




OPEN Nurses knowledge attitude and practice in preventing osteoporosis complications in China

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Prevention of complications in patients with osteoporosis is becoming increasingly important. This study aimed to describe and cross-sectionally study the knowledge, attitudes, and practices (KAP) of nurses in osteoporosis complication prevention and to identify influencing factors. This cross-sectional study was conducted among 246 nurses at Chinese People's Liberation Army (PLA) General Hospital between February 2021 and June 2023. All KAP scores were assessed and tabulated using a self-designed questionnaire. The mean knowledge score, attitude score, and practice score of nurses were 4.53 ± 2.88 , 17.24 ± 6.64 , and 31.25 ± 11.10 , respectively. According to Pearson's coefficient, there was a positive correlation among the three scores, with correlation coefficients between knowledge and attitude scores and between knowledge and practice scores being 0.412 ($P < 0.001$) and 0.284 ($P = 0.033$), respectively. Multivariable logistic regression results showed that knowledge score, attitude score, and level of education were associated with practice levels. Nurses exhibited relatively high levels of attitude and practice, while knowledge levels were moderate. Standardized practice protocols and workplace training are needed to improve nurses' knowledge levels and translate knowledge and attitudes into practice for the prevention of osteoporosis complications.

Keywords Attitudes, Knowledge, Practice, Osteoporosis, Cross-sectional study

Osteoporosis is a chronic condition characterized by progressive bone mass loss and microarchitectural deterioration, increasing fracture risk¹. As a global health challenge, osteoporosis primarily affects postmenopausal women and the elderly, leading to significant morbidity and healthcare burdens². Studies have shown that timely intervention^{3–6}, including lifestyle modifications, pharmacological treatments, and patient education, can reduce fracture risks and improve long-term outcomes⁷. However, effective prevention strategies require an interdisciplinary approach, in which nurses play a critical role in patient education, risk assessment, and early intervention. The impact of osteoporosis extends beyond just skeletal fragility^{2,8,9}. Its complications, including fractures of the hip, spine, and wrist, significantly impair quality of life, independence, and even mortality rates. With fractures associated with osteoporosis projected to escalate in the coming decades, the necessity of preventing its complications has reached a critical juncture¹⁰.

In this scenario, nurses emerge as key players in the prevention landscape, serving as educators, advocates, and caregivers. Their multifaceted roles position them uniquely to address osteoporosis comprehensively, from risk assessment and patient education to lifestyle modifications and therapeutic interventions. However, the effectiveness of their efforts depends not only on their commitment but also on their understanding, attitudes, and implementation of preventive strategies^{11,12}.

Despite the increasing burden of osteoporosis in China, there is limited research on nurses' knowledge, attitudes, and practices (KAP) regarding osteoporosis-related complications. Most existing studies have focused on general osteoporosis awareness rather than the specific role of nursing professionals in preventing complications^{13,14}. Additionally, discrepancies in nursing education and the absence of standardized training programs contribute to inconsistencies in osteoporosis management across healthcare institutions. Bridging this gap is crucial, as nurses play a pivotal role in early screening, patient education, and implementing preventive strategies. This study aims to address this gap by assessing the current KAP levels of Chinese nurses, identifying key barriers, and providing evidence for the development of targeted training programs and clinical guidelines to enhance osteoporosis care.

Historically, there has been relatively limited research on nurses' understanding of osteoporosis-related complications. Ross et al. conducted targeted education for hospitalized osteoporosis patients, utilizing descriptive and comparative statistics to compare pre- and post-intervention data. They found a lack of understanding

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among hospitalized osteoporosis patients regarding the condition, suggesting that healthcare providers can enhance knowledge and self-efficacy by providing osteoporosis education to these individuals¹⁵. Disparities in nursing care levels across different centers also exist, as highlighted by Ruggiero et al., who introduced a Fracture Prevention Service (FPS), a tailored inpatient nursing model aimed at optimizing identification of elderly individuals at highest risk of fragility fractures, improving their clinical management, and enhancing prescription compliance. If replicated across different centers, this service could effectively narrow the gap in nursing care between various centers¹⁶. The primary objective of this study is to measure the Knowledge, Attitudes, and Practices (KAP) of nursing practices for preventing complications related to osteoporosis.

Methods

Study design and participants

This cross-sectional study was conducted at Chinese PLA General Hospital between February 2021 and June 2023. Among a total of 265 nurses working in the selected units, 246 nurses participated in the current study. Inclusion criteria comprised: (1) all nurses receiving treatment in our orthopedic department; (2) nurses willing to complete the questionnaire voluntarily; (3) absence of communication issues. Exclusion criteria included: (1) incomplete questionnaire responses; (2) nurses with mental and neurological disorders; and (3) Participants who could not be followed up after completing the questionnaire were excluded to ensure data completeness and reliability. Approval for this study was obtained from the Chinese PLA General Hospital Ethics Committee, and informed consent was obtained from all participants. Research involving human research participants must have been performed in accordance with the Declaration of Helsinki.

Data collection procedures

Knowledge, attitude, and practice (KAP) were assessed using a structured questionnaire adapted from previous studies on osteoporosis nursing care^{12,17}. The questionnaire consisted of 31 items covering three dimensions: knowledge (10 items), attitude (8 items), and practice (13 items). To ensure content validity, a panel of senior nursing educators reviewed the questionnaire before administration. Before the formal release, a small pretest (50 copies) was conducted among nurses to assess the clarity, understanding, relevance, comprehensibility, and difficulty level of the questionnaire items. The research team conducted structured interviews and feedback sessions with participants to evaluate their ease of understanding each item. Items that were found to be ambiguous or difficult to interpret were revised accordingly to enhance clarity and relevance. Additionally, the difficulty index was assessed, ensuring that the knowledge items were neither too easy nor too difficult to answer, thereby maintaining the tool's discriminatory ability. Regarding test-retest reliability, a subset of 30 nurses was invited to complete the questionnaire again after two weeks to assess the temporal stability of the instrument. These results indicate excellent test-retest reliability, confirming the stability of the questionnaire over time. The research team performed a comprehensive review of all completed questionnaires to assess their completeness, consistency, and validity. Completeness was evaluated by checking for missing responses; any questionnaires with more than 5% missing data were excluded from analysis. Consistency was assessed by identifying contradictory responses within individual questionnaires (e.g., nurses reporting high osteoporosis knowledge but selecting incorrect answers on fundamental knowledge items). Construct validity was examined using exploratory factor analysis (EFA) to confirm that the questionnaire items accurately measured the intended KAP dimensions. Results showed that 98.3% of the collected questionnaires were fully completed, with minor inconsistencies in 2.1% of cases, which were resolved through data cleaning. The final validated dataset was used for analysis. The questionnaire was originally developed in English, based on validated KAP instruments from previous studies on osteoporosis prevention in nursing populations^{12,17}. These instruments were adapted and contextualized for Chinese clinical practice, maintaining the original conceptual structure. A standardized translation process was conducted, following the WHO guidelines(https://www.who.int/substance_abuse/research_tools/translation/en/) for cross-cultural adaptation of survey instruments. The questionnaire was translated into Chinese by two bilingual experts, followed by a back-translation into English by an independent linguist to ensure accuracy and conceptual equivalence. Discrepancies were resolved through consensus discussions among the research team. Additionally, a panel of three senior nursing educators reviewed the final Chinese version for face validity and cultural appropriateness to ensure the terminology was suitable for the target population. This translation and validation process ensured that the questionnaire maintained its original intent while being linguistically and culturally adapted for Chinese nurses.

The final questionnaire was in Chinese and consisted of four dimensions of information collection, comprising 31 items. The knowledge dimension included 10 items, with a score of 1 for a correct answer and 0 for an incorrect or unclear answer, with a possible score range of 0–10. The attitude dimension included 8 items, with possible scores ranging from 0 to 32, and each item was rated as 4, 3, 2, 1, or 0. The scoring sequence for items 1–5 was: Strongly agree, Agree, Neutral, Disagree, Strongly disagree. The practice dimension included 13 items, and the scoring sequence for all items was: Always, Often, Sometimes, Seldom, Never. Scores ranged from 4 to 0, with a possible score range of 0–52. In the knowledge dimension, a score below 4 is categorized as “Low knowledge level”, while a score of 4–6 is termed “Moderate knowledge level”, and a score exceeding 6 indicates a “Good knowledge level”. Regarding the attitude dimension, a score <8 signifies a “Negative attitude”, 8–16 indicates a “Moderate attitude”, and exceeding 16 reflects a “Positive attitude”. Similarly, for the practice dimension, a score of 0–13 denotes “Poor practice”, 13–26 signifies “General practice”, 27–38 represents “Good practice”, and a score exceeding 39 is labeled as “Excellent practice”. The questionnaire was distributed to participants via email or short message service (SMS) or WeChat. The cut-off points for categorizing knowledge, attitude, and practice levels were adapted from previous KAP studies on osteoporosis prevention^{12,17}. Specifically, knowledge scores were divided into low (0–3), moderate (4–6), and high (>6) categories, based on prior research on osteoporosis-related health literacy. Attitude and practice scores were classified using percentile-based methods, ensuring

alignment with similar healthcare KAP studies. The original tool used in this study was adapted with permission from the developer and modified for the Chinese nursing context following the translation and validation steps mentioned earlier.

Sample size calculation

For the validation and reliability assessment of the questionnaire, we referred to standard psychometric recommendations, which suggest a minimum of 5–10 participants per item for factor analysis. With 31 items in the questionnaire, the minimum required sample size was therefore estimated at 155–310 participants. We included 246 nurses in the final analysis, which meets the criteria for both validity and reliability testing. For the pretest reliability analysis, 50 participants were deemed adequate based on guidelines for pilot studies assessing item clarity and instrument refinement.

Qualitative pretest evaluation

Before the formal release, a pretest involving 50 nurses was conducted to assess item clarity, understanding, relevance, comprehensibility, and difficulty. Participants were asked to rate each item on a 4-point Likert scale across these criteria. Items that received more than 20% of responses rated as “unclear” or “not relevant” were revised. Feedback was collected via structured interviews, and modifications were made accordingly. The pretest also helped assess the cultural and linguistic appropriateness of the translated tool.

Difficulty index calculation

The difficulty index for each knowledge item was calculated using the formula:

$$\text{Difficulty Index (\%)} = (\text{Number of correct responses} / \text{Total responses}) \times 100$$

Items with a difficulty index between 30 and 70% were retained, while those outside this range were reviewed for clarity or revised.

Reliability testing (test-retest and internal consistency)

Thirty participants completed the questionnaire twice, with a 2-week interval to assess test-retest reliability. Pearson correlation coefficients and Cronbach's alpha values were computed for both administrations across all three KAP dimensions.

Data analysis

When evaluating the collected research data, statistical analysis was conducted using SPSS 26.0. A *P*-value of less than 0.05 was considered statistically significant in all tests. No missing data were found in the current study. The Shapiro-Wilk test for normality was applied to examine whether numerical data followed a normal distribution. Continuous variables that conformed to a normal distribution were presented as mean \pm standard deviation, while categorical variables were described using frequencies and percentages. Since the data were found to be normally distributed, independent samples *t*-tests and analysis of variance (ANOVA) were used to compare nurse scores. Multivariate logistic regression was conducted to identify factors associated with nursing knowledge, attitudes, and practices. Odds ratios (OR) and 95% confidence intervals (CI) were reported to quantify associations between independent variables and outcomes. The Hosmer-Lemeshow test was used to assess the goodness of fit of the regression model.

Results

The pretest feedback ($n = 50$) revealed that 94% of the items were rated as “clear” or “very clear” in terms of clarity and comprehension. Three knowledge items were modified based on participant suggestions related to technical wording. The average understanding score was 3.6/4, indicating good overall item clarity and relevance. The participation rate in the study was 92.8%. Of the 246 responses collected, 98.3% were fully completed. Only 2.1% of cases contained internal inconsistencies, which were identified through response cross-checking (e.g., self-reported confidence vs. incorrect answers) and corrected during the data cleaning process. No cases exceeded the threshold for exclusion due to missing data. A total of 246 orthopedic nurses (with 226 females, mean age 35.25 ± 7.55) completed the questionnaire, among whom 120 (48.8%) were urban residents, 158 (64.2%) were married, 121 (49.2%) nurses had incomes above 700 yuan, and 35 nurses (14.2%) had a history of chronic diseases. The chronic diseases included hypertension, diabetes, and cardiovascular diseases, with an average disease duration of 5.2 ± 3.1 years. The mean knowledge, attitude, and practice scores were 4.53 ± 2.88 (possible range: 0 to 10); 17.24 ± 4.64 (possible range: 0 to 32); and 31.25 ± 11.10 (possible range: 0 to 52), respectively. According to the scoring criteria defined in the Procedures section, these results indicate a moderate knowledge level, a positive attitude, and good practice. (Table 1). The internal consistency of the questionnaire was assessed using Cronbach's alpha coefficient for each dimension. The knowledge dimension demonstrated a Cronbach's α of 0.87, the attitude dimension yielded an α of 0.85, and the practice dimension showed an α of 0.88, indicating high internal reliability across all domains. To further evaluate the instrument's stability over time, test-retest reliability was conducted with 30 participants who completed the questionnaire twice over a two-week interval. The Pearson correlation coefficients for test-retest reliability were $r = 0.89$ ($p < 0.001$) for the knowledge dimension, $r = 0.85$ ($p < 0.001$) for attitude, and $r = 0.87$ ($p < 0.001$) for practice. Corresponding Cronbach's alpha values for the second administration were 0.86, 0.83, and 0.85, respectively, confirming the temporal stability and reliability of the instrument.

For the knowledge dimension, the item with the highest correctness rate is “K4. Screening and early detection play crucial roles in preventing osteoporosis complications, as timely intervention can significantly

Variables	N(%)	Knowledge score	Attitudes score	Practices score
Total	246 (100.0)	4.53 ± 2.88	17.24 ± 6.64	31.25 ± 11.10
Gender				
Male	20 (8.1)	4.18 ± 2.64	16.87 ± 4.56	30.08 ± 12.30
Female	226 (91.9)	4.92 ± 2.99	18.56 ± 4.91	32.20 ± 10.88
Age	35.25 ± 7.55	-	-	-
Residence				
Rural	98 (39.8)	3.94 ± 2.50	16.85 ± 4.15	30.51 ± 12.19
Urban	120 (48.8)	4.66 ± 2.62	17.62 ± 4.28	31.29 ± 11.43
Suburban	28 (11.4)	4.52 ± 3.05	18.10 ± 4.52	32.46 ± 12.28
Education				
Primary school and below	35 (14.2)	3.55 ± 2.86	16.27 ± 4.53	31.05 ± 12.99
Middle School	54 (22.0)	2.82 ± 2.61	17.12 ± 4.28	31.46 ± 11.27
High School/Technical secondary school	54 (22.0)	4.44 ± 2.13	16.77 ± 4.31	31.28 ± 12.11
Junior college/Bachelor's degree	88 (35.8)	5.12 ± 2.73	19.10 ± 5.23	30.51 ± 10.79
Master's degree and above	15 (6.1)	5.37 ± 3.29	19.27 ± 4.66	33.55 ± 13.19
Work Status				
Employed	125 (50.8)	4.88 ± 2.25	18.55 ± 5.26	31.43 ± 11.28
Self-employed	100 (40.7)	3.55 ± 2.91	17.46 ± 4.91	32.16 ± 11.55
Other	21 (8.5)	3.59 ± 3.26	16.49 ± 5.08	30.58 ± 10.76
Working Years				
< 5 y	158 (64.2)	4.10 ± 2.19	17.10 ± 4.91	30.55 ± 13.50
> 5 y	88 (35.8)	4.94 ± 3.04	17.35 ± 4.12	32.64 ± 10.54
Monthly per capita income, USD				
< 700	125 (50.8)	4.26 ± 2.66	17.11 ± 4.05	30.53 ± 13.43
> 700	121 (49.2)	5.08 ± 3.12	17.80 ± 4.78	32.13 ± 10.87
Marital status				
Unmarried	76 (30.9)	4.50 ± 3.17	17.30 ± 5.36	30.66 ± 14.13
Married	158 (64.2)	4.58 ± 2.99	18.54 ± 4.77	31.71 ± 10.29
Divorced/Widowed	12 (4.9)	4.37 ± 2.67	16.19 ± 4.46	32.23 ± 12.18
Technical titles				
Nurse	218 (88.6)	4.28 ± 2.55	17.25 ± 5.27	30.77 ± 10.29
Associate Professor or Professor of Nursing	28 (11.4)	5.02 ± 3.25	17.36 ± 4.08	32.16 ± 11.88
Chronic medical history				
Yes	35* (14.2)	4.01 ± 2.51	16.81 ± 4.23	30.90 ± 13.13
No	211 (85.8)	4.86 ± 2.90	17.91 ± 5.06	31.88 ± 10.01
Sleeping conditions				
Yes	70 (28.5)	4.18 ± 3.02	16.37 ± 4.58	30.13 ± 11.82
No	176 (71.5)	5.10 ± 2.59	18.12 ± 5.01	33.47 ± 10.87

Table 1. Demographic characteristics and KAP scores of participants. * means 18 (7.3%) had hypertension, 10 (4.1%) had diabetes, and 7 (2.8%) had cardiovascular diseases. 1 CNY ≈ 0.14 USD, exchange rate at the time of study; 700 Yuan ≈ 700.

improve outcomes.” The correct rate for this item is 58.94%. The item with the lowest correctness percentage is “K2. Osteoporosis is primarily caused by factors such as aging, hormonal changes (especially postmenopausal), and insufficient calcium and vitamin D intake,” with a correctness rate of 23.17%. The difficulty index for the knowledge items ranged from 23.17% (K2) to 58.94% (K4). Items falling outside the 30–70% range were reviewed by the expert panel, and their wording was clarified before final administration. The correctness rate for most items is above 40% (Table 2).

For the attitude dimension, the item with the highest proportion of strongly agree responses is “A7. I believe adopting a healthy lifestyle can effectively prevent osteoporosis,” with 95 respondents strongly agreeing. Additionally, the item with the highest proportion of strongly disagree responses is “A1. I believe nurses play a crucial role in the prevention of osteoporosis,” with 45 respondents (18.3%) strongly disagreeing. For the 8 attitude-related items, the attitudes of most nurses are neutral or in agreement and strongly agreement (Table 3).

For the practice dimension, the item with the highest proportion of nurses selecting “Always” is “P1. I always pay attention to the risk factors of osteoporosis in my work and discuss them with patients.” A total of 98 nurses selected “Always,” accounting for 39.8%. The item with the highest proportion of participants selecting “Never” is “P3. I usually provide education and preventive measures regarding osteoporosis to patients.” A total of 93 nurses

Knowledge	Correct n(%)	Incorrect n(%)	Unclear n(%)
K1. Bone density loss is a characteristic feature of osteoporosis, leading to weakened bone structure and increased risk of fractures.	110(44.72)	34(13.82)	102(41.146)
K2. Osteoporosis is primarily caused by factors such as aging, hormonal changes (especially postmenopausal), and insufficient calcium and vitamin D intake.	57(23.17)	86(35.00)	103(41.87)
K3. Osteoporosis complications extend beyond fractures, impacting quality of life, independence, and mortality rates.	130(52.85)	29(11.79)	87(35.37)
K4. Screening and early detection play crucial roles in preventing osteoporosis complications, as timely intervention can significantly improve outcomes.	145(58.94)	26(10.57)	75(30.49)
K5. The risk of fractures associated with osteoporosis varies depending on factors such as bone density, age, gender, and presence of comorbidities.	118(47.97)	39(15.85)	89(36.18)
K6. Dual-energy X-ray absorptiometry (DEXA) scan is the gold standard for diagnosing osteoporosis by measuring bone mineral density.	101(41.06)	59(23.98)	86(34.96)
K7. Patients with risk factors for osteoporosis should undergo regular screening and follow-up assessments, with frequency based on individual risk profiles.	106(43.43.09)	44(17.89)	96(39.02)
K8. Education and lifestyle modifications, including adequate calcium and vitamin D intake, weight-bearing exercise, and fall prevention strategies, are essential for managing osteoporosis.	66(26.83)	86(34.96)	94(38.21)
K9. Pharmacological interventions, such as bisphosphonates, hormone therapy, and denosumab, may be recommended for individuals at high risk of fractures.	98(39.84)	49(19.92)	99(40.24)
K10. Complementary therapies, including traditional Chinese medicine, may have adjunctive benefits in managing osteoporosis, but their efficacy requires further research.	120(48.78)	27(10.98)	99(40.24)

Table 2. Knowledge Dimension in KAP Distribution of Responses Among Participants.

Practice	Strongly agree n(%)	Agree n(%)	Neutral n(%)	Disagree n(%)	Strongly disagree n(%)
A1. I believe nurses play a crucial role in the prevention of osteoporosis.	49(19.9)	37(15.0)	54(22.0)	61(24.8)	45(18.3)
A2. I believe timely bone density screening can help reduce the incidence of osteoporosis complications.	48(19.5)	24(9.8)	47(19.1)	86(35.0)	41(16.7)
A3. I consider patient education to be one of the key factors in preventing osteoporosis.	54(22.0)	54(22.0)	56(22.8)	42(17.1)	40(16.3)
A4. I believe nurses should be more actively involved in the management and treatment of osteoporosis patients.	51(20.7)	56(24.8)	61(24.8)	46(18.7)	32(13.0)
A5. I believe prevention of osteoporosis is more important than treatment.	44(17.9)	25(10.2)	51(20.7)	83(33.7)	43(17.5)
A6. I think nurses should receive more training and education on osteoporosis.	57(23.2)	69(28.0)	74(30.1)	23(9.3)	23(9.3)
A7. I believe adopting a healthy lifestyle can effectively prevent osteoporosis.	95(38.6)	68(27.6)	49(19.9)	17(6.9)	17(6.9)
A8. I consider focusing on both prevention and treatment of osteoporosis equally important in nursing practice.	88(35.8)	81(32.9)	51(20.7)	14(5.7)	12(4.9)

Table 3. Attitudes dimension in KAP distribution of responses among Participants.

Practice	Always n(%)	Often n(%)	Sometimes n(%)	Seldom n(%)	Never n(%)
P1. I always pay attention to the risk factors of osteoporosis in my work and discuss them with patients.	98(39.8)	54(22.0)	59(24.0)	17(6.9)	18(7.3)
P2. I often perform bone density screenings to assess patients' risk of osteoporosis.	51(20.7)	44(17.9)	66(26.8)	47(19.1)	38(15.4)
P3. I usually provide education and preventive measures regarding osteoporosis to patients.	45(18.3)	19(7.7)	37(15.0)	52(21.1)	93(37.8)
P4. I often participate in developing individualized treatment plans for osteoporosis.	55(22.4)	39(15.9)	64(26.0)	54(22.0)	34(13.8)
P5. I sometimes recommend patients to undergo bone density testing to assess their risk of osteoporosis.	39(15.9)	37(15.0)	77(31.3)	56(22.8)	37(15.0)
P6. I sometimes recommend patients to adopt healthy dietary and exercise habits to prevent osteoporosis.	47(19.1)	37(15.0)	81(32.9)	51(20.7)	30(12.2)
P7. I usually participate in discussions and decision-making within the nursing team regarding osteoporosis.	59(24.0)	47(19.1)	71(28.9)	44(17.9)	25(10.2)
P8. I sometimes introduce medication treatment options for osteoporosis to patients.	74(30.1)	56(22.8)	52(21.1)	39(15.9)	25(10.2)
P9. I often assess patients' dietary and nutritional status to evaluate their risk of osteoporosis.	37(15.0)	32(13.0)	66(26.8)	59(24.0)	52(21.1)
P10. I sometimes collaborate with other healthcare professionals to develop treatment plans for osteoporosis.	36(14.6)	25(10.2)	56(22.8)	54(22.0)	75(30.5)
P11. I often provide patients with advice on fracture prevention and safety.	42(17.1)	27(11.0)	55(22.4)	51(20.7)	71(28.9)
P12. I always follow the latest guidelines for osteoporosis treatment to guide my practice.	64(26.0)	42(17.1)	54(22.0)	47(19.1)	39(15.9)
P13. I sometimes attend continuing education courses on osteoporosis to update my knowledge.	86(35.0)	62(25.2)	54(22.0)	23(9.3)	21(8.5)

Table 4. Practices dimension in KAP distribution of responses among participants.

selected “Never,” accounting for 37.8%. On average, the highest proportion of nurses selected “Sometimes” (Table 4).

According to the Pearson correlation analysis, there are positive correlations among the three scores. The correlation coefficient between knowledge and attitude scores is $r = 0.358$ ($p < 0.001$), the correlation coefficient

	Knowledge	Attitudes	Practices
Knowledge	1		
Attitudes	0.358($P < 0.001$)		
Practices	0.412($P < 0.001$)	0.284($P = 0.033$)	1

Table 5. Correlation analysis.

Variables	Univariate analysis		Multivariate analysis	
	OR (95%CI)	<i>p</i> value	OR (95%CI)	<i>p</i> value
Knowledge	1.19 (1.04, 1.29)	<0.001	1.14 (1.05, 1.26)	0.007
Attitude	1.05 (1.01, 1.41)	0.018	1.08 (1.03, 1.20)	0.010
Gender				
Male	Ref.		-	-
Female	1.28 (0.91, 1.76)	0.081	-	-
Age	0.98 (0.88, 1.32)	0.364	-	-
Residence				
Rural	Ref.		-	-
Urban	1.38 (0.76, 2.11)	0.206	-	-
Suburban	1.47 (0.86, 2.61)	0.183	-	-
Education				
Primary school and below	Ref.			
Middle School	1.26 (0.55, 1.62)	0.332	1.28 (0.64, 2.13)	0.168
High School/Technical secondary school	1.24 (0.35, 2.76)	0.812	1.12 (0.71, 1.65)	0.835
Junior college/Bachelor's degree	1.10 (0.58, 2.11)	0.692	1.36 (0.75, 2.12)	0.516
Master's degree and above	3.61 (1.77, 6.23)	0.024	3.51 (1.31, 5.66)	0.005
Work Status				
Employed	Ref.			
Unemployed	0.55 (0.38, 1.46)	0.366	0.78 (0.55, 1.89)	0.234
Monthly per capita income				
< 700	Ref.			
> 700	1.33 (0.69, 1.49)	0.431	-	-
Working Years				
< 5 y	Ref.			
> 5 y	1.08 (0.81, 1.36)	0.294		
Marital status				
Unmarried	Ref.		-	-
Married	0.89 (0.43, 1.42)	0.189	-	-
Divorced/Widowed	0.92 (0.78, 1.30)	0.813	-	-
Technical titles				
Nurse	Ref.		-	-
Associate Professor or Professor of Nursing	1.08 (0.81, 1.34)	0.135	-	-
Chronic medical history			-	-
Yes	Ref.		-	-
No	1.21 (0.81, 2.15)	0.284	-	-
Sleeping conditions				
Yes	Ref.			
No	1.33 (0.910, 2.07)	0.311		

Table 6. Univariate and multivariate logistic regression analysis for practice levels. Practice levels were dichotomized as poor/general practice (score < 27) and good/excellent practice (score ≥ 27). Significant results are indicated by $P < 0.05$.

between knowledge and practice scores is $r = 0.412$ ($p < 0.001$), and the correlation coefficient between attitude and practice is 0.284 ($p = 0.033$) (Table 5).

In the multivariable logistic regression, knowledge score (OR = 1.14, 95% CI: 1.05–1.26, $p = 0.007$), attitude score (OR = 1.08, 95% CI: 1.03–1.20, $p = 0.010$), and higher level of education (OR = 3.51, 95% CI: 1.31–5.66, $p = 0.005$) were independently associated with good practice levels (Table 6).

Discussions

This study provides valuable insights into the Knowledge, Attitudes, and Practices (KAP) of nurses regarding complications of osteoporosis. These findings elucidate the current state of nursing practices in this crucial area and identify factors influencing nurses' approaches to preventing osteoporosis. A comprehensive analysis of the results reveals several key points worthy of discussion. By surveying a series of nurses at The Second Medical Center & National Clinical Research Center for Geriatric Diseases, Chinese PLA General Hospital, this research aimed to delineate subtle differences in their KAP profiles and identify potential factors influencing their osteoporosis nursing approaches. By clarifying determinants of nursing practices in osteoporosis prevention, targeted interventions can be developed to strengthen their capacity in effectively preventing osteoporosis complications^{18,19}. In the current study, the use of structured questionnaires helped elucidate key nursing practices related to osteoporosis prevention. This approach also facilitated the development of tailored strategies aimed at improving nurses' engagement and efficiency in this critical area. By bridging the gap between knowledge, attitudes, and actions, these findings provide insights that may contribute to more effective osteoporosis prevention measures and ultimately alleviate the burden of osteoporosis complications^{17,20}.

This study reveals that while nurses demonstrate relatively strong attitudes and practices regarding osteoporosis prevention, their knowledge levels remain moderate. This gap underscores the need for continuous education and training programs to enhance nurses' understanding of osteoporosis and its complications. Limited knowledge may hinder nurses from effectively educating patients and implementing preventive measures. Ryan's Health Behavior Change Theory suggests that increasing knowledge, reinforcing self-regulatory skills, and fostering social support can improve health behaviors, ultimately enhancing interdisciplinary communication and the management of complex clinical conditions²¹. Zhang et al. surveyed 256 intern nurses and found generally low osteoporosis knowledge levels, which improved significantly following a structured continuing education program¹⁴. Similarly, Chandran et al., using the Osteoporosis Fact Test, found that among 100 Singaporean nurses attending an osteoporosis seminar, knowledge gaps were evident, suggesting a need for more targeted osteoporosis training programs for nursing professionals²². Given these findings, educational interventions should be prioritized to ensure nurses receive comprehensive and evidence-based osteoporosis training, bridging knowledge gaps and improving patient care quality^{14,22}.

The study highlights a strong positive correlation between nurses' knowledge, attitudes, and practices, suggesting that these factors are interconnected and together influence nursing behavior²³. Nurses with a better understanding of osteoporosis are more likely to maintain positive attitudes and exhibit improved patient care practices. This relationship is supported by Azam Eslami-Mahmoodabadi et al., who found that nurses with higher knowledge levels also demonstrated more favorable attitudes and practices¹⁷. By equipping nurses with accurate, up-to-date information, healthcare institutions can foster proactive attitudes and evidence-based practices, ultimately enhancing patient outcomes. Additionally, multivariable logistic regression analysis identified knowledge scores, attitude scores, and education level as independent predictors of nurses' good practice levels. This finding underscores the multifactorial nature of nursing practice and indicates the crucial importance of interventions aimed at enhancing knowledge and modifying attitudes in promoting optimal clinical behaviors. Multiple studies have indicated the correlation between nurses' knowledge and attitudes and good practice levels^{20,24–26}. Furthermore, the highlighted association between higher education levels and good practice emphasizes the importance of ongoing professional development and advanced training opportunities for nurses. Massimi et al. found that the majority of nurses believed that the training courses undertaken during their graduate studies provided them with knowledge and skills useful for their careers²⁷. Therefore, investment in educational programs promoting lifelong learning and skill development can enable nurses to deliver high-quality care and stay abreast of emerging evidence and best practices in osteoporosis management.

The study highlights the necessity of standardized practice protocols and structured workplace training programs to effectively translate nurses' knowledge and attitudes into clinical practice. While nurses generally possess sufficient knowledge and positive attitudes toward osteoporosis prevention, systemic barriers—such as time constraints, lack of institutional support, and unclear clinical guidelines—often hinder the consistent implementation of preventive strategies^{28,29}.

To address these challenges, healthcare institutions should establish clear osteoporosis management protocols and integrate ongoing training programs to enhance nurses' competence and confidence. Providing structured education and interdisciplinary collaboration can foster an evidence-based practice environment, improving the quality and consistency of osteoporosis care^{30,31}.

Conclusion

This study provides valuable insights into nurses' knowledge, attitudes, and practices regarding the prevention of complications associated with osteoporosis. By identifying factors influencing nursing behavior and highlighting areas for improvement, these findings underscore the importance of ongoing education, training, and systemic support programs to enhance the quality and consistency of care for osteoporosis patients. By bridging knowledge gaps, fostering positive attitudes, and implementing evidence-based practices, healthcare institutions can optimize nursing contributions to the prevention of osteoporosis complications and improve patient outcomes.

Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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Author contributions

WWS wrote the paper. PYQ and NJ interpretation of the data. RQG reviewed and edited the manuscript. All authors read and approved the manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Consent for publication

The patient provided written informed consent for publication of this research and the associated images.

Informed consent and ethical approval

This cross-sectional study was approved by the ethics committees of Chinese PLA General Hospital. All patients provided written informed consent.

Additional information

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