

Osteoporosis Knowledge, Beliefs, and Preventive Behaviors in Postmenopausal Breast Cancer Survivors

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Research article

Keywords: Postmenopausal Breast Cancer Survivors, Aromatase Inhibitor, Bone Mineral Density, Facts on Osteoporosis Quiz

Posted Date: March 3rd, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-285750/v1>

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Version of Record: A version of this preprint was published at BMC Women's Health on August 11th, 2021. See the published version at <https://doi.org/10.1186/s12905-021-01430-1>.

Abstract

Background

Aromatase inhibitor therapy induces bone loss and risk of fracture in postmenopausal breast cancer survivors (PBCS). Targetable patient-level factors to mitigate osteoporosis risk in this population are underreported. Here, we assessed the association between osteoporosis knowledge and beliefs, receipt of bone mineral density, and osteoporosis preventive behaviors among PBCS.

Methods

In this cross-sectional study, early stage PBCS with diabetes mellitus (ages 55-86 years) completed the Facts on Osteoporosis Quiz, Osteoporosis Health Beliefs Scale, and Osteoporosis Preventive Behaviors cross-sectional questionnaires. Multivariate logistic regression assessed factors associated with engagement in strength-training exercise.

Results

Mean age was 66.1 years with 20% self-reporting as non-Hispanic White, 40% non-Hispanic Black, 27% Hispanic, and 13% other. Osteoporosis knowledge (10.5 ± 3.4), seriousness (14.9 ± 3.8), and susceptibility (14.0 ± 3.5) mean scores were low. Most (75%) PBCS were adherent to calcium and vitamin D supplements, but only 47% reported engagement in strength-training exercises. Married/partnered, higher osteoporosis knowledge and health motivation scores were associated with exercise. After adjustment of marital status and osteoporosis knowledge, only health motivation was associated with exercise (OR 5.56, 95% CI 1.35-22.93).

Conclusions

PBCS are motivated to keep a healthy lifestyle despite limited osteoporosis knowledge, perceived risk, and susceptibility. However, <50% participated in strength-training exercise. Oncologic care should include osteoporosis and fracture prevention strategies, directed at encouraging cancer survivors to increase engagement in strength-training exercises and calcium intake.

Background

Breast cancer is the most prevalent cancer type among postmenopausal women, but as breast cancer mortality decreases, more women will die of causes other than breast cancer due to multiple competing risks[1, 2]. Bone loss generally occurs in postmenopausal women due to the decline in estrogen levels with age and leads to increased risk of osteoporosis. Adjuvant hormonal therapy with aromatase inhibitors (AIs) for the treatment of estrogen receptor-positive breast cancer exacerbates the risk of fragility fractures by reducing circulating estrogen and increasing bone loss at twice the rate that occurs

physiologically[3]. Osteoporosis is highly relevant to the growing number of breast cancer survivors, the majority of whom will be in their sixth to eighth decade of life by 2040[4]. Thus, the management of bone health is of clinical importance in postmenopausal breast cancer survivors (PBCS).

Clinical guidelines for the management of bone health in PBCS on AIs have been issued [5, 6] but adherence to these guidelines is inconsistent [7–9]. The recommendation to mitigate bone loss includes bone mineral density (BMD) screening, weight-bearing exercise, dietary education, and calcium and vitamin D supplementation [10, 11]. Recent attention has been directed towards the assessment of osteoporosis knowledge and participation in osteoporosis preventive behaviors among breast cancer survivors. Osteoporosis knowledge was lower in PBCS compared to postmenopausal women without cancer [12]. PBCS were also more likely to be overweight or obese and consumed less fruits, vegetables, and protein than the recommended guidelines [13]. Lastly, there is a high prevalence of vitamin D deficiency and low calcium intake in this population[14].

In addition to bone loss, PBCS are more likely to develop comorbid conditions such as diabetes mellitus and cardiovascular disease [15], which are also associated with increased fracture risk [16, 17]. Consequently, PBCS may be more focused on the impact of breast cancer and managing other chronic diseases and less concerned about osteoporosis. Given that osteoporosis is asymptomatic until fracture occurs, monitoring risk factors in PBCS can help to lower the incidence of the disease. In order to raise awareness of AI-induced osteoporosis, examining the level of knowledge in PBCS is one of the prerequisites that together with self-efficacy can lead to successful prevention strategies. Furthermore, PBCS should be aware that osteoporosis is serious, and there is increased susceptibility to osteoporosis because of their existing medical conditions [18]. Thus, the benefits of participating in an osteoporosis preventive strategy outweighs the perceived barriers [19].

Although few studies demonstrated deficits in osteoporosis knowledge among cancer survivors, the interrelationships between knowledge, beliefs, and preventive behaviors in PBCS with other chronic diseases have not been reported. Thus, the goal of this study is to understand factors associated with osteoporosis knowledge, perceived risk, and adherence to osteoporosis preventive behaviors among older breast cancer survivors with diabetes mellitus.

Methods

Study Design

This cross-sectional study was part of an ongoing longitudinal study investigating the relationship between breast cancer and diabetes beliefs among older breast cancer survivors. The institutional review board at Mount Sinai Hospital approved the study and all participants provided verbal informed consent. A convenience sample of thirty participants were women 55 years of age or older with pre-existing diabetes mellitus and histologically confirmed early stage breast cancer (stage I-III A) diagnosed within the last 5 years. Clinical and socio-demographic information, including receipt of bone density testing,

most recent bone density scores, height, weight, body mass index, and vitamin D/calcium supplements were obtained from hospital chart review. Trained research assistants administered survey questionnaires by telephone within two months to assess osteoporosis knowledge, beliefs, and behaviors. Patients were excluded from the study if they were non-English speaking.

Osteoporosis Knowledge

We used the Facts on Osteoporosis Quiz (FOOQ) to measure the level of osteoporosis knowledge among the participants. FOOQ is a 20-item True-False survey instrument with a reported 0.87 content validity index [20]. The total raw score for the FOOQ was calculated as the sum of correct answers and ranges from 0–20. We characterized participants as having osteoporosis knowledge if they scored ≥ 14 (i.e., if they answered $\geq 70\%$ of the items correctly).

Osteoporosis Health Beliefs

We administered the susceptibility (perceived risk of developing osteoporosis), seriousness (perception of threat from having osteoporosis), and health motivation (general tendency to engage in health behaviors) subscales of the Osteoporosis Health Beliefs (OHBS) questionnaire [21]. Internal consistency for this instrument ranges from $\alpha = 0.61$ (health motivation) to 0.80 (susceptibility)[22]. Each construct is composed of five items and each item is scored from 1 (strongly disagree) to 5 (strongly agree). By summing the scores, the possible total score for each construct ranged from 5–25.

Osteoporosis Health Promoting Behaviors

Self-reported adherence to calcium or vitamin D supplements was assessed using the Medication Adherence Report Scale (MARS) [23] a 10-item validated adherence measure that is rated on a 5-point Likert scale (1= “always” to 5= “never”). Self-reported adherence was the average of the 10 questions and a score > 4.5 was defined as adherent [24]. We also constructed a 7-item questionnaire to capture engagement in osteoporosis preventive behaviors such as dietary intake of calcium-containing foods and weight-bearing exercise. Participants reported the amount of daily or weekly servings for each food item and the number of weekly 30-minutes strength-training exercise (for e.g. aerobics, jogging, dancing, and weightlifting). Participants who responded that they had ≥ 1 eight oz. calcium fortified beverage or ≥ 1 oz. servings of cheese per day were considered engaging in osteoporosis preventive behaviors.

Statistical Analysis

We report descriptive statistics for the clinical and sociodemographic characteristics of the study participants. Fisher’s exact test was used to determine the association between osteoporosis knowledge and receipt of bone density with osteoporosis preventive behaviors (diet/exercise, adherence to calcium/vitamin D supplements). Student t-test and Wilcoxon Rank Sum tests were used to assess the association between knowledge and beliefs scores with engagement in osteoporosis preventive behaviors. Multivariable logistic regression assessed for the association between osteoporosis preventive behaviors (exercise/diet) and beliefs (health motivation) after adjusting for knowledge and marital

status. All analyses were conducted using SAS Statistical software version 9.4 (SAS Institute Inc., Cary, NC).

Results

Patient Characteristics

Thirty breast cancer survivors completed the survey questionnaires and their characteristics are summarized in Table 1. The mean age was 66.1 years (standard deviation [SD] = 7.91). Our cohort was racially and ethnically diverse with 20% self-reporting as non-Hispanic White, 40% non-Hispanic Black, 27% Hispanic, and 13% other. The majority of participants (63%) had more than a high school education, earned more than \$1500 per month (53%), and 77% were not married or partnered. The mean height and median weight (IQR) were 161.7 cm (SD = 7.2) and 76.95 (71–90) kg, respectively, and 57% of this cohort was obese (Body Mass Index [BMI] \geq 30). The distribution of breast cancer stages were: 10.3% stage 0, 41.4% stage I, 37.9% stage II, 10.3% stage III. The majority (80%) were receiving hormone therapy in the form of aromatase inhibitor. Out of the 30 participants, 25 had received at least one bone density scan by dual-energy x-ray absorptiometry (DEXA) within the last six years. The mean T-scores for those who had received a DEXA were: 0.28 ± 1.13 at the lumbar spine, -0.73 ± 1.13 at the femoral neck, and -0.04 ± 1.15 for the total hip.

Table 1
Clinical and socio-demographic characteristics of postmenopausal breast cancer survivors.

Characteristics	
Mean Age (years), \pm SD	66.1 \pm 7.91
Race/Ethnicity, N (%)	
<i>White</i>	6 (20)
<i>Black</i>	12 (40)
<i>Latino/Hispanic</i>	8 (27)
<i>Other</i>	4 (13)
High School Education or more, N (%)	19 (63)
Monthly Income >\$1500, N (%)	16 (53)
Married, N (%)	7 (23)
Mean Height (cm), \pm SD	161.7 \pm 7.2
Median Weight (kg), IQR	76.95 (71–90)
Mean Body Mass Index (kg/cm ²), \pm SD	31.2 \pm 5.8
Breast Cancer Stage, N (%)	
Stage 0	3 (10.3)
Stage I	12 (41.4)
Stage II	11 (37.9)
Stage III	3 (10.3)
Aromatase Inhibitor Therapy, N (%)	24 (80)
Receipt of Bone Density Screening (DEXA), N (%)	25 (83)
Mean T-score, \pm SD	
<i>Lumbar Spine</i>	0.28 \pm 1.13
<i>Femoral Neck</i>	-0.73 \pm 1.13
<i>Total Hip</i>	-0.04 \pm 1.15
Mean Osteoporosis Knowledge Score, \pm SD	10.5 \pm 3.4
Osteoporosis Health Beliefs	
<i>Mean Susceptibility Score (\pm SD)</i>	14.0 \pm 3.5

Characteristics	
<i>Mean Seriousness Score (\pm SD)</i>	14.9 \pm 3.8
<i>Median Health Motivation Score (IQR)</i>	19 (18–20)
Osteoporosis Preventive Behaviors, N (%)	
<i>Calcium Fortified Beverage</i>	14 (47)
<i>Caffeinated Beverage</i>	18 (60)
<i>Cheese</i>	14 (47)
<i>Fish</i>	11 (37)
<i>Eggs</i>	5 (17)
<i>Strength-training exercises</i>	14 (47)
<i>Calcium/Vitamin D supplement adherence</i>	15 (75)

Table 2
Factors associated with one or more 30-minute strength-training exercises weekly

Factors	Adherent	Non-adherent	p-value
Mean Age (years), \pm SD	66.4 \pm 8.45	65.9 \pm 7.67	0.9
Race/Ethnicity, N (%)			0.09
<i>White</i>	5 (83)	1 (17)	
<i>Black</i>	5 (42)	7 (58)	
<i>Latino/Hispanic</i>	4 (50)	4 (50)	
<i>Other</i>	0 (0)	4 (100)	
Married, N (%)	6 (86)	1 (14)	0.03[†]
Monthly Income >\$1500, N (%)	9 (56)	7 (44)	0.3
High School Education or more, N (%)	10 (53)	9 (47)	0.5
Median Weight (kg), IQR	73.8 (72–82)	89.2 (68–97)	0.2
Mean Body Mass Index (kg/cm ²), \pm SD	30.7 \pm 3.56	31.7 \pm 7.32	0.7
Receipt of Bone Density Screening (DEXA), N (%)	12 (48)	13 (52)	1.0
Mean T-score, \pm SD			
<i>Lumbar Spine</i>	0.33 \pm 1.03	0.23 \pm 1.28	0.8
<i>Femoral Neck</i>	-0.69 \pm 1.15	-0.77 \pm 1.17	0.9
<i>Total Hip</i>	0.04 \pm 1.15	-0.11 \pm 1.20	0.8
Mean Osteoporosis Knowledge Score, \pm SD	12.3 \pm 2.84	8.94 \pm 3.04	0.004[‡]
Osteoporosis Health Beliefs			
<i>Mean Susceptibility Score (\pm SD)</i>	13.9 \pm 4.6	14.13 \pm 2.25	0.8
<i>Mean Seriousness Score (\pm SD)</i>	14.2 \pm 4.28	15.5 \pm 3.41	0.4
<i>Median Health Motivation Score (IQR)</i>	20 (20–21)	18 (17–19)	0.0002[§]
Calcium/Vitamin D supplement adherence, N (%)	6 (40)	9 (60)	1.0

Osteoporosis Knowledge and Beliefs

The mean correct score on the FOOQ was 10.5 (SD = 3.4). The majority of participants (83%) correctly answered questions regarding whether “osteoporosis affects men and women,” that “there are many ways to prevent osteoporosis,” and that “there are treatment for osteoporosis after it develops”. However, 93% of participants answered incorrectly that “walking has a great effect on bone health”. Overall, only

23% of participants were classified as having osteoporosis knowledge ($\geq 70\%$ correct). Regarding health beliefs, the susceptibility to osteoporosis subscale had the lowest mean score (14.0 ± 3.5), although the majority (53%) agreed or strongly agreed that their “chances of getting osteoporosis are high.” Similarly, on the seriousness subscale, the mean score was (14.9 ± 3.8), and most participants (73%) agreed “it would be very serious if [I] got osteoporosis”. Interestingly, participants had the highest scores on the health motivation subscale (median 19 [interquartile range 18–20]), and 80% agreed that they followed recommendations to keep healthy.

Osteoporosis Health Behaviors

Twenty (67%) participants reported they were actively taking vitamin D or calcium supplements on the MARS questionnaire and their responses were confirmed from chart review. The mean medication adherence score was 4.73 (SD = 0.45). Only 47% of participants reported at least daily intake of ≥ 8 oz. of calcium-fortified beverage; similarly, only 47% reported consuming at least 1 oz. serving of cheese daily. In addition, 47% of participants reported that they engaged in more than one 30-minute strength-training exercises weekly.

Factors associated with engagement in osteoporosis preventive behaviors

Participants who received a bone density scan had higher adherence to calcium/vitamin D supplements (mean score 4.8 vs. 3.9, $p = 0.02$). When medication adherence was dichotomized, 83% of those who received a bone density scan were adherent to calcium/vitamin D supplements compared to 0% of those who had not received a bone density scan ($p = 0.05$). There was also a significant association between receipt of bone density scan and calcium beverage intake (56% vs. 0%, $p = 0.04$). We observed no association between receipt of bone density and osteoporosis knowledge, health beliefs, or diet/exercise.

Compared to black and Hispanic women, women who self-identified as white or other race were more likely to consume ≥ 1 oz. serving of cheese daily (17% and 38% vs. 100% and 75%, respectively [$p = 0.003$]). Additionally, married women and those with more than a high school education were more likely to report eating ≥ 1 oz. serving of cheese daily (86% vs. 35% [$p = 0.03$] and 63% vs. 18% [$p = 0.03$], respectively). Those who were married were also more likely to participate in one or more 30-minute strength-training exercises weekly (86% vs. 35% [$p = 0.031$]). We observed a significant difference in osteoporosis knowledge scores between those who engaged in ≥ 1 30-minute strength training exercise weekly and those who did not (mean knowledge score 12.3 vs. 8.9, $p = 0.004$). When knowledge was dichotomized, 86% of knowledgeable participants engaged in strength training exercises compared to 35% with low osteoporosis knowledge ($p = 0.03$). Similarly, those who engaged in strength training exercises had higher health motivation scores (mean score 21.7 vs. 10.1, $p = 0.001$). In a multivariable model, health motivation scores remained associated with exercise (OR 5.56, 95% CI 1.35–22.93), after adjusting for marital status and osteoporosis knowledge. We observed no association between osteoporosis knowledge or osteoporosis health beliefs and adherence to calcium/vitamin D supplements.

Conclusions

Despite low knowledge, perceived risk, and seriousness of osteoporosis, our participants believed in the importance of keeping healthy, and followed recommendations such as adherence to calcium/vitamin D supplement intake. However, similar to the general population, the majority did not engage in sufficient strength training exercises. Our results suggest that educating postmenopausal breast cancer survivors about osteoporosis and the seriousness and risk of developing osteoporosis may help promote them to engage in osteoporosis-preventive behaviors to mitigate bone deterioration.

Discussion

Bone loss is associated with aging and long-term aromatase inhibitor treatment for breast cancer. As such, postmenopausal breast cancer survivors (PBCS) are at increased risk for fragility fractures and require screening, prevention, and treatment of osteoporosis. In this study, we evaluated the factors associated with osteoporosis knowledge, health beliefs, and preventive behaviors in postmenopausal women with early stage breast cancer. The majority of patients (80%) were receiving hormone therapy in the form of aromatase inhibitor, and 83% of patients had received a bone density scan within the last six years. Osteoporosis knowledge was low among this population, with average score of 10.5 out of a maximum of 20. Participants did not perceive that they were susceptible to osteoporosis and did not perform weight-training exercises regularly. Although most participants were adherent to calcium/vitamin D supplements, they had very low dietary calcium intake.

We found that participants, who were not married, had less than a high school education, or lower monthly income were less knowledgeable about osteoporosis. These results are consistent with previously reported studies in postmenopausal women [25–27] and PBCS [12, 28]. Interestingly, 80% of our participants knew that bone loss normally speeds up after menopause. However, we did not observe an association between receipt of bone density or bone density scores with osteoporosis knowledge. This suggests that the information obtained from bone density screening may not translate sufficiently to knowledge about osteoporosis or osteoporosis preventive behaviors. The lack of association was demonstrated in other studies showing that postmenopausal women who received bone density screening had insufficient knowledge about osteoporosis [29, 30]. However, these previous studies were not conducted in breast cancer survivors who may have higher risk for osteoporosis, in addition to competing demands from multiple illnesses. We also found that many participants (57%) recognized that a lifetime of low calcium/vitamin D intake increases the risk of osteoporosis, but this knowledge did not translate to an association with self-reported adherence to calcium/vitamin D supplements. In addition, participants with poor osteoporosis knowledge may not be aware of the importance of also including calcium rich foods in their diet nor which foods are high in calcium. Health care providers should better educate older breast cancer survivors who are at higher risk of developing osteoporosis about osteoporosis risk factors and preventive behaviors.

Our study participants had a low sense of seriousness and perceived risk of osteoporosis compared to participants of similar age, menopausal status, and bone density in other studies [31, 32]. This is consistent with the low level of osteoporosis knowledge we found among our participants since the majority did not know that menopause is a risk factor for osteoporosis. Participants may also be more likely to believe osteoporosis is not a serious threat and have low perceived risk of developing osteoporosis if they do not have any clinical evidence or symptoms of osteoporosis such as history of fracture or bone pain. In addition, Hsieh et al. [33] showed that compared to breast cancer, cardiovascular disease, and neurological disorders, most women were less concerned with osteoporosis and therefore had lower perceived susceptibility. Given that our population were all breast cancer survivors, they may have perceived osteoporosis to be much less serious or risky. In addition, as more than half our cohort was obese and overall, there were few participants who had a diagnosis of osteopenia, it is possible that they may have felt less susceptible. In fact, we did find that those with lower lumbar bone density scores had higher susceptibility scores. This suggests that knowledge gained from bone density score may increase perceived susceptibility to osteoporosis.

Osteoporosis knowledge and health beliefs were significantly associated with osteoporosis preventive behaviors. In particular, those with higher knowledge and health motivation scores were more likely to engage in strength-training exercises. We also found that marital status was associated with exercise, but only health motivation remained significantly associated with exercise after adjustment for marital status and osteoporosis knowledge. Thus, finding ways to increase health motivation among older breast cancer survivors may help increase their engagement in strength training exercises which can not only decrease their risk for developing osteoporosis but may also improve their breast cancer prognosis.

The results of the current study are limited due to a modest sample size, which did not enable us to detect stronger associations between osteoporosis knowledge, health beliefs and behaviors. Adherence to supplements, exercise, and diet are not specific to osteoporosis and may reflect a general tendency to keep a healthy lifestyle and prevent or treat other conditions. The study is also cross-sectional in design conducted at a single medical institution, thus limiting generalizability. However, our cohort was diverse in terms of race and socioeconomic status making it representative of the community and other large cities in the United States. Finally, the majority of our participants had a prior bone density scan, which may have affected their perceptions and behavior to osteoporosis.

The results of the present study have implications for practice, future research, and policy. First, given the low knowledge and perceived risk among participants, it is possible that they are more concerned with managing their breast cancer and diabetes diagnoses and less concerned about osteoporosis. Future research should explore the interrelationship between breast cancer, diabetes, osteoporosis beliefs, and their impact on behaviors that promote bone health. Second, clinical guidelines for bone health in breast cancer patients on AIs have been issued but compliance within the oncological community is inconsistent. Barriers that prevent translating these guidelines into practice should be identified to reduce future suboptimal or inadequate treatment of bone health. Lastly, participation in strength-training exercises and adherence to dietary calcium intake were low among participants, but greater health

motivation was the only factor associated with exercise. This finding supports implementation of osteoporosis preventive programs in breast cancer care directed towards increasing strength-training exercise and calcium intake.

Abbreviations

PBCS

Postmenopausal Breast Cancer Survivors

AI

Aromatase Inhibitor

BMD

Bone Mineral Density

FOOQ

Facts on Osteoporosis Quiz

DEXA

Dual-Energy X-ray Absorptiometry

OHBS

Osteoporosis Health Beliefs

MARS

Medication Adherence Report Scale

Declarations

Ethics approval and consent to participate

This study was part of an ongoing longitudinal study and approved by the institutional review board at Mount Sinai Hospital (STUDY-17-00563). All participants provided verbal informed consent.

Consent for publication:

Not Applicable

Availability of data and materials

The data that support the findings of this study are available from the Surveillance, Epidemiology and End Results (SEER)-Medicare Database of the National Cancer Institute (NCI) but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of NCI.

Competing interests

The authors declare that they have no competing interests

Funding

This work was supported by the National Cancer Institute of the National Institutes of Health (R01CA214491 to JJL and T32CA225617 to SB). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. Study data were collected and managed using REDCap electronic data capture tools hosted at Mount Sinai Hospital.

Authors' contributions

SB designed the study, performed data processing, data analyses, and data interpretation. JL coordinated and supervised all aspects of the study. SB and JL wrote the manuscript. All authors read and approved the final manuscript

Acknowledgements

The authors would also like to thank Karisma Pantaleon and Sheryl Mathew for assisting with RedCap survey administration and chart abstraction.

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