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Research on the Impact of Health Education Nursing Based on the Transtheoretical Model of Behavior Change on Self-Efficacy in Osteoporosis Patients with Low Bone Mass

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Abstract: *Objective*: To investigate the impact of health education nursing based on the Transtheoretical Model of Behavior Change on self-efficacy in osteoporosis patients with low bone mass. *Methods*: A total of 91 osteoporosis patients with low bone mass admitted to our hospital from June 2000 to the end of June 2023 were selected and randomly divided into an observation group and a control group using the envelope method, with 46 and 45 cases in each group, respectively. The control group received routine nursing care, while the observation group received health education nursing based on the Transtheoretical Model of Behavior Change. Bone mineral density (lumbar spine L1–L4, femoral neck), disease awareness (Osteoporosis Knowledge Test Questionnaire, OKT-Q), and self-efficacy (Adult Health Self-Management Skills Rating Scale, AHSMSRS) were compared between the two groups. *Results*: After the intervention, bone mineral density levels, disease awareness levels, and self-efficacy levels significantly increased in both groups, with the observation group showing greater improvements in all indicators compared to the control group ($p < 0.05$). *Conclusion*: Interventions based on the Transtheoretical Model of Behavior Change effectively enhance patient self-efficacy and bone health by precisely matching behavioral stages, strengthening social support, and regulating neurobehavioral factors.

Keywords: Transtheoretical model of behavior change; Osteoporosis; Low bone mass population; Self-efficacy; Health education nursing; Bone mineral density

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1. Introduction

Osteoporosis has emerged as a significant global public health challenge, with its associated fracture risk significantly reducing patients' quality of life and life expectancy [1]. Statistics indicate that approximately 200 million people worldwide are affected by this disease, with individuals with reduced bone mineral density constituting a high-risk group [2]. However, in China, the awareness, diagnosis, and treatment rates of osteoporosis

are generally low, with patients often exhibiting key issues such as insufficient disease understanding, weak self-management abilities, and poor intervention compliance, severely limiting the effectiveness of prevention and control efforts [3].

Traditional health education methods mostly focus on the one-way transmission of knowledge, lacking systematic intervention in the dynamic process of individual behavioral change, making it difficult to effectively stimulate patients' intrinsic motivation and facilitate sustained behavioral transformation. The theory of behavior change emphasizes that behavioral change is a staged, dynamically evolving continuous process, typically including the pre-intentional stage, intentional stage, preparation stage, action stage, and maintenance stage. This theory advocates for matching corresponding intervention strategies according to the characteristics of different stages, thereby more effectively guiding and maintaining the establishment of healthy behaviors [4].

Therefore, this study explored the intervention effect of health education nursing based on the theory of behavior change on osteoporosis patients with low bone mass by implementing it among patients admitted to our hospital from June 2000 to the end of June 2023, and provided evidence for clinical selection plans. The specific report is as follows.

2. Data and methods

2.1. General information

A total of 91 patients with osteoporosis with low bone mass admitted to our hospital from June 2000 to the end of June 2023 were selected and randomly divided into an observation group and a control group using the envelope method, with 46 and 45 cases in each group, respectively. There were no statistically significant differences in the basic information between the two groups ($p > 0.05$), as shown in **Table 1**. This study was approved by the hospital ethics committee and complied with the relevant ethical principles of the Declaration of Helsinki.

Table 1. Comparison of general information between the two groups ($\bar{x} \pm s/n$)

Characteristic	Observation group (n = 46)	Control group (n = 45)	t/χ^2	*p*-value
Gender (Male/Female)	16 / 30	17 / 28	0.088	0.766
Age (years)	54–74	53–74	0.012	0.990
	63.15 ± 3.84	63.16 ± 3.91		
Education level [n]			0.478	0.787
High school or below	13	14		
College	21	22		
Bachelor's degree or above	12	9		

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

(1) Patients aged 45 to 75 years
(2) Diagnosed with low bone mass osteoporosis by QCT examination
(3) Able to independently complete the OKT-Q and AHSMSRS scale assessments
(4) No contraindications to long-term calcium or vitamin D medication

(5) Willing to accept a 6-month intervention

2.2.2. Exclusion criteria

(1) Secondary osteoporosis caused by hyperparathyroidism, long-term glucocorticoid use, etc.
(2) Comorbid with malignant tumors, severe heart, liver, or kidney failure, etc.
(3) Unhealed lower limb fractures or limited mobility due to rheumatoid arthritis
(4) Dementia, schizophrenia, etc., affecting cognitive assessment
(5) Participation in other osteoporosis clinical trials within the past 3 months

2.3. Methods

Patients in the control group received routine care: Standardized health education was provided by responsible nurses, which included distributing brochures on osteoporosis knowledge, explaining basic disease information, and daily precautions. Routine medication guidance was also provided, detailing the usage and precautions for drugs such as calcium carbonate D3 tablets and calcitriol. Monthly telephone follow-ups were conducted to understand the patients' basic conditions and answer simple questions.

Patients in the observation group received health education nursing based on the Transtheoretical Model of Behavior Change

(1) An interdisciplinary intervention team was formed, consisting of orthopedic surgeons, specialist nurses, and rehabilitation therapists, who commenced their work after undergoing unified training.
(2) Prior to intervention, patients' behavioral stages were assessed: For those in the pre-contemplation stage, the focus was on elucidating the hazards of osteoporosis and the benefits of proactive intervention through case analysis. For patients in the contemplation stage, the motivational interviewing technique was employed to identify barriers to behavior change, including exercise-related fears and nutritional misconceptions, and personalized health education brochures were used to correct biased perceptions. For patients in the preparation and action stages, stage-specific goals were jointly established, such as gradually increasing sun exposure time (from 15 minutes to 30 minutes daily) and incorporating resistance training exercises (increasing the frequency of elastic band exercises from twice a week to four times a week), and a behavioral commitment contract was signed to reinforce a sense of responsibility.
(3) The family support system was integrated into the intervention: Family members were guided to participate in monitoring dietary calcium intake (ensuring a daily intake of dairy products ≥ 300 mL) and medication adherence.
(4) A digital management file was established, with weekly reminders sent via the WeChat platform to encourage behavior compliance (such as step count tracking and calcium supplement check-ins). Specialist nurses conducted 15–20 minutes video follow-ups every two weeks, using the teach-back method to confirm knowledge retention and adjusting intervention strategies in a timely manner.
(5) For patients entering the maintenance stage, monthly peer support exchange meetings were organized, where successful cases shared their experiences of behavior change to consolidate long-term healthy behaviors.

The entire process lasted for six months, with an emphasis on staged feedback and positive reinforcement.

2.4. Observation indicators

2.4.1. Bone mineral density

Observe and compare the volumetric bone mineral density (vBMD) of the two groups of patients before and after the intervention. Bone mineral density was measured using Quantitative Computed Tomography (QCT). The subjects were asked to lie supine on the CT scanning table, with the body's midline aligned with the center of the scanning gantry and both knees flexed and placed on a specialized pillow to reduce the physiological curvature of the lumbar spine. The scanning range covered the mid-sections of the lumbar vertebrae L1–L4 and both femoral necks, utilizing a spiral CT mode (with a tube voltage of 120 kV and a tube current of 80–100 mAs). During the scanning process, a calibration phantom needed to be placed simultaneously between the subject's lower back and the scanning table, ensuring that the phantom and the spine/femur regions were imaged simultaneously to correct for CT value drift and convert it into absolute bone mineral density values.

2.4.2. Disease cognition

Observe and compare the levels of disease cognition in the two groups of patients before and after the intervention. Cognition levels were measured using the Osteoporosis Knowledge Test Questionnaire (OKT-Q). This questionnaire consists of 22 items, with each correct answer scoring 1 point and incorrect or unknown answers scoring 0 points, resulting in a total score range of 0 to 22 points. Based on the total score, cognition levels were classified into three grades: excellent (≥ 16 points), moderate (11 to 15 points), and inadequate (≤ 10 points).

2.4.3. Self-efficacy

Observe and compare the levels of self-efficacy in the two groups of patients before and after the intervention. Self-efficacy was measured using the Rating Scale of Health Self-Management Skill for Adults (AHSMSRS). This scale comprises 38 items and employs a Likert 5-point rating scale (1 = never, 5 = always), with a total score range of 38 to 190 points. Based on the total score, self-efficacy was classified into three levels: high (141 to 190 points), moderate (90 to 140 points), and low (38 to 89 points). Higher scores indicate higher self-efficacy.

2.5. Statistical methods

Our hospital analyzed the study using the SPSS 21.0 statistical software package. Measurement data were expressed as mean ± standard deviation ($\overline{x} \pm s$) and conformed to a normal distribution. Comparisons between groups were made using the *t*-test. Count data were expressed as relative numbers, and comparisons between groups were conducted using the chi-square (χ^2) test. Clinical efficacy comparisons were made using the rank-sum test, with a p-value < 0.05 indicating statistically significant differences.

3. Results

3.1. Comparison of bone density level between the two groups

Before the intervention, there was no significant difference in bone density levels between the two groups ($p > 0.05$). After the intervention, bone density levels in both groups significantly increased, with the observation group showing greater improvement in all indicators compared to the control group ($p < 0.05$). See **Table 2**.

Table 2. Comparison of bone density level between the two groups before and after intervention ($\overline{x} \pm s$, mg/cm^3)

Group	n	Lumbar spine (L1–L4)		Femoral neck	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Observation group	46	112.15 ± 3.45	134.15 ± 3.51*	238.15 ± 4.91	283.15 ± 8.22*
Control group	45	112.34 ± 3.54	125.91 ± 3.61*	239.41 ± 5.08	261.15 ± 8.36*
t-value		0.259	11.040	1.203	12.658
p-value		0.796	< 0.001	0.232	< 0.001

Note: Compared with the same group before intervention, *$p < 0.05$

3.2. Comparison of disease cognition level between the two groups

Before the intervention, there was no significant difference in disease cognition levels between the two groups ($p > 0.05$). After the intervention, disease cognition levels in both groups significantly increased, with the observation group showing greater improvement in all indicators compared to the control group ($p < 0.05$). See **Table 3**.

Table 3. Comparison of disease cognition level between the two groups before and after intervention ($\overline{x} \pm s$)

Group	n	Pre-intervention	Post-intervention
Observation group	46	8.15 ± 1.33	16.25 ± 1.48*
Control group	45	8.12 ± 1.29	13.94 ± 1.53*
t-value		0.109	7.416
p-value		0.913	< 0.001

Note: Compared with the same group before intervention, *$p < 0.05$

3.3. Comparison of self-efficacy level between the two groups

Before the intervention, there was no significant difference in self-efficacy levels between the two groups ($p > 0.05$). After the intervention, self-efficacy levels in both groups significantly increased, with the observation group showing greater improvement in all indicators compared to the control group ($p < 0.05$). See **Table 4**.

Table 4. Comparison of self-efficacy level between the two groups before and after intervention ($\overline{x} \pm s$)

Group	n	Pre-intervention	Post-intervention
Observation group	46	54.15 ± 8.15	161.29 ± 7.84*
Control group	45	55.08 ± 8.21	150.94 ± 7.93*
t-value		0.542	6.261
p-value		0.589	< 0.001

Note: Compared with the same group before intervention, *$p < 0.05$.

4. Discussion

Osteoporosis is characterized by a reduction in bone mass and damage to the bone microstructure, with the core pathology being a dynamic imbalance between bone formation mediated by osteoblasts and bone resorption

dominated by osteoclasts. With the intensification of population aging, the prevalence of osteoporosis among individuals aged 50 and above in China has reached 19.2%, while the proportion of those with low bone mass exceeds 46.4%. These patients face a significantly increased risk of fractures. Traditional health education methods, such as distributing knowledge booklets, conducting group lectures, and monthly telephone follow-ups, have become commonly used clinical approaches due to their simplicity and low cost [5]. However, this model fails to address the core contradiction of low bone mass individuals who "know but do not believe, and believe but do not act". Data from the control group show that although both lumbar spine bone density and OKT-Q scores improved, the increases plateaued, reflecting the limitations of this approach in overcoming patients' insufficient intrinsic motivation and barriers to behavior maintenance.

The intervention program based on the Theory of Behavior Change is designed to address the aforementioned bottlenecks. This theory views behavior change as a dynamic process of "pre-intention–intention–preparation–action–maintenance" and precisely activates behavior transformation mechanisms through stage-matched strategies: For patients in the pre-intention stage, visual presentations of cases of disability caused by fractures can stimulate risk perception and reconstruct patients' cognitive perception of long-term health value; for those in the intention stage, motivational interviewing techniques expose barriers such as fear of exercise and nutritional misconceptions through open-ended inquiries, while personalized educational booklets simultaneously correct cognitive biases regarding the relationship between calcium absorption and bone metabolism; when patients enter the preparation and action stages, the setting of stepped goals provides a continuous sense of accomplishment through the achievement of small goals, and the signing of behavioral commitment letters strengthens executive control functions [6,7].

Additionally, family collaboration and digital management are incorporated to provide dual safeguards for maintaining patients' behavioral adherence. Family members oversee dietary calcium intake and medication compliance; the WeChat platform facilitates step count recording and calcium supplement check-ins, compensating for the decline in executive function among elderly patients. Specialist nurses conduct biweekly video follow-ups using the teach-back method, enabling effective and timely strategy adjustments to prevent behavioral regression [8]. The continuous implementation of various strategies resulted in the observation group achieving an OKT-Q score of 16.25 and a self-efficacy score of 161.29, both higher than those of the control group. Notably, the immediate positive feedback in digital management consistently reinforces patients' behavioral patterns, while peer support during the maintenance phase strengthens their treatment confidence through successful case studies [9].

5. Conclusion

In summary, interventions based on the Transtheoretical Model of Behavior Change effectively enhance patients' self-efficacy and bone health by precisely matching behavioral stages, strengthening social support, and regulating neurobehavioral factors.

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Disclosure statement

The author declares no conflict of interest.

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