only an important measure to prevent complications such as fractures, but also an effective means to control the development of other related diseases.

Other Diseases

Osteoporosis is primarily characterized by diminished bone formation coupled with increased bone resorption, resulting in a negative bone balance. Estrogen deficiency represents one of the key pathogenic mechanisms underlying primary osteoporosis, making menopausal women a critical target for preventive education. Based on the domestic and international awareness studies discussed above, it is evident that the overall awareness of osteoporosis within the population is low. Moreover, many of these studies have focused specifically on postmenopausal women, leading to the inference that their awareness of osteoporosis is inadequate, thereby placing them at greater health risk.

Goh[38] et al conducted a survey on information, awareness, and behaviors concerning bone health in women with premature ovarian insufficiency (POI) and early menopause (EM). The findings indicate that the level of osteoporosis knowledge within this cohort is moderate. In addition, 20% of participants reported experiencing or having experienced a fragility fracture, underscoring the heightened risk of osteoporosis development associated with POI/EM[38]. Bailey[39] et al revealed limited understanding, perceived risk, and susceptibility to osteoporosis among postmenopausal breast cancer survivors. They recommended the integration of osteoporosis and fracture prevention strategies into oncology care to promote proactive engagement in preventive measures within this demographic.

Osteoporosis has been demonstrated to exhibit a correlation with periodontal disease, particularly pronounced in women during the initial 4 years post-menopause[39,40]. Despite this association, oral health considerations are inadequately addressed in osteoporosis management protocols, contributing to a general unawareness of the interrelationship. Misconceptions prevail among patients, with some erroneously perceiving osteoporosis as exacerbating gum disease, leading to premature discontinuation of osteoporosis medications prior to dental interventions[40]. Professionals like

Dr. Rotman[41] advocate for enhanced communication within the medical community to provide accurate and transparent guidance, thereby preventing unwarranted interruptions in osteoporosis treatment regimens.

Bone Health Education

Numerous studies have demonstrated that public awareness of osteoporosis is insufficient. Therefore, it is imperative to implement educational initiatives aimed at enhancing the population's understanding of osteoporosis. These initiatives should focus on raising awareness, improving self-management efficacy, and promoting healthy behaviors. A variety of health education methods are available; in addition to traditional media such as print materials, television, and radio broadcasting, there has been a notable emergence of innovative educational approaches.

Main Measures

Traditional Education Methods

Conventional bone health education methodologies primarily encompass mass media platforms like television and radio, print media such as health education materials, as well as health seminars and individual consultations led by healthcare professionals. The merits of this conventional approach lie in its ease of implementation, minimal technical demands, and prompt initiation of community-based education. Numerous randomized controlled trials have been undertaken to assess the efficacy of these traditional educational strategies, affirming their effectiveness.

Telier[42] et al and other researchers have demonstrated that standardized management and educational interventions significantly enhance awareness of osteoporosis, self-efficacy, and health-related behaviors. Gaines[43] et al employed a combination of bone health screening, referral, and health education as an updated version of osteoporosis education; however, their findings revealed no significant differences in osteoporosis prevention behaviors between this updated approach and traditional educational methods. Furthermore, there was no notable difference in the improvement of osteoporosis prevention behaviors between the modified and traditional educational approaches.[43] A prior study conducted by Winzenberg and Lee,[44] which compared leaflet-based education with classroom instruction, yielded similar results.

It is evident that traditional skeletal health education methods have certain limitations in enhancing population awareness, self-efficacy, and health behaviors, showing no significant differences in effectiveness across various media. Consequently, with the rapid advancement of new media, there is an urgent need to explore more diverse, efficient, innovative, and comprehensive approaches to health education.

Emerging Modes of Education

Since the onset of the 21st century, the evolution of the economy and advancements in science and technology have profoundly influenced the healthcare sector, with digitalization, informatization, and networking emerging as predominant trends. To address the healthcare requirements of the populace and align with societal progress, medical research scholars are actively investigating novel and evolving avenues for health education.

Des[45] et al, in collaboration with web developers, created an online educational platform tailored for patients with a history of cancer. This platform utilized short videos, images, and animations to convey information, and a randomized controlled study demonstrated its effectiveness in enhancing bone health knowledge within this population. Similarly, another online education program conducted by Nahm[46] et al revealed that online bone health interventions can reach a significant number of individuals, thereby facilitating the widespread dissemination of health knowledge and showcasing substantial potential for further development. In China, researchers like Weiwen Cai[47] have integrated traditional education methods with the WeChat platform to engage the population, taking into account the characteristics of streaming media communication prevalent in the country. The results of their randomized controlled study similarly indicate that incorporating new media can enhance the effectiveness of educational efforts. Additionally, other researchers have begun to implement cutting-edge 3D printing technology in health education. These visualization tools are not only straightforward and cost-effective but also well-received, warranting further investigation in the future.[48]

The Explanation-Simulation-Connection-Communication-Support (ESPCS) model, introduced in recent years, effectively leverages the role of nursing staff in educational interventions and facilitates their participation in health education

throughout the entire process. This model visually presents theoretical knowledge while enhancing psychological interventions for learners.[49] In China, Xiao Li[50] et al applied the ESPCS model to osteoporosis health education, and their findings indicate that participants exposed to the ESPCS model demonstrated higher cognitive and health behavior scores compared to those in the conventional education group, leading to a significant reduction in pain among osteoporosis patients. Furthermore, Nanduri[51] emphasizes the importance of addressing cohort effects in educational settings. He established the Community Healthy Bones Program (PHB), which fosters a supportive social environment that encourages residents to engage in physical activity more robustly.

Considering that osteoporosis is primarily a condition affecting the elderly, most of the aforementioned bone health education initiatives are predominantly tailored to older adults, with minimal attention given to the specific needs and preferences of younger populations. A survey conducted among young individuals revealed that their selection of health information is largely driven by personal interests, indicating a preference for content and approaches that are more aligned with their age group and that utilize contemporary technological methods[52].

Effectiveness Evaluation

An increasing number of studies have been conducted to evaluate the effectiveness of bone health education, and several scholars have undertaken the task of summarizing and analyzing research articles in this domain to elucidate the role of such education in the prevention and treatment of osteoporosis. While numerous individual studies report substantial findings indicating that educational interventions lead to significant enhancements in cognitive levels and self-efficacy compared to pre-educational assessments, it is noteworthy that analyses from several systematic reviews reveal a lack of sufficient evidence supporting the effectiveness of traditional educational approaches for individuals with osteoporosis.[53–55] Furthermore, Rubak[54] indicates that only 20% of the studies included in the analysis demonstrated improvements in discomfort and disability post-education, raising concerns about the future adherence to and persistence of health behaviors within this population. Similarly, Morfeld[55] supports this assertion based on an analysis of previous randomized controlled trials (RCTs), suggesting that while educational interventions may positively influence lifestyle changes, adherence, and quality of life among populations, clear evidence remains elusive.

Notably, a systematic evaluation of health interventions targeting older adults revealed that the use of PowerPoint presentations, the Revised Health Belief Model (RHBM), and computer-based education effectively enhanced participants' knowledge regarding osteoporosis. Furthermore, the RHBM significantly improved participants' self-efficacy in this context.[53] In another systematic review focused on the impact of education on increasing calcium intake, findings indicated that the implementation of mobile health (mHealth) interventions could enhance patients' health beliefs.[56] These results suggest that traditional health education models exhibit certain limitations, highlighting the potential that emerging educational frameworks may address these shortcomings and prove to be more effective in promoting health.

Outlook

Osteoporosis is a prevalent bone-related disease that significantly impacts the long-term health and quality of life of patients. If inadequately managed, it can impose a considerable economic burden on individuals and society as a whole. Often referred to as a "silent disease", osteoporosis frequently goes unnoticed until serious complications arise, underscoring the necessity of assessing public awareness regarding this condition. Previous studies indicate that awareness of osteoporosis among the general population is generally low, with insufficient knowledge concerning effective prevention and treatment measures, alongside existing misconceptions. Furthermore, there are comparatively fewer studies on osteoporosis in China than in developed countries, and the rate of awareness remains notably lower, highlighting a substantial research gap in this area. This situation not only illustrates the general lack of awareness about osteoporosis among the populace but also points to the insufficient attention given to this issue by medical researchers. Consequently, efforts to raise awareness in China should be two-pronged: enhancing public knowledge while simultaneously encouraging medical practitioners to recognize the significance of this line of research.

Based on the above - mentioned research summary, it is evident that advanced age, low educational attainment, and low income are factors influencing the low awareness of osteoporosis. Additionally, several studies suggest that diabetes is also a significant influencing factor. In the subsequent awareness - related surveys, it might be feasible to incorporate

patients with chronic conditions such as sarcopenia, coronary heart disease, and hypertension for in - depth analysis. Moreover, a horizontal comparison of the cognitive disparities among different chronic diseases could be conducted to assess the existence of commonalities.

Awareness of osteoporosis varies across different countries, regions within the same country, and populations within the same region, due to a multitude of influencing factors such as culture, economic status, and lifestyle habits. Therefore, the design of the questionnaire is crucial in the investigation of osteoporosis awareness. The rich geographical diversity of our country, coupled with a wide range of ethnic cultures and significant disparities in living conditions and economic development, results in distinct characteristics among various study populations. Although numerous questionnaires have been developed, there is a scarcity of instruments specifically tailored to the unique attributes of our population, and even fewer that have been employed in clinical studies. Moving forward, we aim to design and implement questionnaires customized to our population, building upon existing data and insights.

The primary objective of the awareness survey is to deliver targeted bone health education aimed at improving knowledge of osteoporosis, enhancing self-efficacy, and reinforcing health-promoting behaviors. An analysis of educational methods reveals that traditional approaches may not adequately address the health needs of the contemporary population, with their effectiveness and acceptance often lagging behind that of innovative educational strategies in practice. In the future implementation of bone health education, we aim to incorporate advanced information technology and networked methodologies to usher in a new era of healthcare.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

There are no conflicts of interest in this paper.

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