Original Article

Application of the health belief model and social cognitive theory for osteoporosis preventive nutritional behaviors in a sample of Iranian women

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Abstract

Background: Osteoporosis is the most common metabolic bone disease. The purpose of this study is to investigate the health belief model (HBM) and social cognitive theory (SCT) for osteoporosis preventive nutritional behaviors in women.

Materials and Methods: In this quasi-experimental study, 120 patients who were women and registered under the health centers in Fasa City, Fars Province, Iran were selected. A questionnaire consisting of HBM constructs and the constructs of self-regulation and social support from SCT was used to measure nutrition performance. Bone mineral density was recorded at the lumbar spine and femur. The intervention for the experimental group included 10 educational sessions of 55–60 min of speech, group discussion, questions and answers, as well as posters and educational pamphlets, film screenings, and PowerPoint displays. Data were analyzed using SPSS 19 via Chi-square test, independent *t*-test, and repeated measures analysis of variance (ANOVA) at a significance level of 0.05.

Results: After intervention, the experimental group showed a significant increase in the HBM constructs, self-regulation, social support, and nutrition performance, compared to the control group. Six months after the intervention, the value of lumbar spine bone mineral density (BMD) T-score increased to 0.127 in the experimental group, while it reduced to −0.043 in the control group. The value of the hip BMD T-score increased to 0.125 in the intervention group, but it decreased to −0.028 in the control group.

Conclusions: This study showed the effectiveness of HBM and constructs of self-regulation and social support on adoption of nutrition behaviors and increase in the bone density to prevent osteoporosis.

Key words: Health belief model, Iran, nutrition, nutritional status, self-regulation, social cognitive theory, social support

Introduction

Osteoporosis is a disease characterized by decreased bone density and loss of bone microstructure, which can lead to an increased risk of fracture.[1] Today, osteoporosis is a major health problem in communities and is known as the silent disease of the century.[2,3]

The period between 2000 and 2010 was entitled by the World Health Organization (WHO) as Bone and Joint Decade (BJD), which concerns bone and joint diseases such as osteoporosis.[4,5]

Women are eight times more at risk of osteoporosis than men;[6] thus, about 200 million women suffer from the disease worldwide.[7] Bone mass in women of all age groups is significantly less than that of men of the same age and race.[8] In both sexes, peak bone mass is achieved by age 30 and then the bone mass gradually decreases with increase in age. Therefore, the purpose of prevention program is to maintain bone mass in the 30–50 age group.[9] People of this age group have more responsibilities in life and pay less attention to their health. They play a key role in managing their families' health; therefore, their mortality, disabilities, and behaviors affect different aspects of health and behavior of their families.[10]

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The national program for prevention, diagnosis, and treatment of osteoporosis in Iran reported that 70% of women and 50% of men over 50 suffer from osteoporosis and osteopenia.[11]

In a study investigating prevalence of osteopenia and osteoporosis in Fars Province based on T-score for spinal cord segments, the T-score values were 42% and 24% in the back segments, 46% and 10% in femoral neck, and 48% and 6% in the entire femur, respectively.[12] A study carried out in Fasa demonstrated that 34.1% of the women had osteoporosis.[13]

The findings of different studies suggest that exercise and adequate intake of calcium and vitamin D have a significant effect on reducing the rate of bone density loss and improving bone mineral density (BMD).[14,15]

Osteoporosis is preventable and curable, and an important point in preventing the disease is to modify thinking, lifestyle, and daily habits in such a way that improves the quality of life and efficiency of individuals.[16] Thus, teaching preventive behaviors such as correct nutrition as a simple and efficient method can help us prevent the disease and promote and maintain our health. One of the most important goals of WHO is to increase the number of women trained in the area of osteoporosis.[17]

Therefore, in order to investigate the factors affecting the adoption of osteoporosis preventive behaviors among women, it is essential to use models that identify the factors affecting behavior. Researchers have used such models to change their subjects' behavior. Two models effective in health education and promotion are the health belief model (HBM) and social cognitive theory. A common cause for resisting against preventive behaviors of osteoporosis is the false belief that the disease is not serious. According to HBM, people change their behavior when they understand that the disease is serious; otherwise they might not turn to healthy behaviors.[18] The structures of the HBM model include perceived severity, perceived susceptibility, perceived benefits, perceived barriers, modifying variables, cues to action, and self-efficacy.

In this study, perceived susceptibility was used to evaluate women's perception about the extent to which they are at risk of osteoporosis. Also, their perceived severity of osteoporosis complications was measured. The sum of these two factors is the women's perceived threat of the disease. The perceived benefits and barriers that refer to the individual's analysis about the benefits of adopting preventive behaviors of osteoporosis, such as diet, and about the potential barriers to carry out preventive behaviors of osteoporosis were investigated. These, alongside women's perceived ability to carry out preventive behaviors, their cues to action (the incentives that affect women within and outside the family, such as friends, doctors, healthcare providers, media, and educational resources), their fear of osteoporosis complications and their sense of inner peace as a result of seeking preventive behaviors are the factors affecting women's decision to comply with the preventive behaviors of osteoporosis.

This model is mostly used to collect data on individual behavior variables. However, there are other factors that can lead to behavior.[19,20] Behavior modification and prevention programs are successful if they are flexible and tailored to individual features and characteristics. Social cognitive theory is one of the theories used in research on osteoporosis.[21] Social support and self-regulation structures of social cognitive theory were evaluated in this study to compensate for the deficiencies of HBM. Social support has been defined as assistance available from other people for an individual. It also refers to one's belief that one is respected and loved by others, is a valuable individual with dignity, and belongs to a social network of relationships and mutual obligations.[22] Social support is evaluated through collecting data from various other sources, such as spouse, family, and friends.[23]

Despite the fact that osteoporosis preventive behaviors play an important role in human health and the individual is motivated to do this kind of behavior, one has a difficult job maintaining them and needs planning and informed choice.[23] The self-regulation structure reflects the cognitive, emotional, and behavioral strategies for changing behaviors based on goals valuable to the individual. Evidence suggests that the adoption of self-regulatory skills increases the probability of adopting recommended behaviors.[24]

Self-regulation includes behavior modification based on self-observations. Successful self-regulation is a consistent process of determining purposes, following them, achieving them, and determining new purposes.[23] Considering what has been said above, this study aims to measure HBM constructs and constructs of social support and self-regulation taken from social cognitive theory regarding eating behaviors in the prevention of osteoporosis among women. Conceptual framework of this study is presented in Figure 1.

Materials and Methods

The study is a quasi-experimental, prospective interventional research. The population of this study includes 120 women of age 30–50 years, covered by health centers of Fasa.

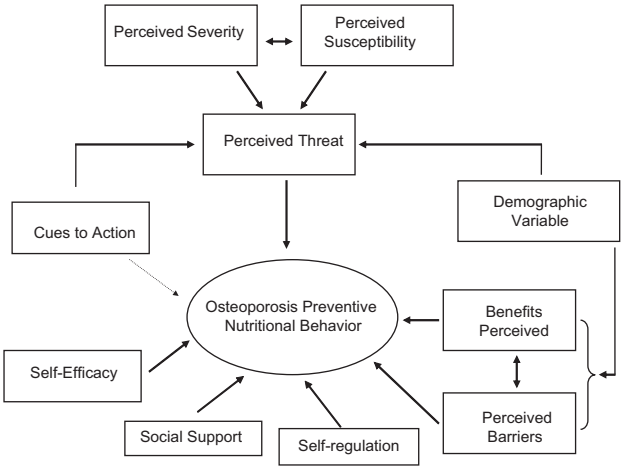

Figure 1: Conceptual framework of this study

Among the six urban health centers of Fasa City, Fars Province, Iran, two centers were randomly selected (a center for the experimental group and a center for the control group). Simple random sampling was used at the health centers, based on the numbers of health records of the mothers covered by the centers. The subjects were then invited to a meeting in a health center. They were explained about the study and the related purposes and their informed consents were obtained. Women with disability, diseases, and problems that prevented them from participating in the study were excluded.

After selecting the experimental and control groups, the pre-test questionnaire was administered to the two groups. Next, to measure bone density, the subjects were sent to Fasa bone densitometry center. After testing, the results were recorded. Bone density was measured by Hologic machine using dual energy X-ray absorptiometry (DEXA) method in[25] L1–L4 bones. The densitometry data including bone density in lumbar spine and femoral bone was collected based on WHO's T-score values. Flow chart of the study participants is given in Figure 2.

The intervention for the experimental group included 10 educational sessions of 55–60 min of speech, group discussion, questions and answers, as well as posters and educational pamphlets, film screenings, and PowerPoint displays. The details of the training sessions are as follows:

First session: Introduction to osteoporosis and its signs, complications, and diagnosis was given.

Second session: A 55-year-old woman who was diagnosed with osteoporosis and had a fracture was invited to show as a model and talk to the subjects about osteoporosis, risk factors, symptoms, complications, and diagnosis with the help of an expert (physician).

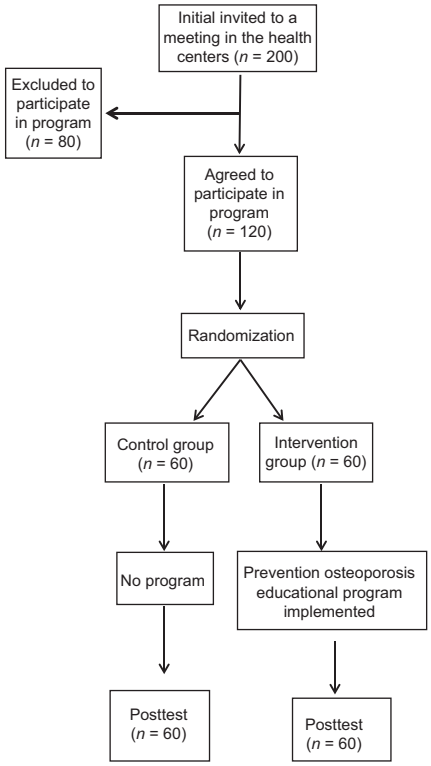

Figure 2: Flow chart of the study participants

Third and fourth sessions: The role of nutrition in preventing osteoporosis, benefits and barriers of diet, following dietary recommendations, self-regulation, planning and goal setting, self-efficacy in observing proper diet, and their activities were recorded in the specified form.

Fifth session: The session was held with the presence of at least one of the family members and the role of the family member in making, facilitating, and providing a suitable food program and in BMD testing was mentioned.

Sixth session: Participants were divided into groups of five to six people each and the role of peers and friends in adopting osteoporosis-preventive behaviors was explained. The participants worked together to make a list of calcium-containing foods.

Seventh session: Previous sessions were reviewed and the subjects were given pamphlets.

Immediately after the intervention, both groups completed the questionnaire. To preserve and enhance the activity of the experimental group, weekly educational text messages about osteoporosis were sent to them and they attended monthly training sessions so that the researchers could follow-up their activities. Six months later, the questionnaire was completed by both groups (experimental and control), and the subjects underwent BMD tests and the results were recorded.

The questionnaire used in this study was developed based on the HBM and the constructs of self-regulation and social protection from social cognitive theory. The questionnaire includes the following parts:

The first part includes demographic questions, including age, body mass index (BMI), education level, marital status, occupation, times of delivery, breastfeeding, smoking, history of osteoporosis, history of osteoporosis in the family, history of a special disease, and history of bone densitometry.

The second section includes questions on structures of the HBM and social support and self-regulation. The questions include: 23 questions on knowledge; 4 questions on perceived susceptibility (the women's opinion about chances of getting osteoporosis); 6 questions on perceived severity (about the complications due to osteoporosis); 8 questions on perceived benefits (about the benefits of preventive behaviors of osteoporosis, such as physical activity and calcium intake); 7 questions on perceived barriers (including the barriers to physical activity and consumption of calcium-rich foods); 4 questions on motivation (of the HBM) (such as motivation to receive health advice and conduct periodic examinations for prevention of osteoporosis); 4 questions on self-efficacy (including the ability to do exercises and observe proper diet); 1 question on external cues to action (resources including family and friends, doctors and health workers, mass media, books and magazines, internet, and other patients with osteoporosis that encourage the subjects toward preventive behaviors of osteoporosis); 3 questions on internal cues to action (including the fear of suffering from complications of osteoporosis and a sense of inner peace following preventive behaviors); 16 questions on self-regulation (including setting goals and planning preventive behaviors of osteoporosis); and 9 questions on social support (support from the family and friends to follow proper diet and carry out physical activity, bone density tests, etc.). Except for the questions on social support structures, all other questions are based on the standard 5-point Likert scale ranging from strongly disagree to strongly agree (scores of 1–5). Scores of questions on external cues to action are calculated as the cumulative frequency. Questions on social support are based on a four-point scale (very much, moderately, a little, and not at all) (scores of 1–4).

The third section consists of questions on nutritional performance. Performance questions consist of 10 questions about the type and amount of food consumed during the past week (scores from 0 to 14). The subjects' performance was assessed via self-report method.

To evaluate the validity of the questionnaire items, item effect size higher than 0.15 and content validity ratio above 0.79 were considered and based on the exploratory factor analysis, they were classified into nine factors. In order to determine face validity, a list of the items was checked by 30 women of age 30–50 years with demographic, economic, social, and other characteristics similar to those of the targeted population. In order to determine the content validity, 12 specialists and professionals (outside the team) in the field of health education and health promotion (n = 10), orthopedic (n = 1), and biostatistics (n = 1) were consulted. Then, based on the Lawshe's table, items with higher center validity ratio (CVR) value (more than 0.56 for 12 people) were considered acceptable and were retained for subsequent analysis. The calculated values in this study for the majority of items were higher than 0.70.

The overall reliability of the instrument based on the Cronbach's alpha was 0.87. Cronbach's alpha was 0.86 for knowledge, 0.71 for perceived susceptibility, 0.82 for perceived severity, 0.79 for perceived benefits, 0.82 for perceived barriers, 0.77 for motivation, 0.79 for self-efficacy, 0.77 for cues to action, 0.73 for self-regulation, and 0.79 for social support. Since the alpha values calculated for each of the structures studied in this research were higher than 0.7, the reliability level of the instrument was considered acceptable.

This study was approved by the ethics committee of Tarbiat Modares University. The aims and importance of the study were explained to the subjects and their written consent was obtained. The participants were assured that the information would remain confidential. Data analysis was carried out through SPSS 19 using Chi-square test, independent t-test, Mann–Whitney–Wilcoxon test, and repeated measurement analysis of variance (ANOVA) at a significance level of 0.05.

Results

Based on the results, the mean (SD) age of women who participated in the study was 41.75 ± (5.4) years for the experimental group and 41.77 (5.43) years for the control group. The mean (SD) BMI was 22.44 (3.30) for the experimental group and 22.27 (3.05) for the control group. The average number of deliveries for the experimental group was 2.57 (1.47) and for the control group was 2.50 (1.19). The above parameters did not show a significant difference between the two groups based on the independent t-test. Table 1 shows the demographic data, including education level, marital status, occupation, breastfeeding, smoking, history of osteoporosis, history of

Table 1: Frequency distribution of the subjects in terms of demographic information

Variable	Control group		Experimental group		*P* value
	Percentage	Frequency	Percentage	Frequency	
Occupation					
Employed	16.7	10	20	12	0.673
Housewife	83.3	50	80	48	
Education					
Illiterate	3.3	2	3.3	2	0.771
Primary	15	9	23.3	14	
Secondary	36.7	22	28.3	17	
High school	28.3	17	30	18	
College	16.7	10	15	9	
Marital status					
Single	10	6	13.3	8	0.880
Married	80	48	76.7	46	
Divorced	3.3	2	5	3	
Widowed	6.7	4	5	3	
Breastfeeding					
No	90	54	88.3	53	0.769
Yes	10	6	11.7	7	
Smoking					
No	100	60	98.3	59	0.315
Yes	0	0	1.7	1	
History of osteoporosis in the family					
No	86.7	52	91.7	55	0.378
Yes	13.3	8	8.3	5	
History of a special disease					
No	88.3	53	90	54	0.769
Yes	11.7	7	10	6	
History of bone densitometry					
No	88.3	53	91.7	55	0.543
Yes	11.7	7	8.3	5	

osteoporosis in the family, history of special diseases, and records of bone densitometry. Based on the Chi-square test, no significant difference was found between the two groups in this regard.

The results showed that before intervention, there was no significant difference between the two groups in terms of knowledge, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, motivation, self-efficacy, internal cues to action, self-regulation, social support, and nutrition performance. However, immediately after the intervention and 6 months later, the experimental group showed a significant increase compared to the control group in all of the foregoing scales except for perceived barriers. In structural barriers, the experimental group showed a significant decrease compared to the control group [Tables 2 and 3].

Comparison of BMD T-score in the lumbar spine and femur in women before and 6 months after intervention showed that before intervention, there was no significant difference between the experimental group and the control group in this regard. Six months after the intervention, the value of lumbar spine BMD T-score increased to 0.127 in the experimental group, while it reduced to −0.043 in the control group. The value of the hip BMD T-score increased to 0.125 in the intervention group, while it decreased to −0.028 in the control group [Table 4].

Table 5 shows the distribution of external cues to action for osteoporosis, before, immediately after, and 6 months after the intervention. The number of cues used, especially family and friends, immediately after the intervention and 6 months after the intervention increased as compared to before intervention.

Table 2: Comparison between the mean scores of participants' knowledge, HBM components

Variable	Experimental (*N*=60)			Control (*N*=60)			*P* value[2]
	Mean	SD	*P* value[1]	Mean	SD	*P* value[1]	
Knowledge							
Pre-intervention	7.65	2.36		8.07	2.58		0.358
Post-intervention	10.82	17.3	<0.001	8.67	2.50	<0.001	<0.001
Six months later	18.33	2.25	<0.001	7.17	2.59	<0.001	<0.001
Perceived susceptibility							
Pre-intervention	22.7	2.31		7.13	1.84		0.827
Post-intervention	10.50	2.65	<0.001	7.65	1.71	<0.001	<0.001
Six months later	15.82	2.28	<0.001	8	1.80	<0.001	<0.001
Perceived severity							
Pre-intervention	9.73	2.34		9.22	1.99		0.196
Post-intervention	13.23	3.54	<0.001	9.83	1.95	<0.001	<0.001
Six months later	19.92	4.31	<0.001	10.35	2.05	<0.001	<0.001
Perceived benefit							
Pre-intervention	13.53	3.76		13.30	2.98		0.707
Post-intervention	18.65	4.72	<0.001	14.17	2.85	<0.001	<0.001
Six months later	28.60	5.01	<0.001	14.98	3.01	<0.001	<0.001
Perceived barrier							
Pre-intervention	26.50	4.01		25.70	4.28		0.293
Post-intervention	20.82	4.02	<0.001	24.60	4.40	<0.001	<0.001
Six months later	13.55	3.95	<0.001	23.80	4.46	<0.001	<0.001
Motivation							
Pre-intervention	8.07	2.83		8.33	2.25		0.569
Post-intervention	10.93	2.99	<0.001	9.05	2.11	<0.001	<0.001
Six months later	16.30	2.46	<0.001	9.75	2.46	<0.001	<0.001
Self-efficacy							
Pre-intervention	7.68	1.90		7.67	2.18		0.965
Post-intervention	10.93	2.37	<0.001	8.80	2.19	<0.001	<0.001
Six months later	15.87	2.60	<0.001	9.40	2.47	<0.001	<0.001
External cues to action							
Pre-intervention	5.57	1.91		5.93	1.65		0.262
Post-intervention	7.15	1.91	<0.001	6.35	1.70	<0.001	<0.001
Six months later	12.25	1.46	<0.001	7.53	1.56	<0.001	<0.001

HBM: Health belief model, SD: Standard deviation

Discussion

This study showed that a key prevention method for osteoporosis is that of community-based intervention strategies using behavior change models such as the HBM and social cognitive theory. In this study, the participants' mean score of knowledge of osteoporosis before intervention was below average, which is consistent with the results of previous studies.[24,26-29] Results show that there were significant differences between the mean scores of knowledge before, immediately after, and 6 months after the intervention in the experimental group. The knowledge scores in this group increased significantly after intervention. This is consistent with the results of Ghaffari *et al*.,[30] Winzenberg *et al*.,[31] and Wafaa Hassan *et al*.[32] Although the mean score of knowledge significantly increased in the control group as well, there was a significant difference between the mean scores of knowledge for the two groups. The increase in knowledge and other constructs can be due to the participants' access to information as well as their participation in the training course held by the Fasa health center about diseases and health issues for women and health volunteers. The increase in knowledge score in the intervention group was significant and deserves consideration.

Table 3: Comparison of mean scores of self-regulation, social support, and nutrition performance regarding osteoporosis prevention

Variable	Experimental			Control			*P* value[2]
	Mean	SD	*P* value[1]	Mean	SD	*P* value[1]	
Self-regulation							
Pre-intervention	93.25	7.76		24.43	5.82		0.233
Post-intervention	38.37	7.92	<0.001	26.27	5.72	<0.001	<0.001
Six months later	63.12	8	<0.001	27.82	6.04	<0.001	<0.001
Social support							
Pre-intervention	13.98	3.65		13.62	3.70		0.586
Post-intervention	21	4	<0.001	14.33	3.79	<0.001	<0.001
Six months later	30.22	4.35	<0.001	14.78	4.08	<0.001	<0.001
Nutrition performance							
Pre-intervention	4.80	1.87		5.05	2		0.481
Post-intervention	7.75	1.87	<0.001	5.40	1.79	<0.001	<0.001
Six months later	11.78	1.49	<0.001	5.55	1.67	<0.001	<0.001

[1]Comparison with first evaluation (RM ANOVA - Bonferroni *post hoc*). [2]Comparison between experimental and control groups (*t*-test for evaluation and Mann-Whitney for difference). SD: Standard deviation

Table 4: The mean T-score of lumbar spine and femur in women

	Experimental			Control			*P* value[2]
	Mean	SD	Median	Mean	SD	Median	
Spine							
Pre-intervention	0.118	1.254	0.20	0.108	1.220	0.20	0.973
Six months later	0.245	1.248	0.35	0.065	1.228	0.10	0.413
Hip							
Pre-intervention	−0.240	1.108	−0.20	−0.222	1.114	−0.20	0.935
Six months later	−0.115	1.087	−0.15	−0.250	1.107	−0.35	0.420

[2]Comparison between experimental and control groups (Mann-Whitney test). SD: Standard deviation

Table 5: Distribution of external cues to action regarding osteoporosis prevention

	Before intervention				Immediately after intervention				Six months after the intervention			
	Experimental		Control		Experimental		Control		Experimental		Control	
	Number	Percent	Number	Percent	Number	Percent	Percent	Percent	Number	Percent	Number	Percent
Physicians and health personnel	30	27.5	28	27.2	35	22	30	26.8	50	22.4	30	25.2
Families and friends	20	18.3	16	15.5	45	38.3	18	16.1	55	24.7	20	16.8
Books	15	13.8	13	12.6	20	12.6	15	13.4	28	12.6	16	13.4
Journals and publications	12	11	15	14.6	14	8.8	17	15.2	20	9	16	13.4
Radio and television	25	22.9	20	19.4	27	17	18	16.1	35	15.7	21	17.6
Patients	4	3.7	7	6.8	8	5	8	7.1	20	9	9	7.6
Internet	3	2.8	4	3.9	10	6.3	6	5.4	15	6.7	7	5.9
Total	109	100	103	100	159	100	112	100	223	100	119	100
P value	0.886				0.250				0.621			

In the present study, there was a significant difference between perceived susceptibility of the two groups 6 months after the intervention. This can be attributed to the effects of the intervention on the subjects' perceived susceptibility. In other words, after intervention, most women believed they were at risk for osteoporosis. This is consistent with the results of Tussing *et al*.[33] and Dohney *et al*.[34]

Before intervention, there was no significant difference between the two groups in terms of perceived severity. However, after intervention, the perceived severity of the experimental group significantly increased compared to the control group. This is consistent with the results of Khorsandi *et al*.[10] and Hazavehei *et al*. However, the perceived severity in the studies of Tussing *et al*.[33] and

Sanaeinasab *et al.*[35] showed no significant increase after intervention.

The mean scores for perceived benefits showed greater increase in the experimental group than in the control group immediately after and 6 months after the intervention. Ebadi Fard Azar *et al.*[36] showed that the construct of perceived benefits in the intervention group significantly increased after training, but this was not true for the control group. This is consistent with the findings of the present study. In the study by Mehrabbeik on the prevention of osteoporosis among women with low socioeconomic status, perceived benefits showed a significant increase after intervention.[37] The increase in the perceived benefits can be the result of an emphasis on diet and the role of nutrition in preventing osteoporosis during training.

The results of this study showed no significant difference between the two groups before intervention in terms of barriers. However, the difference was significant immediately and 6 months after intervention for the experimental group. In other words, the educational interventions significantly reduced the barriers to proper diet and thereby reduced the risk of osteoporosis. In the study of Anderson *et al.*[28] and Khorsandi *et al.*,[10] perceived barriers of the study population regarding calcium intake decreased after intervention. People are successful in preventing osteoporosis if they have enough incentive for change and for maintaining good behavior. After intervention, the experimental group's mean score showed a significant increase on motivation, compared to the control group. Baumeister and Vohs suggested that motivation and self-regulation play an important role in performing a behavior.[38] In Mcleod and Johnson's review study, motivation was found to be an effective factor in osteoporosis prevention.[39]

The construct of self-efficacy includes individuals' judgments about their ability to accomplish certain goals or tasks by their actions in specific situations. It depends on the person's sense of control over his/her behavior and the environment. If they set higher goals and become more committed, their behavior becomes more favorable.[40]

The mean scores of self-efficacy in the present study showed that before intervention, both groups had low ability to control diet. After intervention, the mean score of self-efficacy increased significantly in the experimental group. This is consistent with the results of Sedlak *et al.*,[17] Tussing Lisa and Chapman-Novakofski Karen,[33] and Piaseu *et al.*,[41] but is inconsistent with that of Jessup *et al.*[42]

External cues of action are social factors included in the HBM and refer to perceived social pressures leading to doing or not doing a behavior. These external cues alongside internal ones led the women toward osteoporosis prevention behaviors. In this study, external cues for the subjects included family, friends, doctors, and health workers. Immediately after and 6 months after the intervention, the external cues increased. They have an influential role as a source of information and support for eating behaviors and for providing resource and guidance that people need to assess their bone density. The mean score for the internal cues to action significantly increased after intervention in the experimental group, compared to the control group. This is consistent with the results of Khorsandi *et al.*[10] and Ebadi Fard Azar *et al.*[36] Before intervention, no significant difference was observed between the two groups in terms of self-regulation. However, after intervention, self-regulation of the experimental group significantly increased compared to that of controls. Ryan showed that with an increase in self-regulation, people had better health behavior.[43] In the study by Besser *et al.*, people had better knowledge about osteoporosis. However, they had low self-regulation associated with the disease.[44] MiJeong showed that self-regulation (including self-observation, goal setting, and expertise) played a key role in performing and maintaining behaviors for osteoporosis in older women.[45] Wolfe's study based on social cognitive theory showed an increase in performing behaviors among employees and suggested self-regulation as the most important predictor of behavior.[46]

Self-regulation refers to getting close to the states the individual has long been waiting for and getting away from those one has been afraid of. Leventhal *et al.* found that fear of communication increases problem-solving activities so that if the person understands the risk and has a plan of action to deal with it, he/she is likely to be able to take action to reduce the risk. Self-regulation is a technique that can help recognize barriers and deal with them. In this case, when the person observes that he/she is responsible for the change, he/she will gain motivation to continue the program.[47] The mean score of social support showed a significant increase in the intervention group compared to the control group immediately after and 6 months after the intervention. Edmonds *et al.*,[48] Hsieh *et al.*,[49] and Ievers-Landis *et al.*[21] stressed in their studies that osteoporosis prevention behaviors can be increased through increased social support. Springer *et al.*[50] and King *et al.*[51] also indicated that there is a relationship between physical activity and social support. In other words, the more the social support from family and friends, the better the subjects' exercise.

Social support affects disease control through two processes: (1) A direct effect through increasing health-related

behaviors such as encouraging healthy behavior and (2) modulating effects via reducing the effects of acute and chronic stress on health and helping patients cope with stress resulting from osteoporosis.[22]

In many other studies on different health behaviors, the role of external cues and supports was reported as positive.[52-55] Reminders from other people, subjective norms, and significant others had positive impact on women's behaviors and encouraged them to carry out osteoporosis prevention behaviors.

In this study, before intervention, there was no significant difference between the mean scores of women in osteoporosis prevention behaviors and both groups had low performance in maintaining a proper diet. Immediately after and 6 months after the intervention, the mean performance score of women in the intervention group significantly increased compared to controls. This shows the positive effects of the education on women's performance. Hazavehei *et al.* also reported an increase in calcium intake in the intervention group after intervention.[56] In the study by Al Seraty *et al.* on 100 female students using the HBM, the students' performance on calcium intake after intervention showed a significant increase compared to before intervention.[32] This is consistent with the result of Shirazi *et al.*'s study on the effects of education in prevention of osteoporosis among women of age 40–65 years, based on trans-theoretical model.[7]

The study by Tarshizi *et al.* showed that subjects' osteoporosis prevention behavior levels were not appropriate before the training. However, by applying the HBM training in the experimental group, a significant difference was observed in this area.[57] In the study by Mehrabbeik, a significant difference was reported between the level of physical activity after intervention in the experimental and control groups, but no significant difference was observed between the mean daily calcium and vitamin D intake before and after training. The intake levels were unsatisfactory.[37] The results of this study are consistent with the results of Khorsandi *et al.*,[10] Wallace,[58] and Ebadi Fard Azar *et al.*[36] Shojaezadeh *et al.*'s study showed that there was a significant increase in calcium intake in the second phase, but in the third stage (3 months after the intervention), the calcium intake decreased.[59]

Six months after the intervention, the value of lumbar spine BMD T-score increased to 0.127 in the experimental group, while it reduced to −0.043 in the control group. The value of the thigh BMD T-score increased to 0.125 in the intervention group, while it decreased to −0.028 in the control group. This shows the effects of educational intervention based on HBM, social support, and self-regulation on the performance of osteoporosis prevention behaviors and improvement of bone density among women in the intervention group. In a study, Huang *et al.* investigated the effectiveness of an osteoporosis prevention program among women in Taiwan based on the HBM and the three factors of knowledge, self-efficacy, and social support. The results showed that in the intervention group, perceived barriers and benefits improved significantly. Regarding the effects of the program on social support from family, friends, and staff, a significant increase was observed in the intervention group. Self-efficacy and knowledge variables also increased because of the training program. BMD improved in the intervention group, while it reduced in the control group.[60] Zhao *et al.* showed that calcium intake improved bone density.[61]

The results show the effectiveness of the intervention program and the importance of educational interventions to improve osteoporosis prevention behaviors. Results of the education based on the HBM, social support, and self-regulation showed that people with higher mean scores in these constructs performed better in activities for the prevention of osteoporosis and had better bone density.

The limitations related to this research project include its sampling method. Convenience sampling is selecting the research participants on the basis of being accessible and convenient to the researcher. Another concern about such data centers is whether subjects are able to accurately recall past behaviors. Cognitive psychologists have warned that the human memory is fallible,[62] and thus, the reliability of self-reported data is tenuous on some items.

Conclusions

Based on the results obtained from this study, it can be concluded that providing educational programs in this regard for family members, physicians, and other health personnel and offering training programs in radio and television broadcasting are essential. Further studies should use more comprehensive interventions on the structures of calcium intake benefits and barriers and use other behavioral change theories. It is advised that researchers explain social and behavioral barriers in calcium intake in different cultural contexts.

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