The Open Public Health Journal
DOI: 10.2174/0118749445442180260223075700, 2026, 19, e18749445442180
ISSN: 1874-9445

RESEARCH ARTICLE **OPEN ACCESS**

Predicting Preventive Behaviors of Osteoporosis Based on Health Belief Model among Menopausal Women: A Descriptive-correlational Study

Salar Majidi-Sakani[1], Behrouz Fathi[2], Hamidreza Khalkhali[3], Jamileh Amirzadeh-Iranagh[1] and Alireza Didarloo[1,*]

[1]*Department of Public Health, School of Public Health, Urmia University of Medical Sciences, Urmia, Iran*
[2]*Department of Management Sciences and Health Economics, School of Public Health, Urmia University of Medical Sciences, Urmia, Iran*
[3]*Department of Biostatistics and Epidemiology, School of Medicine, Urmia University of Medical Sciences, Urmia, Iran*

Abstract:

Introduction: Osteoporosis is a prevalent disease among menopausal women. Adopting healthy behaviors and lifestyles is one of the important ways to prevent this health problem. Despite the positive effects of these behaviors in preventing and controlling it, women's practice of these behaviors remains low. Therefore, identifying the causes of this is essential, and using health promotion models and theories is helpful. The present study aimed to predict osteoporosis preventive behaviors through the Health Belief Model (HBM) among menopausal women.

Methods: This study is a descriptive and correlational study that was conducted on postmenopausal women aged 50 and older referring to health centers in Urmia, located in northwest Iran. The study aimed to to determine the factors affecting women's behavior based on the HBM. The sample size was estimated to be 200 people based on the G-Power software, and the samples were selected and entered into the study using a multi-stage random sampling method. Data were collected using a valid and reliable three-part questionnaire: demographic information; a standard tool for knowledge and HBM constructs; and the two domains of dietary habits and physical activity from the Walker Lifestyle Questionnaire as preventive behaviors for osteoporosis. All statistical analyses were performed using SPSS version 26.

Results: The results indicated a positive and significant relationship between HBM components and osteoporosis preventive behaviors. Regression analysis revealed that perceived susceptibility ($\beta = 0.137$, $p = 0.031$), perceived benefits ($\beta = 0.169$, $p = 0.006$), self-efficacy ($\beta = 0.182$, $p = 0.005$), knowledge ($\beta = 0.329$, $p = 0.001$), age ($\beta = -0.178$, $p = 0.002$), and education ($\beta = 0.184$, $p = 0.002$) emerged as significant predictors, collectively accounting for 42.5% of the variance in preventive behaviors.

Discussion: The HBM effectively predicts preventive behaviors for osteoporosis. As such, perceived susceptibility, perceived benefits, perceived self-efficacy, and women's knowledge were factors affecting women's behavior.

Conclusion: It is recommended that health educators use this model to design educational interventions to enhance osteoporosis preventive behaviors among menopausal women.

Keywords: Osteoporosis, Health Belief Model, Preventive behaviors, Menopausal women, Premature mortality, Hip fractures.

*Address correspondence to this author at the Department of Public Health, School of Public Health, Urmia University of Medical Sciences, Urmia, Iran; E-mail: adidarloo@yahoo.com

Cite as: Majidi-Sakani S, Fathi B, Khalkhali H, Amirzadeh-Iranagh J, Didarloo A. Predicting Preventive Behaviors of Osteoporosis Based on Health Belief Model among Menopausal Women: A Descriptive-correlational Study. Open Public Health J, 2026; 19: e18749445442180.
http://dx.doi.org/10.2174/0118749445442180260223075700

Received: September 23, 2025
Revised: November 29, 2025
Accepted: December 12, 2025
Published: March 03, 2026

1. INTRODUCTION

Developments in human societies have led to an increase in resources, facilities, and opportunities for life. With the increase in life expectancy, the number of elderly people has also increased. One of the major challenges that emerges in this regard is the increasing prevalence of osteoporosis in human populations. In fact, the aging of societies has contributed to the increase in osteoporosis [1], to the point that this disease has recently become one of the four major diseases affecting human life [2], and millions of people worldwide suffer from it [3]. In addition to age, gender also influences the risk of osteoporosis. According to international statistics, approximately 35% of women are at risk of osteoporosis and related fractures, while the risk for men is about 20% [4]. Among women, those approaching menopause are at significantly higher risk of developing osteoporosis [5, 6]. Some findings suggest that women are up to eight times more likely to develop osteoporosis than men, indicating the critical role of gender and age as risk factors [7].

Furthermore, osteoporosis prevalence varies across different countries and societies, with developing and underdeveloped nations exhibiting higher rates. Studies conducted in Iran show that the average bone density among Iranians is lower than global standards, and the prevalence of osteoporosis is higher than the global average [8]. Data from national programs for osteoporosis prevention, diagnosis, and treatment in Iran show that among individuals over 50 years old, approximately 70% of women and 50% of men suffer from osteoporosis [5].

Osteoporosis and its associated fractures result in significant morbidity, reduced productivity, premature mortality, and increased healthcare costs. The disease negatively impacts individuals' quality of life, well-being, and physical and mental health. Some studies suggest that only 20% of people with hip fractures survive more than one year after the fracture [9]. With the increasing elderly population, osteoporosis is expected to place increasing pressure on healthcare systems worldwide in the coming years [10].

In spite of the numerous challenges and complications posed by osteoporosis, effective preventive and coping strategies exist [11]. The most effective approach to preventing and controlling this public health issue is for individuals in the community to adopt preventive behaviors. However, adherence to osteoporosis prevention behaviors remains suboptimal [1, 12]. Studies show that although women are most affected by osteoporosis, their participation in preventive behaviors is insufficient [13, 14]. Some studies even report that people who already have osteoporosis fail to modify their preventive behaviors. Findings from a study by Jahle-Kuns *et al*. (2022) indicate that awareness of osteoporosis is less than 40% [14]. Research focused on women also shows that in different countries, women lack sufficient awareness about osteoporosis preventive behaviors, follow inappropriate diets, and have limited awareness about osteoporosis and its prevention [15].

Understanding the factors that influence the adoption of osteoporosis preventive behaviors and modifying these factors can help improve preventive and health-promoting behaviors. In this regard, the use of health education and health promotion theories and models can be useful. One such model is the HBM [2]. The Health Belief Model was chosen for this study because of its particular relevance to osteoporosis prevention. As a symptomless "silent disease," osteoporosis prevention relies heavily on an individual's perception of personal threat. The core constructs of the HBM -perceived susceptibility and severity-address this primary motivation directly. Furthermore, the model's focus on overcoming perceived barriers (*e.g.*, cost, time) to achieve long-term benefits is particularly relevant to the nature of osteoporosis preventive behaviors, making it more appropriate for this study than models that focus primarily on social influences.

The health belief model is one of the most common and cost-effective models used in educational interventions [16]. This model emphasizes the central role of individuals in disease prevention and positions them as key agents in effectively confronting osteoporosis. According to this model, individuals play a fundamental role in managing their health. By actively involving individuals in the prevention process, this approach facilitates the internalization of preventive behaviors, enabling individuals to comprehend the importance, benefits, and potential harms of preventive measures [17].

The HBM consists of several constructs, including perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. Perceived susceptibility refers to an individual's assessment of their risk of developing the disease. Perceived severity reflects the extent to which an individual considers the disease to be serious and acknowledges its consequences. Perceived benefits indicate the advantages an individual associates with adopting preventive behaviors or reducing the risks associated with the disease. At this stage, individuals decide whether to take preventive action. Perceived barriers represent obstacles that hinder individuals from adopting preventive behaviors. A major perceived barrier can be the financial cost of treatment and prevention, which may diminish the perceived benefits. Cues to action serve as triggers that prompt individuals to recognize the need for action or increase their knowledge of potential health risks through reminders and warnings. Self-efficacy reflects an individual's belief in their ability to perform the necessary actions [18, 19].

Numerous studies indicate that the HBM and its constructs can significantly influence osteoporosis preventive behaviors. Research conducted in various countries and cultural contexts, such as studies by Ercan *et al*. [20], Kolac *et al*. [21], and Elgzar *et al*. [22] demonstrates that the HBM and its components can enhance knowledge and health beliefs regarding osteoporosis and reduce the associated risks.

Based on the aforementioned introduction, osteoporosis is a growing health concern among women,

particularly among menopausal women. The HBM can play a vital role in promoting preventive behaviors, thereby reducing the prevalence of osteoporosis and its associated complications. However, few studies in Iran have specifically applied the HBM to investigate osteoporosis preventive behaviors among menopausal women. Therefore, the present study was designed and conducted to address this gap by identifying the factors influencing osteoporosis preventive behaviors among postmenopausal women based on the HBM.

2. MATERIALS AND METHODS

The present study is a descriptive correlational investigation. The study population consists of all menopausal women in the city of Urmia, northwest Iran. The research sample includes menopausal women who meet the eligibility criteria and have family records in the comprehensive health centers of Urmia. The inclusion criteria comprised menopausal women residing in Urmia, having been at least 1 year past their last menstrual period, aged 50 years or older, with the physical and mental capability to complete the questionnaire, and willing to participate in the study. Exclusion criteria included lack of willingness to participate, attendance in formal osteoporosis education sessions within the past six months, and incomplete questionnaire responses.

To determine the sample size, G*Power software was used with an effect size of 0.30, an alpha error probability of 0.05, and a confidence level of 0.99, yielding a sample size of 200. A multi-stage random sampling method was employed. Initially, Urmia was divided into four geographical regions: north, south, east, and west. One comprehensive health center was randomly selected from each region (totaling four centers). A list of eligible postmenopausal women covered by these centers was prepared, and 50 eligible women from each center were randomly selected using simple random sampling. Subsequently, telephone contact was made with the selected participants to explain the study's purpose. The phone numbers of those who agreed to participate were recorded for follow-up. The entire study procedure, including sampling, participant selection, and data collection, was carried out between September and November 2023.

A three-part questionnaire was used for data collection. The first section covered demographic information, the second section included questions on osteoporosis-preventive behaviors (dietary behavior frequency and physical activity), and the third section contained a standardized questionnaire assessing Knowledge and constructs of the HBM.

The first section of the questionnaire collected demographic data, including age, education level, employment status, income level, and number of family members. The second section measured osteoporosis-preventive behaviors, specifically dietary behavior frequency and physical activity. To assess physical activity, the physical activity section of the Walker Lifestyle Questionnaire[3] was employed. This questionnaire was validated and standardized in Iran by Mohammadi Zeidi *et al*. [23], with a reported Cronbach's alpha coefficient of 0.79. The Walker Healthy Lifestyle Physical Activity Questionnaire consists of eight questions regarding physical activity, using a four-point Likert scale (never, sometimes, often, always) to indicate an individual's level of physical activity. Each question is scored from 1 to 4 (1 = never, 2 = sometimes, 3 = often, 4 = always). The Walker questionnaire evaluates health-promoting behaviors across six dimensions, one of which is physical activity. In this study, participants were asked to record their physical activity and exercise status.

Dietary behavior frequency was assessed using a Food Frequency Questionnaire (FFQ) to measure calcium intake. This questionnaire consists of 19 items related to the consumption of calcium-rich foods (including skim milk, low-fat milk, full-fat milk, chocolate milk, strained yogurt, regular yogurt, full-fat yogurt, cream yogurt, buttermilk, cream, ice cream, whey, raw spinach, cooked spinach, and turnips). It was designed and validated by Ghaffari *et al*. in 2011 for an educational intervention on osteoporosis, with a reported Cronbach's alpha coefficient of 0.76 [24].

To obtain dietary information, participants were asked to report their average consumption of each food item over the past two months based on the questionnaire's options (almost never, 1–3 times per month, once per week, 2–4 times per week, 5–6 times per week, once per day, 2–3 times per day, 4–5 times per day, or 6 or more times per day). To score the completed questionnaires, food intake values were first converted to grams. Consequently, using food composition tables, the calcium content per 100 grams for each food item was calculated, and the total calcium intake for each participant was determined.

The third section consisted of a standardized questionnaire assessing knowledge and HBM constructs regarding calcium intake and physical activity, developed, validated, and approved by Beheiraei *et al*. in 2005 [25]. This questionnaire contains 36 questions covering perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and perceived self-efficacy, each with six items related to osteoporosis and its preventive behaviors (calcium intake and physical activity). Responses were rated on a five-point Likert scale from "strongly disagree" (score 1) to "strongly agree" (score 5). Perceived barriers were scored inversely. Thus, each construct had a minimum score of 6 and a maximum score of 30. In the present study, Confirmatory Factor Analysis (CFA) was not conducted because the construct validity of the instrument had already been established in a similar population by Baheiraei *et al*., and only internal consistency reliability was reassessed using Cronbach's alpha. In this psychometric evaluation, Cronbach's alpha coefficients were reported as follows: knowledge (0.70), perceived susceptibility (0.78), perceived severity (0.80), perceived benefits (0.77), perceived barriers (0.70), self-efficacy (0.75), and cues to action (0.72).

Data analysis was performed using SPSS software version 26, employing descriptive and analytical statistics. Results were considered statistically significant at $P < 0.05$.

3. RESULTS

Table 1 presents the demographic characteristics of the participants. The mean age of the sample was 57.1 ± 6.3 years. Regarding age groups, 33% of participants were 50–55 years old (n=66), 31% were 56–60 years old (n=62), 23% were 61–65 years old (n=46), and 13% were older than 65 years old (n=26). In terms of education level, 40.5% (n=81) had below high school education, 25.5% (n=51) held a high school diploma, 24.5% (n=49) had an associate or bachelor's degree, and 9.5% (n=19) had a master's degree or above. Most participants were homemakers (69.5%, n=139), while 5.5% (n=11) were employed and 25% (n=50) reported other employment statuses. Regarding income, 74.5% (n=149) reported a monthly income above 50 million Rials. Household size analysis showed that 10.5% lived alone (n=21), 54.5% lived in two-person households (n=109), 27% lived in three-person households (n=54), and 8% had more than three family members (n=16).

Table 2 presents the descriptive statistics of the study variables. The mean scores (± SD) were as follows: physical activity (10.19 ± 3.17), weekly calcium intake (6831.91 ± 1704.52 mg), perceived susceptibility (14.95 ± 3.35), perceived severity (15.26 ± 3.65), perceived benefits (14.88 ± 3.65), perceived barriers (14.36 ± 3.19), cues to action (15.04 ± 3.37), perceived self-efficacy (16.70 ± 4.14), and knowledge (9.13 ± 3.91). Skewness and kurtosis values indicated that all variables were within acceptable ranges for normality.

Correlation coefficients among the study variables are presented in Table 3. Preventive behaviors showed significant positive correlations with calcium intake (r = 0.548, $p < 0.01$), physical activity (r = 0.477, $p < 0.01$), perceived susceptibility (r = 0.338, $p < 0.01$), perceived severity (r = 0.260, $p < 0.01$), perceived benefits (r = 0.382, $p < 0.01$), cues to action (r = 0.305, $p < 0.01$), perceived self-efficacy (r = 0.384, $p < 0.01$), and knowledge (r = 0.576, $p < 0.01$). A small but significant correlation was also observed with perceived barriers (r = 0.168, $p < 0.05$). In addition, all Health Belief Model constructs generally demonstrated significant correlations with one another.

To examine the predictive power of HBM components, a simultaneous linear regression analysis was conducted (Table 4). The model predicting preventive behaviors was statistically significant, with R = 0.627, R^2 = 0.451, and Adjusted R^2 = 0.425, indicating that the predictor variables explained 42.5% of the variance in preventive behaviors (SE = 8.620; Durbin–Watson = 2.03).

Standardized regression coefficients are presented in Table 5. Among the predictors, perceived susceptibility (β = 0.137, p = 0.031), perceived benefits (β = 0.169, p = 0.006), perceived self-efficacy (β = 0.182, p = 0.005), knowledge (β = 0.329, p = 0.001), age (β = –0.178, p = 0.002), and education (β = 0.184, p = 0.002) significantly predicted preventive behaviors. Perceived severity, perceived barriers, and cues to action did not show significant predictive effects.

Among all variables, knowledge had the strongest predictive value, such that higher levels of knowledge were associated with greater adoption of osteoporosis preventive behaviors.

Overall, six variables-perceived susceptibility, perceived benefits, perceived self-efficacy, knowledge, age, and education-were identified as significant predictors of osteoporosis preventive behaviors.

Table 1. Demographic findings.

	Frequency	Percentage
Age		
50-55 years	66	33
56-60 years	62	31
61-65 years	46	23
Above 65 years	26	13
Education Level		
Below high school	81	40.5
High school diploma	51	25.5
Associate and bachelor's degree	49	24.5
Master's and above	19	9.5
Employment Status		
Homemaker	139	69.5
Employed	11	5.5
Others	50	25
Income Level		
Less than 30 million rials	26	13
30 to 50 million rials	25	12.5
Above 50 million rials	149	74.5

(Table 1) contd.....

	Frequency	Percentage
Number of Family Members		
1	21	10.5
2	109	54.5
3	54	27
More than 3	16	8

Table 2. Descriptive findings of study variables.

Variable	Mean	Standard Deviation	Kurtosis	Skewness	Min.	Max.
Physical Activity	10.19	3.17	0.107	0.342	2	19
Calcium intake(mg in week)	6831.91	1704.52	0.278	-0.224	2946.60	10967.90
Perceived susceptibility	14.95	3.35	0.061	0.075	6	25
Perceived severity	15.26	3.65	0.033	-0.254	6	24
Perceived benefits	14.88	3.65	0.109	-0.062	6	25
Perceived barriers	14.36	3.19	-0.008	-0.351	7	23
Cues to action	15.04	3.37	0.097	-0.009	6	25
Perceived self-efficacy	16.70	4.14	0.048	-0.264	6	27
Knowledge	9.13	3.91	-0.078	-0.401	0	19

Table 3. Correlation coefficients among research variables.

Variable	Calcium Intake	Physical Activity	Perceived Susceptibility	Perceived Severity	Perceived Benefits	Perceived Barriers	Cues to Action	Perceived Self-Efficacy	Knowledge	Age	Education
Preventive behaviors	**0.548	**0.477	**0.338	**0.260	**0.382	*0.168	**0.305	**0.384	**0.576	**-0.293	**0.348
Calcium intake	1	**0.316	**0.197	**0.192	**0.194	**0.398	**0.412	**0.244	**0.343	**-0.215	**0.252
Physical activity		1	**0.277	**0.389	**0.224	**0.226	**0.213	**0.296	**0.480	**-0.267	**0.213
Perceived susceptibility			1	**0.288	**0.153	**0.268	**0.193	**0.238	**0.445	**-0.140	0.024
Perceived severity				1	*0.161	*0.161	**0.235	**0.343	**0.541	0.024	0.118
Perceived benefits					1	**0.267	**0.359	*0.158	**0.396	**-0.161	**0.264
Perceived barriers						1	*0.241	*0.164	**0.343	-0.065	*0.151
Cues to action							1	**0.283	**0.404	-0.102	**0.313
Perceived self-efficacy								1	**0.509	0.007	0.071
Knowledge									1	-0.166	**0.310
Age										1	-0.131

Note: *$p < 0.05$;**$p < 0.01$.

Table 4. Regression model significance.

Model	R	R^2	Adjusted R^2	Standard Error	Durbin-Watson Statistic
Preventive behaviors	0.627	0.451	0.425	8.620	2.030
Calcium intake	0.540	0.292	0.258	3.436	1.871
Physical activity	0.556	0.310	0.277	2.696	1.823

Table 5. Standardized prediction coefficients.

Model	Variable	Unstandardized Coefficients B	Standard Error	Standardized Beta	t-Value	Significance Level	Tolerance	VIF
Preventive behaviors	Perceived susceptibility	0.452	0.209	0.137	2.168	0.031	0.760	1.315
	Perceived severity	-0.178	0.201	-0.57	-0.884	0.378	0.691	1.447
	Perceived benefits	0.527	0.190	0.169	2.769	0.006	0.775	1.291
	Perceived barriers	-0.299	0.209	-0.84	-1.430	0.157	0.834	1.199
	Cues to action	-0.026	0.210	-0.008	-0.124	0.902	0.739	1.352
	Perceived self-efficacy	0.499	0.175	0.182	2.843	0.005	0.708	1.412
	Knowledge	0.957	0.242	0.329	3.955	0.001	0.417	2.399
	Age	-0.402	0.126	-0178	-3.197	0.002	0.935	1.070
	Education	2.057	0.666	0.184	3.089	0.002	0.814	1.228
Calcium intake	Perceived susceptibility	0.076	0.083	0.064	0.912	0.363	0.760	1.315
	Perceived severity	0.19	0.080	0.017	0.238	0.812	0.691	1.447
	Perceived benefits	0.266	0.076	0.243	3.506	0.001	0.775	1.291
	Perceived barriers	-0.094	0.083	-0.075	-1.128	0.261	0.834	1.199
	Cues to action	0.284	0.084	0.241	3.392	0.001	0.739	1.352
	Perceived self-efficacy	0.097	0.070	0.101	1.389	0.167	0.708	1.412
	Knowledge	0.047	0.096	0.046	0.488	0.626	0.417	2.399
	Age	-0.103	0.050	-0129	-2.047	0.042	0.935	1.070
	Education	0.321	0.265	0.082	1.210	0.228	0.814	1.228
Physical activity	Perceived susceptibility	-0.013	0.065	-0.013	-0.194	0.846	0.760	1.315
	Perceived severity	0.177	0.063	0.204	2.817	0.005	0.691	1.447
	Perceived benefits	0.024	0.060	0.028	0.409	0.683	0.775	1.291
	Perceived barriers	0.069	0.066	0.070	1.054	0.293	0.834	1.199
	Cues to action	-0.027	0.066	-0.029	-0.410	0.682	0.739	1.352
	Perceived self-efficacy	0.069	0.055	0.090	1.254	0.211	0.708	1.412
	Knowledge	0.204	0.076	0.252	2.694	0.008	0.417	2.399
	Age	-0.131	0.039	-0.207	-3.327	0.001	0.935	1.070
	Education	0.215	0.208	0.069	1.032	0.304	0.814	1.228

4. DISCUSSION

The present study aimed to predict osteoporosis preventive behaviors among postmenopausal women in Urmia based on the HBM. The findings indicate a significant positive relationship between the HBM components and osteoporosis preventive behaviors among postmenopausal women. According to the regression model results, four components-perceived benefits, perceived susceptibility, perceived severity, and cues to action-remained in the model and were statistically significant. The model predicted 36.8% of the variance in osteoporosis preventive behaviors.

Among the HBM components, the highest predictive coefficients were related to Knowledge, perceived benefits, self-efficacy, and perceived susceptibility, respectively. A review of previous studies demonstrated that some research findings align with and confirm the results of the present study. For example, a study conducted by Solimanian *et al*. found that the HBM model predicted 48% of the variance in physical activity as a preventive behavior for osteoporosis [26]. Similarly, a study by Baghiani Moghadam *et al*. in Yazd revealed that the HBM variables collectively explained 36% of osteoporosis preventive behaviors [27]. Another study by Khani Jeihooni *et al*. showed that the HBM constructs explained approximately 30% of osteoporosis-preventive behaviors [28]. These findings suggest that the HBM can serve as a useful framework for designing interventions and educational programs aimed at encouraging women to adopt health-promoting behaviors.

According to the HBM, one of the key factors influencing the adoption of health-promoting behaviors is individuals' Knowledge and knowledge. The greater the individuals' Knowledge of health problems, the more effectively they can protect themselves. In the present study, Knowledge and knowledge were the most significant factors influencing osteoporosis preventive behaviors. Baghiani Moghadam *et al*. found a positive, significant correlation between women's Knowledge and their preventive behaviors regarding osteoporosis [27]. Similar findings were reported by Liza *et al*. [29] and Vered *et al*. [30], all of whom identified Knowledge as a crucial factor in osteoporosis prevention. These findings are consistent with the results of the present study.

Perceived benefits were another HBM component influencing osteoporosis preventive behaviors. Khani Jeihooni *et al*. reported that perceived benefits significantly improve osteoporosis preventive behaviors among women [28]. Ghaffari *et al*. also found that improvements in the perceived benefits component of the HBM were associated with better osteoporosis prevention behaviors [24]. Similarly, Khorsandi *et al*. demonstrated a

positive correlation between perceived benefits and pregnant women's performance in osteoporosis prevention [31]. Additionally, research by Jang and Ahn indicated that perceived benefits enhance osteoporosis preventive behaviors in women [32]. Findings from Gammage and Klentrou also confirmed that self-efficacy, perceived benefits, and perceived barriers were significant predictors of preventive behaviors [33]. These studies collectively suggest that when individuals recognize the benefits and positive outcomes of health behaviors, they are more likely to adopt such behaviors. Therefore, improving this aspect of the model through appropriate educational methods could increase the likelihood of women adopting osteoporosis preventive behaviors.

Self-efficacy is another critical HBM factor influencing health behavior change, which was also confirmed in the present study. The findings suggest that when individuals believe they can perform recommended health behaviors despite potential obstacles, they are more likely to adopt those behaviors. Wallace found that self-efficacy was a significant predictor of exercise and calcium intake among postmenopausal women [34]. Similarly, Vahedian-Shahroodi *et al*. showed that self-efficacy significantly predicted physical activity [35]. Jang and Ahn also reported that self-efficacy and knowledge enhance osteoporosis preventive behaviors in women [32]. These results align with the findings of the present study, further reinforcing the importance of self-efficacy in adopting health-promoting behaviors.

Perceived susceptibility is another influential factor in adopting preventive behaviors. By strengthening individuals' perceptions of the seriousness and severity of a disease and its complications, perceived susceptibility plays a crucial role in promoting preventive actions. When individuals perceive themselves to be at risk, they are more likely to seek information and take preventive measures [36, 37]. The findings of the present study confirm that perceived susceptibility is significantly associated with osteoporosis preventive behaviors. Malak *et al*. found that improving perceived susceptibility among Jordanian women led to better osteoporosis prevention behaviors [38]. Ghaffari *et al*. similarly reported that improvements in perceived susceptibility were linked to better osteoporosis-preventive behaviors [24]. Jang and Ahn demonstrated that perceived susceptibility can enhance osteoporosis preventive behaviors in women [32]. Additionally, Gammage and Klentrou identified perceived susceptibility as a significant predictor of preventive behaviors [33]. These studies support the present study's findings, further confirming the role of perceived susceptibility in the adoption of health behaviors.

Overall, the HBM suggests that by enhancing perceived severity, perceived susceptibility, perceived benefits, and self-efficacy, and by reducing perceived barriers, women can gain greater knowledge about osteoporosis. With improved knowledge, individuals actively seek beneficial information to help them manage and reduce the complications of the disease.

5. LIMITATION

Despite providing significant insights into the relationship between osteoporosis preventive behaviors and the Health Belief Model, this study has several methodological constraints. Firstly, its correlational nature means that while relationships can be identified, causal inferences cannot be made. Secondly, the generalizability of the results is limited to populations with characteristics similar to those of the sample. Lastly, the use of self-report measures for behaviors raises the possibility of response bias, which may have affected the data's accuracy.

CONCLUSION

Since preventive behaviors are fundamental to effective disease management, understanding the influential factors is crucial. In this study, the HBM components, along with Knowledge, explained 36.8% of the variance in osteoporosis preventive behaviors. Among these, knowledge, perceived benefits, perceived susceptibility, and self-efficacy were the primary determinants. Increasing knowledge, self-efficacy, perceived susceptibility, and perceived benefits encourages women to adopt more preventive behaviors, learn coping strategies, and become aware of the potential complications associated with osteoporosis. Therefore, understanding individuals' preventive behaviors toward the disease can significantly influence their coping strategies. Using the HBM, it is possible to enhance women's knowledge and preventive behaviors, enabling more effective management of osteoporosis as a growing public health concern.

AUTHORS' CONTRIBUTIONS

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to its submission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

HBM	=	Health Belief Model
FFQ	=	Food Frequency Questionnaire
CFA	=	Confirmatory Factor Analysis

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This paper, extracted from the thesis of a master of science, was confirmed and approved by the ethics committee affiliated with Urmia University of Medical Sciences, Iran. (proposal number: 3078, ethics code: ir.umsu.rec.1401.158).

HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

All data generated or analyzed during this study are included in this published article.

FUNDING

The research was funded by the Ethics Committee affiliated with Urmia University of Medical Sciences, Iran, which provided essential financial support for the study.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The authors sincerely appreciate all the participants who cooperated with thenthroughout this study. The authors also extend gratitude to their colleagues who assisted in conducting the sessions and completing the questionnaires.

REFERENCES

[1] Föger-Samwald U, Dovjak P, Azizi-Semrad U, Kerschan-Schindl K, Pietschmann P. Osteoporosis: Pathophysiology and therapeutic options. EXCLI J 2020; 19: 1017-37. http://dx.doi.org/10.17179/excli2020-2591 PMID: 32788914

[2] Suciana F, Rusmingsih E, Eds. Effect of health education using audiovisual on knowledge of osteoporosis prevention in elderly. J Phys Conf Ser 2019; 1179: 012141. http://dx.doi.org/10.1088/1742-6596/1179/1/012141

[3] Dennison E, Clynes M. Fast Facts: Postmenopausal Osteoporosis. Garden, Karimabad: Women's and Children's Health 2021. http://dx.doi.org/10.1159/isbn.978-3-318-06972-3

[4] Wright NC, Looker AC, Saag KG, *et al*. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. J Bone Miner Res 2014; 29(11): 2520-6. http://dx.doi.org/10.1002/jbmr.2269 PMID: 24771492

[5] Hemmati F, Sarokhani D, Sayehmiri K, Motadayen M. Prevalence of osteoporosis in postmenopausal women in Iran: A systematic review and meta-analysis. Majallah-i Zanan, Mamai va Nazai-i Iran 2018; 21(3): 90-102. http://dx.doi.org/10.22038/ijogi.2018.11068

[6] Panahi R, Dehghankar L, Hosseini N, Hasania E. Factors related to adoption of osteoporosis preventive behaviors among females' high school students; a case study of Qazvin city. J Educat Commu Health 2020; 7(2): 105-12. http://dx.doi.org/10.29252/jech.7.2.105

[7] Schurman L, Bagur A, Claus-Hermberg H, *et al*. [Guidelines for the diagnosis, prevention and treatment of osteoporosis, 2012]. Medicina 2013; 73(1): 55-74. PMID: 23335710

[8] Mousaviasl S, Alijani Renani H, Gheibizadeh M, Saki Malehi A. The effect of education based on the health belief model on osteoporosis prevention behaviors in female high school students. Jundishapur J Chron Dis Care 2016; 5(4): 34852. http://dx.doi.org/10.17795/jjcdc-34852

[9] Al Seraty WHH, Ali WGM. The impacts of health belief model based intervention for osteoporosis prevention among female students in Al Dawadmi Applied Medical Science, Shaqraa University, Saudi Arabia. J Biol Agric Healthc 2014; 4(7): 125-31. http://dx.doi.org/10.12691/ajnr-4-3-7

[10] Chandran M, Brind'Amour K, Fujiwara S, *et al*. Prevalence of osteoporosis and incidence of related fractures in developed economies in the Asia Pacific region: A systematic review. Osteoporos Int 2023; 34(6): 1037-53. http://dx.doi.org/10.1007/s00198-022-06657-8 PMID: 36735053

[11] Rondanelli M, Faliva MA, Barrile GC, *et al*. Nutrition, physical activity, and dietary supplementation to prevent bone mineral density loss: A food pyramid. Nutrients 2021; 14(1): 74. http://dx.doi.org/10.3390/nu14010074 PMID: 35010952

[12] Rodrigues I. Bridging the gap between physical activity evidence and practice for older adults with osteoporosis and frailty [master's thesis]. Waterloo (ON): University of Waterloo; 2021. Available from: http://hdl.handle.net/10012/17745

[13] Barańska A, Drop B, Religioni U, *et al*. Assessment of awareness and knowledge about osteoporosis in relation to health prevention among patients treated in osteoporosis clinics. J Clin Med 2023; 12(19): 6157. http://dx.doi.org/10.3390/jcm12196157 PMID: 37834801

[14] Jehle-Kunz S, Häuselmann H, Keschawarzi M, Lamy O, Luzuy F, Marcoli N. Risk factors, manifestation, and awareness of osteoporosis among patients of various specialists in Switzerland: Results of a national survey. Healthcare 2022; 10(2): 295. http://dx.doi.org/10.3390/healthcare10020295 PMID: 35206909

[15] Terrio K, Auld GW. Osteoporosis knowledge, calcium intake, and weight-bearing physical activity in three age groups of women. J Community Health 2002; 27(5): 307-20. http://dx.doi.org/10.1023/A:1019840709367 PMID: 12238730

[16] Baldwin AS, Rochefort C, Geary B. Understanding health behaviour change: guiding theoretical models. In: Understanding health behaviour change: guiding theoretical models. United Kingdom: Routledge 2022. Available from: 10.4324/9780367198459-REPRW69-1

[17] Rezapour B, Sharafkhani N. Explaining the performance of nurses in order to prevent nosocomial infections in urmia city hospitals: Application of the health belief model. Open Public Health J 2024; 17(1): 18749445256801. http://dx.doi.org/10.2174/0118749445256801231210163327

[18] Daniati N, Widjaja G, Olalla Gracìa M, Chaudhary P, Nader Shalaby M, Chupradit S. The health belief model's application in the development of health behaviors. Health Educat Health Promot 2022; 9(5): 521-7.

[19] Washburn L. Understanding the health belief model. Knoxville (TN): University of Tennessee 2020.

[20] Ercan S, İnce Parpucu T, Başkurt Z, Başkurt F. Health belief model - Male osteoporosis: A cross-sectional study. Cent Eur J Public Health 2023; 31(3): 184-90. http://dx.doi.org/10.21101/cejph.a7789 PMID: 37934477

[21] Kolac N, Yıldız A. The effect of health belief model-based short interviews in women in the postmenopausal period on the prevention of osteoporosis: A randomized controlled trial. Int J Nurs Pract 2023; 29(1): 13121. http://dx.doi.org/10.1111/ijn.13121 PMID: 36524466

[22] Elgzar WT, Nahari MH, Sayed SH, Ibrahim HA. Determinant of osteoporosis preventive behaviors among perimenopausal women: A cross-sectional study to explore the role of knowledge and health beliefs. Nutrients 2023; 15(13): 3052. http://dx.doi.org/10.3390/nu15133052 PMID: 37447378

[23] Mohammadi Zeidi I, Pakpour Hajiagha A, Mohammadi Zeidi B. Reliability and validity of Persian version of the health-promoting lifestyle profile. J Mazandaran Univ Med Sci 2011; 20(1): 102-13.

[24] Ghaffari M, Tavassoli E, Esmaillzadeh A, Hasanzadeh A. The effect of education based on health belief model on the improvement of osteoporosis preventive nutritional behaviors of second grade middle school girls in Isfahan. J Health Syst Res 2011; 6 (4).

[25] Baheiraei A, Ritchie JE, Eisman JA, Nguyen TV. Psychometric properties of the Persian version of the osteoporosis knowledge

and health belief questionnaires. Maturitas 2005; 50(2): 134-9. http://dx.doi.org/10.1016/j.maturitas.2004.05.001 PMID: 15653011

[26] Solimanian A, Niknami S, Hajizadeh I, Hashemian M, Soleymanian A, Gheitasi M. The Effectiveness of a theory-based educational intervention for increasing exercise to prevent osteoporosis in pre-menopausal women. Payesh 2015; 14(6): 711-20.

[27] BaghianiMoghadam MH, Khabiri F, Morovati Sharifabad MA, Dehghan A, Falahzadeh H. Determination of social variables affected the health belief model in adopting preventive behaviors of osteoporosis. TB 2016; 15(2): 45-57.

[28] Khani Jeihooni A, Hidarnia A, Kaveh MH, Hajizadeh E, Gholami T. Survey of osteoporosis preventive behaviors among women in fasa: The application of the health belief model and social cognitive theory. Iran South Med J 2016; 19(1): 48-62. http://dx.doi.org/10.7508/ismj.1395.01.005 PMID: 27095985

[29] Liza H, Darat HN, Pande KC. Knowledge about osteoporosis in Bruneian women attending an orthopaedic clinic. Malays Orthop J 2009; 3(1): 28-31. http://dx.doi.org/10.5704/MOJ.0905.004

[30] Vered I, Werner P, Shemy G, Stone O. Nurses' knowledge and perceptions about osteoporosis: A questionnaire survey. Int J Nurs Stud 2008; 45(6): 847-54. http://dx.doi.org/10.1016/j.ijnurstu.2007.01.011 PMID: 17362958

[31] Khorsandi M, Shamsi M, Jahani F. The survey of practice about prevention of osteoporosis based on health belief model in pregnant women in Arak city. Majallah-i Ilmi-i Danishgah-i Ulum-i Pizishki-i Rafsanjan 2013; 12(1): 35-46.

[32] Jang HJ, Ahn S. An equation model development and test based on health belief model regarding osteoporosis prevention behaviors among postmenopausal women. Korean J Adult Nurs 2015; 27(6): 624-33. http://dx.doi.org/10.7475/kjan.2015.27.6.624

[33] Gammage KL, Klentrou P. Predicting osteoporosis prevention behaviors: Health beliefs and knowledge. Am J Health Behav 2011; 35(3): 371-82. http://dx.doi.org/10.5993/AJHB.35.3.10 PMID: 21683025

[34] Wallace LS. Osteoporosis prevention in college women: Application of the expanded health belief model. Am J Health Behav 2002; 26(3): 163-72. http://dx.doi.org/10.5993/AJHB.26.3.1 PMID: 12018752

[35] Vahedian-Shahroodi M, Elaheh L-m, Esmaily H, Tehrani H, Hamidreza M. Prediction of osteoporosis preventive behaviors using the health belief model. Iran J Health Educ Health Promot 2014; 2(3): 199-207.

[36] Bastami F, Sharafkhani N, Bakhteyar K, Heydari M, Hassanzadeh A, Mostafavi F. Effect of educational intervention based on health belief model on psychological factors of AIDS preventive behaviors in addicts. J Res Health 2017; 7(6): 1120-9.

[37] Abbasi M, Ayadi N, Shafiee H. Role of social well-being and academic vitality in predicting the academic motivation in nursing students. Educ Strategy Med Sci 2016; 8(6): 49-54.

[38] Malak MZ, Toama ZT. The effect of osteoporosis health education program based on health belief model on knowledge and health beliefs towards osteoporosis among Jordanian female teachers. Eur Sci J 2015; 11(3)https://eujournal.org/index.php/esj/article/view/5107