

■ Original Article

Breast Feeding Is Associated with Postmenopausal Bone Loss: Findings from the Korea National Health and Nutrition Examination Survey

Hyun Joo Kim¹, Hyuktae Kwon^{2,*}, Seung-Won Oh², Cheol Min Lee², Hee-Kyung Joh³, Youngju Kim¹, Yoo-Jin Um¹, Sang Hyun Ahn¹

¹Department of Family Medicine, Seoul National University Hospital, Seoul, Korea

²Department of Family Medicine, Healthcare System Gangnam Center, Seoul National University Hospital, Seoul, Korea

³Health Service Center, Seoul National University, Seoul, Korea

Background: Postmenopausal osteoporosis is a common disease which can cause various morbidity and economic burden. Lactation is known to cause a decline in bone mineral density (BMD), but there are controversies on whether decreased BMD is fully recovered after lactation and whether lactation duration has an influence on postmenopausal BMD. This study was conducted to see whether breastfeeding is associated with postmenopausal bone loss using a highly representative sample of Korean population.

Methods: Retrospective cross sectional study was done using data collected from Korea National Health and Nutrition Examination Survey V. The study outcome was BMD measured with dual-energy X-ray absorptiometry and divided into 2 groups: normal or low BMD (T score < -1), and breastfeeding duration was categorized into 4 groups (never, 1st, 2nd, and 3rd tertile). Logistic regression analysis was done to examine the association between lactation duration and BMD.

Results: Among 1,694 postmenopausal women (mean age, 63.5 ± 9.1), 85.71% were in low BMD group. Compared to never breastfeeding group, postmenopausal women with longer than 79 months of breastfeeding duration are more likely to have low BMD (adjusted risk ratio [ARR] = 1.24; 95% confidence interval, 1.17 to 1.32). As the duration of breastfeeding increases, ARR and risk difference for low BMD also increases (P for trend = 0.008).

Conclusion: The study results showed that total breastfeeding duration was associated with postmenopausal low BMD. All women planning on breastfeeding should be aware of its risks and should take adequate dietary calcium and vitamin D before, during, and after breastfeeding.

Keywords: Breast Feeding; Lactation; Bone Density; Postmenopausal

Received: February 28, 2015, Revised: June 18, 2015, Accepted: July 22, 2015

*Corresponding Author: Hyuktae Kwon Tel: +82-2-2112-5745, Fax: +82-2-2112-5635, E-mail: ezkel@snuh.org/hyuktae@gmail.com

Copyright © 2015 The Korean Academy of Family Medicine

This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Postmenopausal osteoporosis is an important health issue worldwide. It can lead to pain, limitations in daily activity, and osteoporotic bone fractures.¹⁾ The Korea National Health and Nutrition Examination Survey (KNHANES) IV and V found prevalence of osteoporosis and osteopenia to be 38% and 48.7%, respectively, in women > 50 years of age.²⁾ The economic cost and burden of osteoporosis is enormous. In 1990, the direct and indirect cost of hip fractures worldwide was \$34.8 billion and is estimated to increase to \$131.5 billion by 2050.³⁾ This is, therefore, an undeniably important health issue, and it is crucial to identify and attenuate the risk factors for bone mineral density (BMD) loss in postmenopausal women. Many studies have shown pregnancy and lactation to be associated with BMD decline: About 280 to 400 mg of calcium is lost through breast milk every day, and daily losses of $\geq 1,000$ mg have been reported.^{4,5)} By the sixth month of lactation, approximately 3% to 7% of maternal BMD has been lost;⁶⁾ in women who breastfed for 12 months, the loss can increase to as much as 10%.^{7,8)} It is generally known that full recovery to normal BMD is achieved within 1 year in mothers who breastfeed for fewer than 6 months.⁸⁾ However, it is unclear whether full recovery can be achieved after lactation for more than 12 months or whether total lactation duration is associated with BMD later in life. Many studies have investigated the association between total lactation duration and the long-term effects on maternal BMD.⁹⁻¹⁹⁾ However, the results are conflicting. In this study, we aimed to retrospectively examine the association between total breastfeeding duration and postmenopausal BMD using data from the KNHANES V, a survey conducted from 2010 to 2012 that is highly representative of the Korean population.

METHODS

1. Study Population

Data for this retrospective cross-sectional study were collected through the KNHANES V, a nationwide cross-sectional survey conducted in South Korea from 2010 to 2012. Out of the 17,476 people surveyed, 7,982 men and 5,382 premenopausal women were excluded. In addition, 112 women with no childbirth history were excluded. Women who already had a history of osteoporosis treatment were classified as having low BMD. To exclude any effects of secondary causes of osteoporosis, women with rheumatic arthritis, thyroid disease, or chronic renal failure were also excluded. After further excluding those with missing data, a total of 1,694 postmenopausal women were included in this study (Figure 1).

2. Study Variables

BMD was measured using dual-energy X-ray absorptiometry

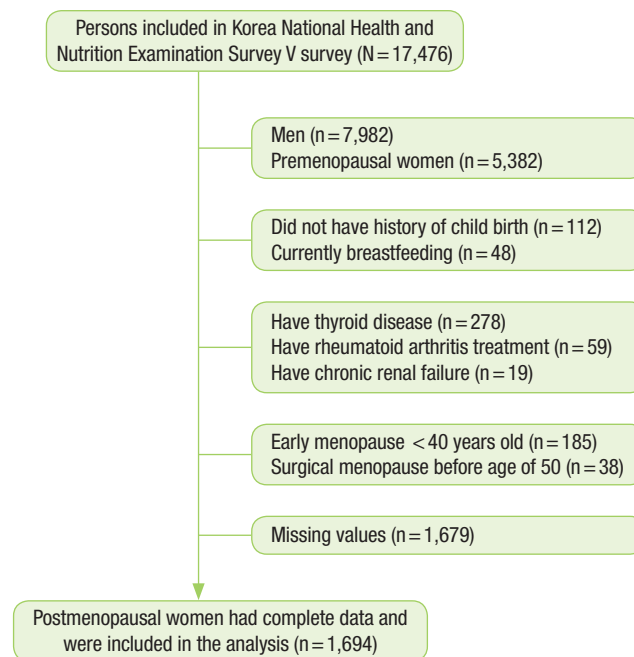


Figure 1. Study population.

(DEXA), and the T-scores were calculated using Asia's maximum BMD data (Hologic Discovery; Hologic Inc., Waltham, MA, USA). Osteoporosis was defined as T-score ≤ -2.5 . Osteopenia was defined as $-2.5 < \text{T-score} < -1$. The results were divided into two groups: normal or low BMD. Osteoporosis and osteopenia groups were categorized as low BMD, and the normal BMD group was categorized as normal BMD. Breastfeeding duration data were collected by survey and ranged from 0 to 324 months. Excluding the 105 women who did not breastfeed at all, the women were divided into four quartiles: 1–24 months, 25–44 months, 45–78 months, and > 79 months. Study participants were further questioned about gravidity, age at menarche and menopause, number of deliveries, number of children breastfed, calcium consumption, vitamin supplementation, hormone therapy, smoking, alcohol intake, and weekly physical activity. Height and weight were measured, and serum vitamin D levels were measured.

3. Statistical Analysis

General characteristics of the study population are presented as means with standard deviations for continuous variables and numbers and percentages for categorical variables. Logistic regression models were run to find the relationship between each breastfeeding group and BMD using the group with no breastfeeding history as a reference. Osteopenia and osteoporosis prevalence in the longer duration breastfeeding group was much higher than in the group that had never breastfed. Therefore, instead of presenting the odds ratio, we calculated adjusted risk ratios (ARR) and adjusted risk differences after

Table 1. General characteristics of the study population

Characteristic	Normal BMD (N=242)	Low BMD (N=1,452)	P-value*
Age (y)	56.7 ± 6.3	64.7 ± 9.0	< 0.001
Body mass index	25.03 ± 3.4	24.05 ± 3.2	< 0.001
BMD (T-score)			
Total femur	0.61 ± 0.64	-0.97 ± 0.89	< 0.001
Lumbar	-0.04 ± 0.74	-2.09 ± 1.03	< 0.001
Femur neck	-0.23 ± 0.62	-1.93 ± 0.84	< 0.001
Menarche age	15.4 ± 2.0	16.2 ± 2.0	< 0.001
Menopause age	50.01 ± 3.7	49.5 ± 4.2	< 0.001
Time since menopause	7.7 ± 6.5	16.1 ± 10.1	< 0.001
Age of first pregnancy	24.3 ± 3.5	23.6 ± 3.3	0.005
Gravidity	4.6 ± 2.3	5.2 ± 2.4	0.001
No. of delivery	2.7 ± 1.1	3.5 ± 1.6	< 0.001
Daily activity (metabolic equivalents)	300.5 ± 427.2	288.8 ± 411.6	0.638
Daily calcium intake (mg)	556.4 ± 410.5	418.9 ± 280.1	< 0.001
Vitamin D level (ng/mL)	17.9 ± 6.4	17.9 ± 7.0	0.975
History of hormone therapy			< 0.001
Yes	62 (25.62)	224 (15.43)	
Smoking			0.932
Current smoker	9 (3.72)	57 (3.93)	
Nonsmoker	233 (96.28)	1395 (96.08)	
Alcohol			< 0.001
Yes	97 (40.08)	341 (23.49)	
Breastfeeding duration (mo)			< 0.001
Never	28 (11.57)	77 (5.30)	
1–24	114 (47.11)	391 (26.93)	
25–44	39 (16.12)	255 (17.56)	
45–78	42 (17.36)	351 (24.17)	
Over 79	19 (7.85)	378 (26.03)	

Values are presented as mean ± standard deviation for continuous variables and number (%) for categorical variables.

BMD, bone mineral density.

*Chi-square test for categorical variables, t-test for continuous variables.

running a logit model with a binary outcome.²⁰⁾ All statistical analysis was performed using STATA ver. 13.1 (Stata Co., College Station, TX, USA).

RESULTS

A total of 1,694 postmenopausal women with a mean age of 63.5 ± 9.1 years (range, 44 to 93 years) and a mean body mass index (BMI) of 24.2 ± 3.2 (range, 15.3 to 43.6) were included in this study. Of these, 1,452 (85.71%) were in the low BMD group, which includes both osteopenia and osteoporosis.

The low BMD group was significantly older than the normal BMD group (64.7 ± 9.0 vs. 56.7 ± 6.3, $P < 0.001$). Gynecological parameters (age at menarche, gravidity, and number of deliveries) were all significantly higher in the low BMD group (Table 1). Daily activity, blood vitamin D level, and smoking had no significant correlation with BMD. Women with low BMD were more likely to have a lower daily calcium intake than women with normal BMD (418.9 ± 280.1 vs. 556.4 ± 410.5, $P < 0.001$).

Of the total study population, 105 women (6.2%) had never breastfed. As shown in Table 1, the prevalence of low BMD rises as the duration of breastfeeding increases.

Table 2. ARR, ARD, and 95% CIs for low BMD by total breast feeding duration*

Total breastfeeding duration (mo)	No. (%)	ARR (95% CI)	ARD (95% CI) [†]
Never	105 (6.20)	1.0 (reference)	0.0 (reference)
1–24	505 (29.81)	1.06 (1.00 to 1.13)	5 (0 to 10)
25–44	294 (17.36)	1.15 (1.09 to 1.23)	12 (7 to 18)
45–78	393 (23.20)	1.18 (1.10 to 1.26)	14 (8 to 20)
> 79	397 (23.44)	1.24 (1.17 to 1.32)	19 (14 to 24)
		P for trend = 0.008	

ARR, adjusted risk ratio; ARD, adjusted risk difference; CI, confidence interval.

*All results adjusted for age, body mass index, menopause age, gravidity, number of delivery, daily calcium intake, daily activity (metabolic equivalents), alcohol consumption, and smoking. [†]ARD per 100 persons.

Table 3. ARR, ARD, and 95% CIs for low BMD by average breast feeding duration per child*

Average breastfeeding duration per child (mo)	No. (%)	ARR (95% CI)	ARD (95% CI) [†]
Never	105 (6.2)	1.0 (reference)	0 (reference)
1–6	155 (9.15)	1.01 (0.93 to 1.10)	1 (-1 to 8)
7–12	636 (37.54)	1.14 (1.05 to 1.23)	11 (5 to 18)
13–24	612 (36.13)	1.23 (1.13 to 1.34)	17 (11 to 24)
> 25	186 (10.98)	1.20 (1.15 to 1.25)	16 (13 to 20)
		P for trend ≤ 0.001	

ARR, adjusted risk ratio; ARD, adjusted risk difference; CI, confidence interval.

*All results adjusted for age, body mass index, menopause age, gravidity, number of delivery, daily calcium intake, daily activity (metabolic equivalents), alcohol consumption, and smoking. [†]ARD per 100 persons.

Table 2 shows the ARR, adjusted risk difference per 100 women, and P-value for trend according to breastfeeding duration using data from women who have never breastfed as a reference. All results were adjusted for age, BMI, age at menopause, gravidity, number of deliveries, daily calcium intake, daily activity (metabolic equivalents), alcohol consumption, and smoking. Compared to women who had never breastfed, postmenopausal women who breastfed for > 79 months are more likely to have low BMD (ARR, 1.24; 95% confidence interval, 1.17 to 1.32). As the duration of breastfeeding increases, so does the risk for low BMD (P for trend = 0.008). According to our results, 19 out of 100 postmenopausal women who breastfed for > 79 months were likely to have lower BMD than the women who had never breastfed.

Additional analysis was conducted to assess the effect on BMD of breastfeeding duration per child. Table 3 shows the ARR, adjusted risk difference per 100 women, and P-value for trend according to breastfeeding duration per child. As the breastfeeding duration per child increases, so do the ARR and adjusted risk difference per 100 persons (P for trend < 0.001).

DISCUSSION

This study shows that increased total breastfeeding duration is associated with low BMD. The longer the duration of breast-

feeding, the higher the risk of low postmenopausal BMD. Similar results were seen for breastfeeding duration per child.

Many studies have shown the association between breastfeeding duration and BMD. However, the results are conflicting; some studies found no association between breastfeeding duration and BMD later in life⁹⁻¹²⁾ while others show a positive¹³⁻¹⁵⁾ or negative correlation.¹⁶⁻¹⁹⁾ One study even suggested that breastfeeding for > 18 months is an independent risk factor for vertebral fractures.¹⁹⁾ A similar cross-sectional study conducted with data from 1,486 postmenopausal Turkish women²¹⁾ showed a negative correlation between breastfeeding duration and BMD, and the authors concluded that total duration of breastfeeding might be a significant risk factor for postmenopausal osteoporosis.²¹⁾ Similarly, a study using data from 245 Iranian postmenopausal women showed that BMD was negatively associated with breastfeeding duration.¹⁸⁾ In contrast, another study in Turkey with 586 postmenopausal women found that long breastfeeding duration was not an independent risk factor for low BMD later in life when adjusting for multiple variables.¹²⁾ This study has its limitations in that dietary calcium intake and serum vitamin D levels, which could affect BMD, were not considered in the multivariate analysis. In contrast, some studies show that breastfeeding history is associated with an increased BMD.¹⁵⁾ In a subgroup analysis of 296 women who breastfed and 138 women who did not, women with a history of breastfeeding had higher BMD in the lumbar spine. However, this study differs from ours in that it was done with data from premenopausal women. Additionally, physical activity and smoking, which can affect BMD, were not considered.

Many studies have shown a negative correlation between parity and BMD.²²⁾ In our study, the low BMD group had higher gravidity than did the normal BMD group (4.6 ± 2.3 vs. 5.2 ± 2.4 , P -value = 0.001). Since both lactation duration and gravidity have an association with low BMD, we analyzed lactation duration per child as a separate variable. Even after adjusting lactation duration for gravidity, similar results were shown. The longer the duration of breastfeeding per child, the higher the risk of low postmenopausal BMD.

This study's findings can be explained by the combined effect of PTH-related protein (PTH-rP) secretion and estrogen deficiency during lactation, which increases the mother's skeletal resorption.⁴⁾ It is known that PTH-rP stimulates calcium resorption and, therefore, indirectly suppresses PTH.⁵⁾ Increased bone resorption can lead to BMD loss of about 3% to 10% over six months.¹⁹⁾ Furthermore, about 400 mg of calcium is lost through breast milk daily, which can also contribute to low BMD.⁴⁾ It is generally known that, after breastfeeding for fewer than 6 months, full recovery of BMD to normal levels is achieved by 6 months after weaning.²³⁾ However, as the duration of breastfeeding increases, so does the risk of impairment of postweaning BMD recovery.²³⁾ Whether women during and after

pregnancy have adequate calcium and vitamin D intake can also affect BMD later in life.⁴⁾

Our study is the first conducted with a representative Korean population to find an association between duration of breastfeeding and postmenopausal BMD. The strength of our study lies in its large sample size that is highly representative of the Korean population. Additionally, we used DEXA to measure BMD, which is the standard method. This study also considered lifestyle factors that could affect BMD, such as daily physical activity, alcohol intake, and smoking, and calcium intake and vitamin D levels were also included in the multivariate analysis.

This study has a number of limitations. Because it is a retrospective cross-sectional study, it was not possible to prove causality between breastfeeding duration and BMD. However, because delivery and breastfeeding usually occur in early adult life, and menopause generally occurs ≥ 10 years later, we can say the possibility of reverse causality is very low. In addition, total breastfeeding time was collected only through a survey, which could result in recall bias. Finally, further analysis to determine whether adequate calcium and vitamin intake during the post-weaning period affects BMD recovery could be performed if information were available regarding calcium and vitamin D intake during the post-weaning period.

In conclusion, our results showed that total breastfeeding duration and average breastfeeding duration per child both are associated with low postmenopausal BMD. All pregnant women planning to breastfeed should be aware of the risk of decreased postmenopausal BMD after long periods of lactation. This suggests that adequate calcium and vitamin D intake during pregnancy and lactation may be important to lower the risk of decreased postmenopausal BMD.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGMENTS

We would like to thank Editage (www.editage.co.kr) for their English language editing.

REFERENCES

1. Holroyd C, Cooper C, Dennison E. Epidemiology of osteoporosis. *Best Pract Res Clin Endocrinol Metab* 2008;22:671-85.
2. Park EJ, Joo IW, Jang MJ, Kim YT, Oh K, Oh HJ. Prevalence of osteoporosis in the Korean population based on Korea National Health and Nutrition Examination Survey (KNHANES), 2008-2011. *Yonsei Med J* 2014;55:1049-57.

3. Harvey N, Dennison E, Cooper C. Osteoporosis: impact on health and economics. *Nat Rev Rheumatol* 2010;6:99-105.
4. Kovacs CS. Calcium and bone metabolism during pregnancy and lactation. *J Mammary Gland Biol Neoplasia* 2005;10:105-18.
5. Kovacs CS. Calcium and bone metabolism in pregnancy and lactation. *J Clin Endocrinol Metab* 2001;86:2344-8.
6. Karlsson C, Obrant KJ, Karlsson M. Pregnancy and lactation confer reversible bone loss in humans. *Osteoporos Int* 2001;12:828-34.
7. Pearson D, Kaur M, San P, Lawson N, Baker P, Hosking D. Recovery of pregnancy mediated bone loss during lactation. *Bone* 2004;34:570-8.
8. Oliveri B, Parisi MS, Zeni S, Mautalen C. Mineral and bone mass changes during pregnancy and lactation. *Nutrition* 2004;20:235-40.
9. Henderson PH 3rd, Sowers M, Kutzko KE, Jannausch ML. Bone mineral density in grand multiparous women with extended lactation. *Am J Obstet Gynecol* 2000;182:1371-7.
10. Kojima N, Douchi T, Kosha S, Nagata Y. Cross-sectional study of the effects of parturition and lactation on bone mineral density later in life. *Maturitas* 2002;41:203-9.
11. Paton LM, Alexander JL, Nowson CA, Margerison C, Frame MG, Kaymakci B, et al. Pregnancy and lactation have no long-term deleterious effect on measures of bone mineral in healthy women: a twin study. *Am J Clin Nutr* 2003;77:707-14.
12. Yazici S, Korkmaz U, Erkan M, Korkmaz N, Erdem Baki A, Alçelik A, et al. The effect of breast-feeding duration on bone mineral density in postmenopausal Turkish women: a population-based study. *Arch Med Sci* 2011;7:486-92.
13. Wiklund PK, Xu L, Wang Q, Mikkola T, Lyytikäinen A, Volgyi E, et al. Lactation is associated with greater maternal bone size and bone strength later in life. *Osteoporos Int* 2012;23:1939-45.
14. Bjornerem A, Ahmed LA, Jorgensen L, Stormer J, Joakimsen RM. Breastfeeding protects against hip fracture in postmenopausal women: the Tromso study. *J Bone Miner Res* 2011;26:2843-50.
15. Canal-Macias ML, Roncero-Martin R, Moran JM, Lavado-Garcia JM, Costa-Fernandez Mdel C, Pedrera-Zamorano JD. Increased bone mineral density is associated with breastfeeding history in premenopausal Spanish women. *Arch Med Sci* 2013;9:703-8.
16. Tsvetov G, Levy S, Benbassat C, Shraga-Slutzky I, Hirsch D. Influence of number of deliveries and total breast-feeding time on bone mineral density in premenopausal and young postmenopausal women. *Maturitas* 2014;77:249-54.
17. Okyay DO, Okyay E, Dogan E, Kurtulmus S, Acet F, Taner CE. Prolonged breast-feeding is an independent risk factor for postmenopausal osteoporosis. *Maturitas* 2013;74:270-5.
18. Hosseinpanah F, Sorouri M, Rambod M, Azizi F. Total duration of breastfeeding is associated with low bone mineral density in Iranian postmenopausal women. *Int J Endocrinol Metab* 2011;8:153-8.
19. Bolzetta F, Veronese N, De Rui M, Berton L, Carraro S, Pizzato S, et al. Duration of breastfeeding as a risk factor for vertebral fractures. *Bone* 2014;68:41-5.
20. Norton EC, Miller MM, Kleinman LC. Computing adjusted risk ratios and risk differences in Stata. *Stata J* 2013;13:492-509.
21. Dursun N, Akin S, Dursun E, Sade I, Korkusuz F. Influence of duration of total breast-feeding on bone mineral density in a Turkish population: does the priority of risk factors differ from society to society? *Osteoporos Int* 2006;17:651-5.
22. Bayray A, Enquesselassie F. The effect of parity on bone mineral density in postmenopausal women: a systematic review. *J Osteopor Phys Act* 2013;1:104.
23. More C, Bettembuk P, Bhattoa HP, Balogh A. The effects of pregnancy and lactation on bone mineral density. *Osteoporos Int* 2001;12:732-7.