Educational Intervention Impact on Osteoporosis Knowledge, Health Beliefs, Self-Efficacy, Dietary Calcium, and Vitamin D Intakes in Young Adults

Alexa L. Evenson ▼ Gregory F. Sanders

BACKGROUND: Successful prevention of osteoporosis begins early in life. Adequate intake of calcium and vitamin D plays a role in this prevention along with knowledge, health beliefs, and self-efficacy related to preventive dietary behaviors.
PURPOSE: The purpose of this theory-based study was to examine young adults' knowledge of osteoporosis, health beliefs, self-efficacy, dietary calcium, and vitamin D intakes as measures of preventive behaviors.
METHODS: A pre-/posttest design was used to determine knowledge, health beliefs, and self-efficacy. A convenience sample of young adults (n = 153) was obtained at a Midwestern college. Participants completed pre- and postquestionnaires that included an osteoporosis knowledge test, health belief scale, self-efficacy scale, and 3-day food records.
RESULTS: Health beliefs were a significant predictor of dietary calcium intake and vitamin D intake. Both interventions increased osteoporosis knowledge and health beliefs but not self-efficacy. No differences were found between genders. Both interventions did not significantly alter dietary behavior; however, average dietary calcium intake met current recommendations.
CONCLUSION: Either educational method could be implemented in courses or community education to increase knowledge and health beliefs.

Osteoporosis is a chronic disease defined by decreased bone mass and increased fracture risk (National Osteoporosis Foundation, 2010). Approximately10 million people in the United States have osteoporosis and an additional 34 million are at risk for developing osteoporosis (National Osteoporosis Foundation, 2010). Women are more likely than men to be diagnosed with osteoporosis; however, men are also at risk as they age (Dawson-Hughes et al., 2010). The prevalence of osteoporosis is expected to increase in both genders due to increased life expectancy and an increasing older population (Kannus, Parkkari, Niemi, & Palvanen, 2005).

Unmodifiable osteoporosis risk factors include increased age, female gender, white race, and family history. Risk factors that can be modified include dietary intake of calcium and vitamin D, physical activity, low body mass index, excessive alcohol use, and smoking (Robitaille et al., 2008). Peak bone mass is developed by age 30 years and therefore preventive actions of maximizing bone mass to reduce osteoporosis-related fractures in later life should begin as early as possible (Heaney, 2000).

Osteoporosis knowledge has been shown to increase with different types of education such as a 3-hour program on osteoporosis, three educational sessions over the course of 3 weeks, or even a 45-minute continuing educational program (Ailinger, Braun, Lasus, & Whitt, 2005; Sedlak, Doheny & Jones, 2000). However, increased osteoporosis knowledge did not always lead to changes in behavior (Kasper, Peterson, & Allegrante, 2001). Some studies have found no association with osteoporosis knowledge and dietary calcium intake, whereas others have found increased dietary calcium (Babatunde, Himburg, Newman, Campa, & Dixon, 2011; Hernandez-Rauda & Martinez-Garcia, 2004; Tussing & Chapman-Novakofski, 2005; Wallace, 2002). With the exception of Bohaty, Rocole, Wehlin, and Waltman (2008), vitamin D knowledge relating to osteoporosis was generally not included in previous studies.

The health belief model (HBM) and the expanded health belief model (EHBM) have been used to identify factors associated with the practice of disease detection and health promotion behaviors (Glanz, Lewis, & Rimer, 1997). The EHBM suggests the foundation of preventive behaviors is obtained from direct and indirect influences of knowledge, attitudes, and self-efficacy. Self-efficacy has been defined as an individual's belief of his or her ability to conduct an action to achieve a specified goal (Bandura, 1977).

Alexa L. Evenson, PhD, RD, The College of Saint Benedict/Saint John's University, St. Joseph, MN.

Gregory F. Sanders, PhD, North Dakota State University, Fargo, ND.

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Calcium intake and self-efficacy have been related (Tussing & Chapman-Novakofski, 2005), but other studies have not found any HBM constructs that predict calcium intake (Anderson, Chad, & Spink, 2005; Wallace, 2002). The length, type of intervention, and findings of educational interventions for preventing osteoporosis differ, and there seems to be no consensus on what style and length of intervention is best for behavior change. Interventions that primarily deliver only information have been found to increase knowledge but not preventive behaviors (Sedlak et al., 2000). Several studies have examined osteoporosis knowledge, health beliefs, and self-efficacy in combination but failed to include preventive behavior assessments (Berarducci, 2004; Chan, Kwong, Zang, & Wan, 2007; Curry, Hogstel, Davis, & Frable, 2002). Educational interventions range from 45-minute lectures (Bohaty et al., 2008; Sedlak et al., 2000) to semester-long educational courses (Kasper et al. 2001). Only a few studies have included information in educational interventions regarding adequate dietary vitamin D intake (Bohaty et al., 2008; Curry et al., 2002; Soloman et al., 2006). One study that included assessment of dietary vitamin D intake after an educational intervention only examined osteoporosis knowledge and did not include health beliefs or self-efficacy (Bohaty et al., 2008). In addition, few studies have included men or gender comparisons. Previous research indicates there are no baseline differences in osteoporosis knowledge, health beliefs, or self-efficacy between genders (Chan et al., 2007; Gammage, Francoeur, Mack, & Klentrou, 2009).

There are four gaps in the literature that the current study attempted to fill: (1) to add to the existing knowledge base of educational interventions that are applied to both men and women as much of the literature focuses solely on women; (2) to determine which type of educational intervention influences osteoporosis knowledge, health beliefs, and self-efficacy; (3) to assess vitamin D content in knowledge, health beliefs, and self-efficacy measures; and (4) to fill the gap of assessing preventive vitamin D behaviors by assessing dietary vitamin D intakes.

Methods

Participants and Recruitment

The study was reviewed and approved by the Institutional Review Board at the investigator's university. Male and female students enrolled in an introductory nutrition course (multiple sections) were recruited through an in-class announcement invitation. A consent form, questionnaires, and demographic questions were provided in an online format. One hundred fifty-three young adults (84.4% response rate) ages 18–23 years participated in the study including 41 males (27%) and 112 females (73%). The majority of participants were white (80.5%). A χ^2 test showed that there were no statistically significant differences between the three groups (Control, Treatment 1, and Treatment 2) for all demographic and lifestyle variables.

Data Collection and Measures

Permission to use and modify the Osteoporosis Knowledge Test (OKT) revised in 2011, the Osteoporosis Health Belief Scale (OHBS), and the Osteoporosis Self-Efficacy Scales (OSES) was granted by Dr. Gendler at Grand Valley State University. The OKT was revised by Gendler, Coviak, Martin, Kim, and Von Hurst (2011). The OKT (revised 2011) has six subscales: Risk Factors, Exercise, Calcium, Vitamin D, General, and Medication. The subscale of medication was added for the current study, and the complete OKT (revised 2011) with medication subscale will be referred to as OKT-D.

Beliefs about osteoporosis were measured using a modified Osteoporosis Health Belief Scale (OHBS-D). The original OHBS is a 42-item instrument with seven subscales: Susceptibility, Seriousness, Benefits Exercise, Benefits Calcium, Barriers Exercise, Barriers Calcium, and Health Motivation. The original OHBS uses a 5-point Likert scale from "strongly agree" (5) to "strongly disagree" (1) (Kim, Horan, Gender, & Patel, 1991). This scale was modified to include new subscales of Benefits Vitamin D and Barriers Vitamin D using similar wording to the calcium questions to create the OHBS-D. The OHBS-D scale included a total of 54 items.

Self-efficacy relating to physical activity, calcium and vitamin D intakes was measured using a modified Osteoporosis Self-Efficacy Scale (OSES-D). The original OSES was developed by Horan, Kim, Gendler, Froman, and Patel (1998) and is a 21-item instrument with two subscales: an osteoporosis self-efficacy exercise scale (10 items) and an osteoporosis self-efficacy calcium scale (11 items). The original OSES was modified to include a new vitamin D subscale (11 items) to create the OSES-D. The OSES-D scale included a total of 32 items.

Dietary assessment information was collected using 3-day food diaries (1 weekend day and 2 weekdays). Participants were instructed to record all food and beverages consumed including serving size, method of preparation, time of day of consumption, brand of product, additional vitamin/mineral fortification information of the product, and any additional information they would like to include about the food or beverages. Dietary calcium and vitamin D intakes were analyzed using Diet Analysis Plus Software (10th edition). The software sums the daily calcium (mg) and vitamin D (IU) intakes. Dietary calcium and vitamin D intakes were averaged for the 3-day collection period.

Treatment groups were identified by lecture day and times. The sections of the nutrition course were randomly assigned into control, treatment one (lecture), and treatment two (hands-on activities). The pretest OKT-D, OHBS-D, and OSES-D were completed during the beginning of the semester. All three treatment groups had an 8-week period between completing the pretest and posttest. A 70-minute lecture-based educational intervention on preventing osteoporosis by obtaining adequate dietary vitamin D, calcium, and exercise was developed and implemented in class for participants in treatment one. The second treatment group included a hands-on/small group educational intervention. This educational intervention specifically targeted the OKT-D, the subscales of the OHBS-D (i.e., barriers to vitamin D intake), and the OSES-D. Class activities were modeled after previous research (Tussing & Chapman-Novakofski, 2005) and included:

1. *Determining risk and protective effects on bone mass (15 minutes)*—building block game to represent bone instability and identify risk factors for osteoporosis.
2. *Determining susceptibility (15 minutes)*—measuring height and weight; risk factor quiz.
3. *Overcoming barriers (10 minutes)*—serving size and portion size games: identify correct portion sizes of calcium-rich and vitamin D-rich foods.
4. *Facts and myths—practice of behaviors (12 minutes)*—supplements, lactose intolerance, calcium and vitamin D sources, tasting vitamin D fortified milks; tasting dairy alternatives; practice reading supplement labels.
5. *Practice bone health—high-calcium and high-vitamin D recipe sharing (10 minutes)*—snacks of high-calcium and high-vitamin D foods; recipe contest.
6. *Goal setting and sharing (5 minutes)*—participants created a goal for themselves regarding osteoporosis protection and how they will meet their goal; shared this goal with two or more classmates.
7. *Formative assessment (3 minutes)*—participants completed a formative assessment of what they liked most and least about the class, and any improvements to the activities that they recommended.

After the educational interventions, participants from the three groups were asked to complete an additional 3-day food diary (FD2).

Results

Effects of Educational Interventions on Osteoporosis Knowledge, Health Beliefs, and Self-Efficacy Between Genders

To test the influence of gender on osteoporosis educational interventions, a 3 × 2 repeated-measures analysis of variance (ANOVA) was conducted with gender as a covariate. There were no significant differences found by gender for any total scale score or subscale of the OKT-D, OHBS-D, OSES-D, dietary calcium, and dietary vitamin D intakes between educational intervention styles.

Effects of Educational Interventions on Osteoporosis Knowledge, Health Beliefs, and Self-Efficacy

No significant differences at baseline were found in total scores or subscale scores for the OKT-D, OHBS-D, OSES-D, dietary calcium, or dietary vitamin D between the three groups. OKT-D total scores were considered low at baseline (57%). The further step of using the repeated-measures ANOVA indicated that OKT-D total scores increased significantly over time, $P(1,149) = 134.25$, $p < .001$, for all three groups (from 57% to 72%). Tukey's honest significant difference post-hoc analysis showed significant differences in OKT-D total scores between the control group and treatment one group only, $P(2,149) = 3.80$, $p < .02$. All subscales of the OKT-D increased significantly over time ($p < .05$) in all three groups. However, there were significant differences between groups only in the exercise subscale, $F(2,149) = 3.20$, $p < .04$.

Osteoporosis health beliefs were significantly different over time within groups, $F(1,149) = 10.422$, $p < .002$, but not between groups. The OHBS-D subscales that were significantly different over time within groups were benefits of exercise, $F(2,149) = 17.62$, $p < .001$, benefits of calcium, $F(1,149) = 19.90$, $p < .001$, and benefits of vitamin D, $F(1,149 = 37.16$, $p < .001$. No significant differences were found in the subscales between treatment groups.

With regard to the influence of intervention on osteoporosis self-efficacy, the repeated-measures ANOVA established no significant differences over time or between groups found for OSES-D total or subscales of the OSES-D including calcium, exercise, or vitamin D.

Effects of Educational Interventions on Dietary Calcium and Vitamin D Intakes

In a 3 × 2 repeated-measures ANOVA, dietary calcium and vitamin D intakes were not significantly different over time or between groups. However, both treatment groups showed an increase in dietary vitamin D intake, whereas the control group decreased. Average dietary calcium intake was approximately 1078 mg per day. This level met the recommendations set forth by the Institute of Medicine. Average dietary vitamin D intakes were approximately 224 IU per day, well below the recommendation of 600 IU.

Nutrient Intakes Related to Osteoporosis Health Beliefs and Self-Efficacy

Two separate simultaneous regressions were conducted (see Table 1) to predict dietary calcium intake and dietary vitamin D intake. The predictor variables for both dietary calcium and vitamin D intakes were the OHBS-D and OSES-D subscales. The OHBS-D overall regression was significant, $F(9,151) = 2.26$, $p < .02$, accounting for approximately 11.2% of the variance in dietary calcium intake. The only significant predictor of dietary calcium intake was the subscale barriers to calcium (Table 1). When perceived barriers to calcium increased, dietary calcium intake was found to decrease. The OHBS-D overall regression was not significant for dietary vitamin D intake ($p > .07$).

The OSES-D overall regression was significant for dietary vitamin D intake, $F(3,152) = 1.80$, $p < .01$, and accounted for approximately 7.3% of the variability in dietary vitamin D intake. Significant predictors included the OSES-D subscales of calcium and vitamin D (Table 1). As self-efficacy of obtaining adequate calcium increased, so did dietary vitamin D intake. The OSES-D overall regression was not significant for dietary calcium intake.

Discussion

This study attempted to fill the gap of including both men and women in osteoporosis educational interventions. There were no differences found in outcome measures between genders.

TABLE 1. SIMULTANEOUS REGRESSION PREDICTING DIETARY CALCIUM AND VITAMIN D INTAKES (*N* = 153)

Variable	B	*SE*	β	*p*
Calcium intake				
Osteoporosis Health Belief Subscales				.021*
Susceptibility	−23.77	21.23	−.19	.27
Seriousness	−38.40	22.86	−.25	.10
Benefits Exercise	−5.51	23.95	−.03	.82
Benefits Calcium	−23.36	21.22	−.15	.27
Benefits Vitamin D	−36.50	24.56	−.22	.14
Barriers Exercise	6.31	23.20	.05	.79
Barriers Calcium	−77.49	31.64	−.48	.016*
Health Motivation	4.48	21.02	.03	.83
OHBS-D Total	21.89	17.42	.55	.21
Osteoporosis Self-Efficacy Subscales				.19
Exercise	−.15	.32	−.05	.63
Calcium	.81	.47	.28	.09
Vitamin D	−.25	.44	−.10	.56
Vitamin D intake				
Osteoporosis Health Belief Subscales				.047*
Susceptibility	−1.01	7.84	−.02	.90
Seriousness	13.65	7.50	.27	.07
Benefits Exercise	5.13	7.88	.01	.56
Benefits Calcium	1.97	8.42	.04	.82
Benefits Vitamin D	13.06	8.87	.25	.14
Barriers Exercise	2.98	9.00	.06	.74
Barriers Vitamin D	6.63	11.05	.12	.55
Health Motivation	13.32	7.28	.26	.07
OHBS-D Total	−5.36	6.32	−.40	.40
Osteoporosis Self-Efficacy Subscales				.01*
Exercise	−.13	.15	−.09	.21
Calcium	.74	.22	.54	.001*
Vitamin D	−.52	.20	−.42	.01*

Note. B = unstandardized coefficients; β = standardized coefficient; OHBS = Osteoporosis Health Belief Scale; *SE* = standard error
$^*p < .05$.

This study also evaluated the effectiveness of osteoporosis educational interventions for young adults by measuring changes in osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium, and vitamin D intakes.

The findings indicated average total osteoporosis knowledge was low at baseline (57%), which is consistent with previous findings (Anderson et al., 2005; Gammage & Klentrou, 2011). Both osteoporosis educational interventions (lecture and hands-on activities) were successful at increasing osteoporosis knowledge, similar to previous research (Babatunde et al., 2011; Bohaty et al., 2008). Interestingly, the control group also increased in osteoporosis knowledge, and health beliefs over time, despite not receiving the osteoporosis education until after the post-test was completed. The increase may simply be due to participating in a nutrition course.

Both osteoporosis educational interventions increased osteoporosis health beliefs, also in agreement with previous research (Gammage & Klentrou, 2011; Gammage et al., 2009). OHB-D subscale scores on benefits of exercise, benefits of calcium, benefits of vitamin D, and barriers to vitamin D also significantly increased regardless of the osteoporosis educational intervention. Self-efficacy did not change based on osteoporosis educational intervention, which agrees with previous research (Gammage et al., 2009).

Significant change was identified in OHBS-D subscales of benefits of exercise, benefits of calcium, and benefits of vitamin D for all three groups. The change may be due to osteoporosis information exposure from other sources. There were no significant differences in barriers to exercise, barriers to calcium, or barriers to vitamin D. Scores were generally very low in these areas, indicating the participants did not perceive these items to be difficult barriers to overcome. These subscales accompany the health beliefs of benefits of exercise, benefits of calcium, and benefits of vitamin D on which, in general, participants scored high. Health motivation subscale scores overall were fairly high in all three groups. The health motivation subscale of the OHBS has been related to the eagerness to participate in health-related behaviors (Gammage & Klentrou, 2011). Although health motivation did not significantly increase, the fact that it was high at baseline indicates that the sample may have been more passionate about health behaviors in general.

Unlike previous research, this study assessed not only dietary calcium intake but also included dietary vitamin D intake both at baseline and after educational interventions. Consistent with previous research, baseline average dietary calcium intake met recommendations (Anderson et al., 2005; Sharma, Hoelscher, Kelder, Day, & Hergenroeder, 2009). Also consistent with previous research, average dietary vitamin D intakes were well below the recommendations (Bohaty et al., 2008; Holick, et al., 2011). The educational interventions did not produce preventive behavior changes, such as increasing dietary calcium and vitamin D intakes. This could be due to the average calcium baseline intakes already meeting recommendations. Dietary vitamin D intakes may be difficult to change, as few foods naturally contain vitamin D. Vitamin D supplementation may be needed in order to reach the recommendation of 600 IU per day.

Regression analysis showed that OHBS-D subscale variables accounted for significant variance in dietary calcium intake and vitamin D intake. Consistent with previous research (Gammage & Klentrou, 2011), the subscale barriers to calcium was the only significant predictor of dietary calcium intake in the model. The variance explained by the overall OHBS-D model was fairly low but also fairly consistent with previous research (Gammage & Klentrou, 2011). In addition, health beliefs explained 16% of the variance in dietary calcium intake. In this study, participants on average were meeting the recommendations for calcium and this finding may help to explain why other subscales did not predict dietary calcium intake and why the approximate variance predicted in this model was slightly lower than previous studies.

The self-efficacy overall model was a predictor of vitamin D intake. Subscales of calcium and vitamin D were significant predictors in the model. The amount of variance in dietary vitamin D intake explained was fairly low. Previous research did not include vitamin D in predictor models or study the effects of self-efficacy on vitamin D intake. However, previous research indicated that higher self-efficacy could lead to consuming more nutrients such as calcium (Larson, Story, Wall, & Newmark-Sztainer, 2006). This study supports self-efficacy as an important aspect of predicting dietary vitamin D intake. Becoming proficient at a skill has been shown to be positively related to changing a behavior and maintaining that behavior (Bandura, 1977). Increasing the time of the educational intervention to master skills such as reading labels and choosing vitamin D-rich foods could increase self-efficacy and therefore related dietary vitamin D intake.

Limitations

This study was conducted at one Midwestern site and consisted of mostly white participants. Convenience sampling was used, and therefore, results cannot be generalized to the general public. The control group, which completed the posttest before receiving the osteoporosis lecture, increased in osteoporosis knowledge and health beliefs. It would have been beneficial to use a control group that was not currently enrolled in a nutrition course. In addition, a few dairy products for portioning out were used in intervention due to time constraints and included cheese, regular white milk, and vanilla ice cream. Perhaps participants did not get to portion foods they commonly eat in order to overcome barriers and thus lead to changes in self-efficacy.

Knowledge alone does not seem to increase self-efficacy. Conceivably, the young adult sample may not perceive osteoporosis as a direct threat at their current age. Previous research (Kasper et al., 2001) similarly found that college-age women believed that they were unlikely to develop osteoporosis, and were more concerned about developing heart disease and breast cancer. Simulating activities such as osteoporosis bone loss with accompanying muscle strength loss or how individuals with bone loss would go about activities of daily living could possibly impact participants' health beliefs and lead to behavior change.

Implications for Research and Practice

The findings of this study indicate the need for further research on osteoporosis education that will lead to behavior change. Promoting osteoporosis preventive behaviors that include obtaining adequate calcium, vitamin D, and exercise throughout the lifespan may be a good strategy for osteoporosis prevention despite this research showing that educational intervention did not change behaviors. Additional educational interventions should be evaluated for effectiveness in changing behaviors.

Young men and women both should be encouraged to begin osteoporosis preventive behaviors as early as possible in order to build peak bone mass and decrease their risk of osteoporosis-related fractures in later life (Larson et al., 2006). Future studies could follow long-term effects of osteoporosis educational interventions to determine changes in preventive behaviors. This study was the first of our knowledge to include vitamin D information on the OHBS-D and OSES-D. Future studies should include vitamin D questions to assess vitamin D knowledge, health beliefs, and self-efficacy as well as assessing dietary vitamin D intake in relation to osteoporosis.

This study also suggests that both types of educational intervention (lecture-based and hands-on activities) increase knowledge and health beliefs, but not self-efficacy related to osteoporosis. Care should be taken to identify areas of osteoporosis health beliefs that could be improved, such as overcoming barriers. In addition, different healthcare providers could use information from this study to provide education for prevention. The sample in this study was meeting calcium recommendations, and conceivably the educational interventions could be tailored more toward vitamin D intake for prevention.

Perhaps in this young adult sample, perception of the severity and susceptibility to osteoporosis is low compared with other diseases as previously found (Kasper et al., 2001). Young adults may be more likely to change behavior if they could practice types of behavior change more in depth, such as purchasing products at a grocery store or cafeteria that have higher amounts of calcium and vitamin D. In addition, because the sample was far below the recommendations for dietary vitamin D intake, supplement use may be warranted. Conceivably, allowing the sample to purchase supplements as an activity could change vitamin D intake behaviors.

Increasing the length of intervention and assessing behavior change over a longer period may result in both creating and capturing more beneficial outcomes. It is uncertain whether the sample participated in any behavior change after the posttest measurement of dietary calcium and vitamin D intakes. Previous research recommends that at least 50 hours of education is needed to create long-term changes in dietary behaviors (Larson et al., 2006). In addition, it has been suggested that educational programs should be tailored to the correct developmental level (Hoelscher, Evans, Parcel, & Kelder, 2002). It is possible that the sample was not at a developmental stage that was ready to make behavior changes based on susceptibility and seriousness of osteoporosis. Rather, they would be more likely to make behavior changes based on certain health beliefs or developmental aspects such as critical thinking skills or mastering a certain skill that may influence health beliefs.

Although this study focused on young adults, further research may be needed in other samples of all age groups. Developmental differences may influence health beliefs. Moreover, it would be important to know how these beliefs change over the lifespan, and how they relate to changes in behavior.

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