Asian Nursing Research 13 (2019) 161–167

Contents lists available at ScienceDirect

Asian Nursing Research

journal homepage: www.asian-nursingresearch.com

Research Article

Effects of Parity and Breastfeeding Duration on Bone Density in Postmenopausal Women

Eun Nam Lee*,☆

College of Nursing, Dong-A University, Busan, Republic of Korea

ARTICLE INFO

Article history:
Received 23 October 2018
Received in revised form
12 April 2019
Accepted 15 April 2019

Keywords:
bone density
breast feeding
parity
osteoporosis, postmenopausal
postmenopause

ABSTRACT

Purpose: This study aimed to identify the effect of parity and breastfeeding duration and the occurrence of lumbar vertebral and femoral neck osteoporosis in Korean postmenopausal women.
Methods: This study analyzed the data of 1,770 women based on the 2010–2011 results of the Korea National Health and Nutrition Examination Survey. Extracted data concerning bone density included variables known to be associated with osteoporosis. Complex sample multivariate logistic regression analysis was conducted to determine whether parity and breastfeeding duration were associated with osteoporosis in postmenopausal women.
Results: Parity was not associated with postmenopausal osteoporosis in the femoral neck or lumbar vertebrae; however, the risk of femoral neck osteopenia was significantly higher in women with a history of 12–24 months of breastfeeding than in women who breastfed for less than 12 months (odds ratio = 2.12, 95% confidence interval = 1.07–4.21). In women who breastfed for 24 months or longer, the risk of lumbar vertebral osteoporosis was significantly higher than in those who breastfed for less than 12 months (odds ratio = 2.73, 95% confidence interval = 1.18–6.32).
Conclusion: Breastfeeding duration may affect the occurrence of lumbar vertebral or femoral neck osteopenia or osteoporosis. Therefore, women who breastfeed for one year or more require education on the risk of bone loss and the need for preventive measures such as adequate calcium intake and physical exercise.

Introduction

Osteoporosis is a chronic metabolic disease that occurs in both men and women; however, its effects are most significant in postmenopausal women. Osteoporosis, an epidemiological condition in which the risk of bone fractures increases, is diagnosed when the bone mineral density (BMD) measurements have fallen more than 2.5 standard deviations below the peak BMD values of healthy adults [1].

In a study that analyzed 2005–2010 data from the US National Health and Nutrition Examination Survey, the prevalence of femoral neck or lumbar spine osteoporosis in women aged 50 years and older was 15.4% [2]. A study analyzing 2008–2011 Korea National Health and Nutrition Examination Survey (KNHANES) data [3] found that the prevalence of lumbar spine and femoral neck osteoporosis in Korean women aged 50 years or older was 30.1% and 23.1%, respectively. Therefore, Korean women have a higher prevalence of osteoporosis compared to Western women, a problem that requires systematic and national attention.

The actual bone mass is determined by the peak bone mass and the subsequent rate of bone loss. The peak bone mass is influenced by genetic and environmental factors, such as nutrition, physical activity, hormonal changes, and lifestyle behavior [4]. Parity and lactation usually occur before or after the age of 30 to 40 years, when the peak bone mass is formed. Given the knowledge that high peak bone mass reduces osteoporosis risk later in life, it makes sense to pay more attention to factors that affect BMD.

In women, pregnancy and breastfeeding affect calcium metabolism, and eventually, BMD [5]. The BMD of the vertebrae and femur decreases owing to high calcium demand and bone resorption during pregnancy [6,7]. However, compared to women who gave birth to one child, those who gave birth to two or more children experienced less reduction in BMD, indicating that parity has a

Eun Nam Lee: https://orcid.org/0000-0002-9421-0118
* Correspondence to: Eun Nam Lee, RN, PhD, Department of Nursing, Dong-A University, Dongdaeshin-dong, 3-ga, Seo-gu, Busan, 49201, Republic of Korea
E-mail address: enlee@dau.ac.kr

https://doi.org/10.1016/j.anr.2019.04.002

protective effect on bones [8–10]. Some also claim that the number of births does not affect the BMD of postmenopausal women because bone loss after pregnancy is restored after delivery [11,12].

Further, some studies reported that during the first six months of breastfeeding after delivery, BMD is reduced by 5–6% because of the decrease in the mothers' estrogen levels and loss of calcium during breastfeeding [13]. However, another study reported that among mothers who breastfed for less than one month after delivery, BMD levels continued to recover for up to 12 months. Further, it was reported that bone loss ceased for mothers still breastfeeding six months after delivery, returning to normal levels [7].

Other studies [14,15] that examined the effect of breastfeeding on BMD among Korean postmenopausal women revealed that the risk of lumbar spine and femoral neck osteoporosis in women who breastfed for 24 months or more was higher than that among women who did not breastfeed or did so for less than six months.

These results suggest that bone mass decreases because of hormonal changes and calcium loss throughout pregnancy and breastfeeding; yet, such changes are reversible, and thus the number of births and breastfeeding duration do not impact the BMD for postmenopausal women [11,12,16]. However, there are also studies that show that the influence of the number of births and breastfeeding duration on BMD may be irreversible [6,7]. These conflicting results indicate that differences in participants' race, age, age of menopause, age of deliveries, number of births, and breastfeeding duration—as well as research design—may be responsible for these inconsistencies.

Particularly, the average number of births and the breastfeeding duration for Korean women differ from those among women in Western and other Asian countries, making it difficult to apply the results of foreign studies in this context. As such, this study utilized data from the KNHANES, which is representative of the Korean population, to analyze the influence of parity and breastfeeding duration on the BMD of the lumbar vertebrae and femoral neck.

Methods

Study design

This descriptive study used the KNHANES V data to identify the influence of parity and breastfeeding duration on osteoporosis occurring in the lumbar vertebrae and femoral neck in Korean postmenopausal women.

Setting and sample

This study utilized the data from the KNHANES V, including the BMD test (2010–2012), which was conducted between the first half of 2010 and the first half of 2011 within the fifth period of the survey. The original KNHANES data were downloaded from the institution's website (https://knhanes.cdc.go.kr) after receiving approval for use. The target population of the KNHANES was the entire Korean population (except prisoners and foreigners), who were subject to primary stratification based on their city and province, followed by secondary implicit stratification based on their housing type. Finally, participants were identified by systematic sampling. Health surveys, physical examinations, and nutritional examinations were conducted with participants.

A total of 17,476 individuals participated in the KNHANES 2010–2011; initially 3,308 postmenopausal women who completed their BMD test and nutritional examinations were included. However, 1,538 participants with incomplete risk factor data and/or no childbirth or breastfeeding experience were excluded. Finally, 1,770 participants were enrolled in the study. Postmenopause was confirmed by asking whether they were still menstruating and included both artificial and spontaneous menopause (Figure 1).

Ethical considerations

Ethical approval was obtained from the institutional review board of the author's institution (Approval no. 2-1040709-AB-N-01-201709-HR043-02).

Measurement and data collection

From the KNHANES data, including health surveys, physical examinations, and nutritional examinations, the author extracted variables reported by a previous study [3] to be risk factors related to osteoporosis and BMD data.

Factors related to osteoporosis

Factors related to osteoporosis included demographic characteristics, lifestyle- and health-related factors, parity, and breastfeeding duration. According to age, participants were divided into those younger or older than 60 years. This stratification was done because most women have the highest rate of bone loss within 10 years of menopause, and the mean age of participants in this study was 61.30 years.

Further, the educational level was classified into middle school or below or high school and higher; the financial status was classified into low, medium-low, medium-high, and high; height was divided into taller or shorter than 160 cm; and weight was classified into less than 50 kg, 50–59 kg, and 60 kg and heavier.

Among the lifestyle- and health-related factors, calcium intake was classified based on the Korean Nutrition Society's recommended daily calcium intake of 700 mg for men and women over the age of 50 years [17]. Presence of intense exercise was measured by whether the individual engaged in more than one session per week of a tiring set of physical exercises (>10 minutes) that left them breathless. Presence of moderate exercise was measured by whether the individual engaged in more than one session per week of slightly tiring physical exercises (>10 minutes) that left them moderately breathless.

Even though both parity and breastfeeding duration were continuous variables, they can be considered more meaningful with categorical variables than continuous variables. In some studies [7,18,19], in the case of breastfeeding for less than six months, the effect on bone density after weaning was said to be reversible, while prolonged breastfeeding for more than 24 months influenced on the reduction of BMD in postmenopausal women [14,15]. Therefore, breastfeeding duration was divided into three groups: less than 12 months, 12–24 months, and more than 24 months. In addition, as the average number of births per woman was 3.31, the number of births was divided into ‘one to two times’ and ‘three times or more’. The other variables were categorized in accordance with the KNHANES questionnaire.

Bone mineral density

The KNHANES measures the BMD of the lumbar spine (L1-4) and femoral neck by Dual-energy X-ray absorptiometry (Discovery QDR-4500W; Hologic INC, MA, USA). The measurement values were processed into T-scores—the standard deviation of an individual's BMD from the mean BMD of a young healthy adult—which were then divided into osteoporosis (T-score ≤ -2.50), osteopenia (T-score $= -1$ to -2.49), and normal bone mass (T-

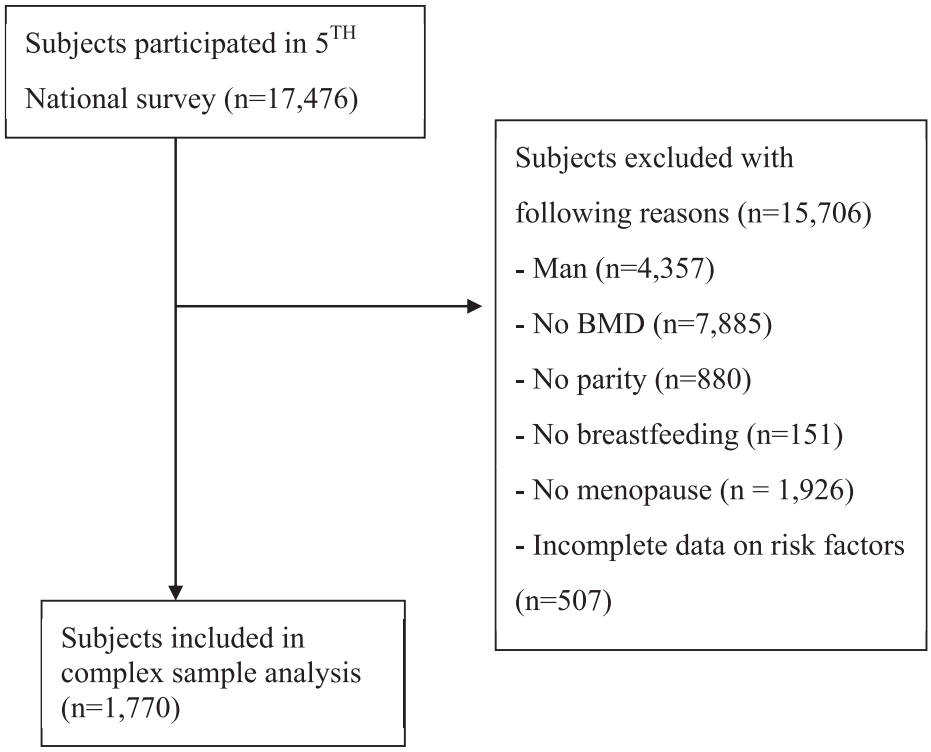

Figure 1. Diagram showing the flow of participants.
Note. BMD = bone mineral density.

score > −1.00) based on the standards set by the World Health Organization [1].

Data analysis

As the data from this study were extracted from a composite stratified sample, statistical analyses were performed by applying strata variables, cluster variables, and weighted values. Because the BMD was tested between January 2010 and May 2011, a weighting value of 192/272 was assigned to 2010 and 80/272 to 2011. Multivariate logistic regression analyses were performed using SPSS/WIN 23.0 (IBM Corp., Armonk, NY, USA). The results were presented in odds ratios and 95% confidence intervals.

Results

A total of 1,770 participants' demographic characteristics and lifestyle- and health-related factors were analyzed in this study. Their results can be generalized to 4,636,704 individuals. Descriptive information about the full sample can be found in Table 1. Participants' mean age was 61.30 ± 0.41 years (range = 27–92 years). The average number of parities was 3.31 ± 0.06 (range = 1–11), and the average breastfeeding duration was 55.19 ± 1.72 months (range = 1–324 months).

Prevalence of osteoporosis in the participants

The prevalence of osteoporosis in the femoral neck calculated with weighted values was 19.9%; 56.3% of the women had osteopenia and 23.8% were normal. The prevalence of osteoporosis in the lumbar spine was 29.2%, with 45.2% having osteopenia and 25.6% being normal (Table 1).

Presence of osteopenia and osteoporosis according to major characteristics of participants

Osteopenia and osteoporosis of the femoral neck according to participants' characteristics

Regarding general characteristics, women aged 60 years and older had 3.87 times higher risk of osteopenia and 23.91 times higher risk of osteoporosis in the femoral neck compared to those aged younger than 60 years. Women who had graduated from middle school had 2.27 times and 11.84 times higher risks of osteopenia and osteoporosis, respectively, compared to those with at least a high school education. In addition, women reporting 'medium-low' financial status had 2.05 times and 2.68 times higher risks of osteopenia and osteoporosis, respectively, compared to those in the 'medium-high' or higher financial status groups.

Women with a height less than 160 cm had 2.47 times higher risk of osteopenia and 9.85 times higher risk of osteoporosis than those with a height of 160 cm or above. Women weighing less than 50 kg had 2.61 times higher risk of osteopenia and 11.57 times higher risk of osteoporosis compared to those weighing more than 60 kg. Women who did not engage in intense physical activity had 1.91 and 2.82 times higher risks of osteopenia and osteoporosis, respectively, compared to those who did; women who did not engage in moderate physical activity had 1.43 and 2.09 times higher risks of osteopenia and osteoporosis, respectively, compared to those who did.

Women with a history of fractures had 2.55 times higher risk of osteoporosis in the femoral neck than did women without any history of fractures. Those who had not received hormone replacement therapy had 1.59 times higher risk of osteopenia and 5.14 times higher risk of osteoporosis than those who had received hormone replacement therapy. Women with a calcium intake of less than 700 mg had 2.97 times higher risk of osteoporosis in the

Table 1 *Osteoporosis Prevalence in the Femur Neck and Lumbar Spine by General Characteristics (n = 1770, N = 4,636,704).*

Variables	Categories	Total	Femur neck			Lumbar spine		
			Normal	Osteopenia	Osteoporosis	Normal	Osteopenia	Osteoporosis
		W%	W%	W%	W%	W%	W%	W%
Age (yrs)	<60	46.9	75.5	44.3	11.4	69.1	47.2	22.6
	≥60	53.1	24.5	55.7	88.6	30.9	52.8	77.4
	Mean ± SE (ranges)	61.30 ± 0.41 (27–92)						
Education	≤Middle school	75.9	60.3	77.5	94.7	58.6	78.3	90.4
	≥High school	24.1	39.7	22.5	5.3	41.4	21.7	9.6
Economical level	≤Middle level	57.5	45.5	61.2	67.4	46.5	56.9	70.3
	≥Upper level	42.5	65.5	38.8	32.6	53.5	43.1	29.7
Height (cm)	<160	85.0	73.3	87.1	96.4	78.5	83.2	95.0
	≥160	15.0	26.7	12.9	3.6	21.5	16.8	5.0
Weight (kg)	<50	22.8	12.2	20.2	46.8	11.2	18.4	42.9
	50~<60	42.9	37.3	47.9	36.5	39.7	46.3	40.8
	≥60	34.2	50.4	31.9	16.7	49.1	35.4	16.3
Drinking	Yes	69.5	80.6	68.0	57.0	78.0	69.4	60.5
	No	30.5	19.4	32.0	43.0	22.0	30.6	39.5
Smoking	Yes	10.2	10.8	8.4	14.6	9.5	11.3	9.1
	No	89.8	89.2	91.6	85.4	90.5	88.7	90.9
Intense exercise	No	83.1	74.9	85.1	89.4	76.7	85.1	86.5
	≥1 day/week	16.9	25.1	14.9	10.6	23.3	14.9	13.5
Moderate exercise	No	72.6	65.9	73.4	80.1	64.7	76.5	74.3
	≥1 day/week	27.4	34.1	26.6	19.9	35.3	23.5	25.7
Family history of osteoporosis	Yes	17.2	21.0	17.1	11.7	17.8	19.4	12.7
	No	82.8	89.0	82.9	88.3	82.2	80.6	87.3
Fracture history	Yes	16.6	11.6	15.7	25.1	8.3	15.0	26.3
	No	83.4	88.4	84.3	74.9	91.7	85.0	73.7
Oral contraceptive pills	Yes	24.0	23.0	25.8	20.3	27.1	24.4	20.1
	No	76.0	77.0	74.2	79.7	72.9	75.6	79.9
HRT	Yes	15.5	22.4	15.4	5.3	21.3	17.0	6.8
	No	84.5	77.6	84.6	94.7	78.7	83.0	93.2
Oophorectomy	Yes	3.1	3.9	3.2	1.7	4.7	2.3	2.9
	No	96.9	96.1	96.8	98.3	95.3	97.7	97.1
Calcium intake (mg)	<700	84.7	80.9	83.9	92.6	79.6	85.6	88.4
	≥700	15.3	19.1	16.1	7.4	20.4	14.4	11.6
Parity (frequency)	≤2	38.7	56.4	37.7	14.6	52.9	38.6	23.5
	≥3	61.3	43.6	62.3	85.4	47.1	61.4	76.5
	Mean ± SE (ranges)	3.31 ± 0.06 (1–11)						
Breast feeding duration (months)	<12	10.1	18.3	3.1	3.1	15.8	10.6	3.0
	12~<24	12.9	17.2	4.1	4.1	20.3	13.1	4.4
	≥24	77.0	64.5	92.8	92.8	63.9	76.3	92.5
	Mean ± SE (ranges)	55.19 ± 1.72 (1–324)						
Total		100.0	23.8	56.3	19.9	25.6	45.2	29.2

Note. HRT = hormone replacement therapy; SE = standard error; W = weighted; yrs = years.

femoral neck than women who consumed more than 700 mg of calcium.

Women with two or fewer births had 2.13 times higher risk of osteopenia and 7.52 times higher risk of osteoporosis than women with three or more births. Women who had breastfed for more than 24 months had 2.67 times higher risk of osteopenia and 8.56 times higher risk of osteoporosis compared to those who had breastfed for less than 12 months (Table 2).

Osteopenia and osteoporosis of the lumbar spine according to participants' characteristics

Regarding general characteristics, women aged 60 years and older had 2.49 times higher risk of osteopenia and 7.64 times higher risk of osteoporosis in the lumbar spine compared to those younger than 60 years. Women with middle school education or below had 2.55 times and 6.67 times higher risks of osteopenia and osteoporosis, respectively, compared to those with at least high school education. In addition, women reporting 'medium-low' financial status had 1.52 times and 2.73 times higher risks of osteopenia and osteoporosis, respectively, compared to those in the 'medium-high' or higher financial status groups.

Women with a height less than 160 cm had 5.24 times higher risk of osteoporosis than those with a height of 160 cm or above. Women weighing less than 50 kg had 2.28 times higher risk of osteopenia and 11.50 times higher risk of osteoporosis compared to those weighing more than 60 kg. Moreover, women weighing between 50 and 59 kg had 1.62 times higher risk of osteopenia and 3.09 times higher risk of osteoporosis compared to women weighing more than 60 kg.

Women who did not engage in intense physical activity had 1.74 times and 1.95 times higher risks of osteopenia and osteoporosis, respectively, compared to those who did; women who did not engage in moderate physical activity had 1.78 and 1.58 times higher risks of osteopenia and osteoporosis, respectively, compared to those who did.

Women with a history of fractures had 1.95 times higher risk of osteopenia and 2.55 times higher risk of osteoporosis than women without a history of fractures, and those who had not received hormone replacement therapy had 3.74 times higher risk of osteoporosis than those who had received hormone replacement therapy. Women consuming less than 700 mg of calcium had 1.52 times higher risk of osteopenia and 1.96 times higher risk of osteoporosis compared to those consuming more than 700 mg.

Women with two or fewer births had 1.79 times higher risk of osteopenia and 3.66 times higher risk of osteoporosis than women with three or more births. Women who had breastfed for more than 24 months had 1.78 times higher risk of osteopenia and 7.52 times

Table 2 *Univariate Logistic Regression of BMD in the Femur Neck and Lumbar Spine by General Characteristics (n = 1770, N = 4,636,704).*

Variables	Categories	Femur neck		Lumbar spine	
		Osteopenia	Osteoporosis	Osteopenia	Osteoporosis
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (yrs)	<60	1.00	1.00	1.00	1.00
	≥60	3.87 (2.80~5.34)	23.91 (13.98~40.90)	2.49 (1.91~3.26)	7.64 (5.55~10.52)
Educational level	≤Middle school	2.27 (1.62~3.20)	11.84 (6.59~21.29)	2.55 (1.87~3.49)	6.67 (4.09~0.88)
	≥High school	1.00	1.00	1.00	1.00
Economical level	≤Middle class	2.05 (1.47~2.86)	2.68 (1.81~3.78)	1.52 (1.15~2.01)	2.73 (1.92~3.87)
	≥Upper class	1.00	1.00	1.00	1.00
Height (cm)	<160	2.47 (1.69~3.60)	9.85 (4.72~20.54)	1.36 (0.96~ 1.93)	5.24 (2.88~9.54)
	≥160	1.00	1.00	1.00	1.00
Weight (kg)	<50	2.61 (1.50~4.53)	11.57 (6.67~20.08)	2.28 (1.44~3.60)	11.50 (7.00~18.89)
	50~<60	2.03 (1.44~2.85)	2.96 (1.82~4.83)	1.62 (1.20~2.18)	3.09 (2.04~4.67)
	≥60	1.00	1.00	1.00	1.00
Drinking	Yes	0.51 (0.37~0.70)	0.32 (0.21~0.48)	0.64 (0.47~0.67)	0.43 (0.30~0,61)
	No	1.00	1.00	1.00	1.00
Smoking	Yes	0.76 (0.41~1.39)	1.40 (0.80~2.47)	1.22 (0.63~2.37)	0.96 (0.54~1.72)
	No	1.00	1.00	1.00	1.00
Intense exercise	No	1.91 (1.34~2.74)	2.82 (1.77~4.49)	1.74 (1.22~2.49)	1.95 (1.29~2.97)
	≥1 day/week	1.00	1.00	1.00	1.00
Moderate exercise	No	1.43 (1.01~2.02)	2.09 (1.34~3.25)	1.78 (1.31~2.43)	1.58 (1.12~2.22)
	≥1 day/week	1.00	1.00	1.00	1.00
Family history of osteoporosis	Yes	0.80 (0.53~1.14)	0.50 (0.29~0.88)	1.11 (0.76~1.62)	0.97 (0.43~1.06)
	No	1.00	1.00	1.00	1.00
Fracture history	Yes	1.42 (0.93~2.17)	2.55 (1.46~4.48)	1.95 (1.21~3.16)	3.95 (2.96~6.26)
	No	1.00	1.00	1.00	1.00
Oral contraceptive pills	Yes	1.16 (0.84~1.60)	0.85 (0.56~1.30)	0.87 (0.63~1.21)	0.87 (0.63~1.21)
	No	1.00	1.00	1.00	1.00
HRT	Yes	1.00	1.00	1.00	1.00
	No	1.59 (1.06~2.38)	5.14 (2.85~9.27)	0.87 (0.63~1.21)	3.74 (2.20~6.36)
Oophorectomy	Yes	0.83 (0.43~1.63)	0.43 (0.16~1.16)	0.48 (0.24~0.96)	0.60 (0.24~1.49)
	No	1.00	1.00	1.00	1.00
Calcium intake (mg)	<700	1.23 (0.79~1.90)	2.97 (1.68~5.24)	1.52 (1.05~2.22)	1.96 (1.19~3.21)
	≥700	1.00	1.00	1.00	1.00
Parity	≤2	2.13 (1.58~2.67)	7.52 (4.69~12.08)	1.79 (1.34~2.40)	3.66 (3.58~5.18)
	≥3	1.00	1.00	1.00	1.00
Breast feeding duration (months)	<12	1.00	1.00	1.00	1.00
	12~<24	1.75 (1.05~2.92)	1.42 (0.47~4.26)	0.97 (0.54~1.72)	1.13 (0.44~2.89)
	≥24	2.67 (1.75~4.13)	8.56 (6.55~20.62).	1.78 (1.14~2.79)	7.52 (3.91~14.49).

Note. BMD = bone mineral density; CI = confidence interval; HRT = hormone replacement therapy; OR = odds ratio; yrs = years.

higher risk of osteoporosis compared to those who had breastfed for less than 12 months (Table 2).

Influence of parity and breastfeeding duration on osteopenia and osteoporosis in the lumbar spine and femoral neck

The author conducted a multivariate logistic regression analysis to see if parity and breastfeeding duration influenced the prevalence of osteopenia and osteoporosis when controlling for demographic characteristics and lifestyle- and health-related factors among postmenopausal women. This study found that parity did not influence the prevalence of osteopenia and osteoporosis in the lumbar spine and femoral neck; however, women who breastfed for 12–24 months had 2.12 times higher risk of osteopenia in the femoral neck compared to women breastfeeding for 12 months or less, and women who breastfed for more than 24 months had 2.73 times higher risk of osteoporosis in the lumbar spine than did those breastfeeding for less than 12 months (Table 3).

Discussion

This study is significant as it investigated the influence of parity and breastfeeding duration on the presence of osteoporosis in the lumbar spine and femoral neck among postmenopausal women

Table 3 *Multivariate Logistic Regression for the Effects of Parity and Breastfeeding Duration on BMD in the Femur Neck and Lumbar Spine (n = 1770, N = 4,636,704).*

Variables	Categories	Femur neck		Lumbar spine	
		Osteopenia	Osteoporosis	Osteopenia	Osteoporosis
		OR (95% CI)[a]	OR (95% CI)[a]	OR (95% CI)[a]	OR (95% CI)[a]
Parity	≤2	1.00	1.00	1.00	1.00
	≥3	1.15 (0.75~1.79)	0.91 (0.51~1.92)	1.14 (0.75~1.69)	1.43 (0.79~2.56)
Breastfeeding	<12	1.00	1.00	1.00	1.00
duration	12~<24	2.12 (1.07~4.21)	2.06 (0.51~8.39)	0.81 (0.40~1.65)	1.02 (0.35~2.98)
(months)	≥24	1.50 (0.84~2.68)	1.70 (0.52~5.69)	0.94 (0.54~1.63)	2.73 (1.18~6.32)

Note. BMD = bone mineral density; CI = confidence interval; OR = odds ratio.

[a] Adjusted for age, educational level, economical level, height, weight, drinking, smoking, intense exercise, moderate exercise, family history, fracture history, oral contraceptive pills, HRT, and oophorectomy.

while controlling for other risk factors based on data generalizable to the entire Korean population. When the author controlled for demographic characteristics and lifestyle- and health-related factors among postmenopausal women, parity did not influence the presence of osteoporosis in the lumbar spine and femoral neck. A study of the association of the risk of osteoporosis by stratifying parity in Korean postmenopausal women into zero to two, three to five, and six or more children showed that there was no significant difference in risk of osteoporosis between women who gave birth to three to five children and those who gave birth to zero to two children; however, the risk of osteoporosis was 2.89 times higher in those who gave birth to more than six children compared to those who gave birth to zero to two children [19].

These findings are in line with a study that analyzed BMD in Sri Lankan women aged 46–98 years by dividing the number of births into one to two, three to four, and five or more, which found that the number of births was unrelated to the BMD of the lumbar spine and the femoral neck [18]. However, there were differences from studies reporting that parity is a significant predicting factor in reduced BMD in the lumbar spine and femoral neck in postmenopausal women [20–23]. It is difficult to determine the influence of parity on BMD as it involves a complex interrelationship between factors such as calcium intake during pregnancy, increase in body mass and body fat, and hormonal changes [13,18]. In general, BMD decreases by about 3% during pregnancy as calcium is lost during fetal development [24]; however, BMD also increases owing to increased mechanical load on the bones from increased weight and body fat during pregnancy, higher bone formation due to placenta lactogen in the early stages of pregnancy, and suppressed bone absorption from the estrogen in the later stages of pregnancy. These effects may offset each other [9], resulting in parity not having a significant impact on the presence of osteoporosis. However, this study couldn't separate their different influences as the author did not measure or control for calcium intake or body weight increase during pregnancy.

However, when the author controlled for demographic characteristics and lifestyle factors, known to be risk factors for osteoporosis in postmenopausal women, it was found that women engaging in 12–24 months of breastfeeding had a higher risk of osteopenia in the femoral neck compared to those breastfeeding for less than 12 months and that those breastfeeding for more than 24 months had a higher risk of osteoporosis in the lumbar spine than did those who breastfed for less than 12 months.

In a study on the effects of breastfeeding for 24 months or more on osteoporosis risk in the same population as in this study [15], postmenopausal women who breastfed for more than 24 months showed a significantly higher risk of osteoporosis compared to women who did not breastfeed. However, this study showed that there were no differences in risk of osteoporosis between women who breastfed for less than 24 months and those who did not breastfeed. Additionally, a study on the risk of breastfeeding and osteoporosis in the same population [14] found that women who breastfed for 19 months or more were at a higher risk of osteoporosis than were women who breastfed for less than six months. Considering the results of a study on the same Korean population, there is a high risk of osteoporosis when postmenopausal women breastfeed for more than 24 months. However, the present study differed from others in that our analysis was conducted by distinguishing women with osteopenia from those without, by separating the lumbar and femoral neck BMD, and excluding women who had never breastfed. Because osteopenia is a precursor to osteoporosis, it is necessary to analyze it separately and to study whether the effect of parity and lactation on BMD varies with the skeletal site.

When women breastfeed right after childbirth, a daily average of 300–400 mg of calcium is transferred to the newborn [24], leading to bone loss. Moreover, prolactin levels are kept high during the first three-five months of breastfeeding, suppressing the hypothalamic–pituitary axis, lowering estrogen levels, and leading to amenorrhea, which ultimately have negative effects on the bones [24]. This could be why longer breastfeeding durations influenced the prevalence of osteoporosis. These results are in line with studies with Turkish women who breastfed for more than one year, which reported that they have a high risk of osteoporosis [25,26]. However, studies with German [27] and Turkish [28] postmenopausal women indicated that the negative influence of breastfeeding duration on BMD was not significant, which differed from the present study. It is worth noting that differences in these studies may be due to differences in research design, age of participants, average birth rates between races, and breastfeeding durations and thus should be interpreted with caution.

This study is meaningful because it provides a rationale for why women with long breastfeeding periods should be considered high risk for osteoporosis and be provided with nursing interventions to reduce the risk of osteoporosis after menopause.

However, a limitation of this study is that we used a cross-sectional design, making it difficult to assert the direct influence of parity or breastfeeding periods on BMD. Moreover, it is difficult to assert that this study could completely control for all factors impacting osteoporosis as it did not investigate nutritional intake, exercise level, or body weight during pregnancy and breastfeeding. Moreover, the possibility of recall bias of individuals cannot be ruled out when reporting the breastfeeding period. In addition, because weight and height were investigated respectively as categorical variables, this study couldn't investigate the effect of weight relative to height on BMD. Also, artificial menopausal women were included in postmenopausal women, which cannot be ruled out that the effect of breast feeding period on bone density may differ in case of early menopause. It is, thus, necessary to prospectively study changes in BMD during pregnancy and breastfeeding of pregnant women with strictly controlling for the confounding variables.

Conclusion

The author concluded that parity in Korean postmenopausal women did not influence the occurrence of osteopenia and osteoporosis in the lumbar spine and femoral neck. In addition, it can be asserted that breastfeeding duration influences the occurrence of osteopenia and osteoporosis in the lumbar spine and femoral neck. Therefore, it is important to educate women about bone loss, especially if they breastfeed for more than a year, as well as to provide preventative education, such as on the importance of adequate calcium intake and exercise.

Conflicts of interest

There are no conflicts of interest to declare.

Acknowledgments

This work was supported by the 2018 Dong-A University research fund.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.anr.2019.04.002.

References

1. Kanis JA, McCloskey EV, Johansson H, Oden A, Melton LJ 3rd, Khaltaev N. A reference standard for the description of osteoporosis. Bone. 2008;42(3):467–75. https://doi.org/10.1016/j.bone.2007.11.001
2. Wright NC, Looker AC, Saag KG, Curtis JR, Delzell ES, Randall S, et al. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. J Bone Miner Res. 2014;29(11):2520–6. https://doi.org/10.1002/jbmr.2269
3. 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(4):1049–57. https://doi.org/10.3349/ymj.2014.55.4.1049
4. Gordon CM, Zemel BS, Wren TA, Leonard MB, Bachrach LK, Rauch F, et al. The determinants of peak bone mass. J Pediatr. 2017;180:261–9. https://doi.org/10.1016/j.jpeds.2016.09.056
5. 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 pre-menopausal women. Maturitas. 2014;77(3):249–54. https://doi.org/10.1016/j.maturitas.2013.11.003
6. Heidari B, Hosseini R, Javadian Y, Bijani A, Sateri MH, Nouroddini HG. Factors affecting bone mineral density in postmenopausal women. Arch Osteoporos. 2015;10:15. https://doi.org/10.1007/s11657-015-0217-4
7. Hyassat D, Alyan T, Jaddou H, Ajlouni KM. Prevalence and risk factors of osteoporosis among Jordanian postmenopausal women attending the national center for diabetes, endocrinology and genetics in Jordan. Biores Open Access. 2017;6(1):85–90. https://doi.org/10.1089/biores.2016.0045
8. Song SY, Kim Y, Park H, Kim YJ, Kang W, Kim EY. Effect of parity on bone mineral density: a systematic review and meta-analysis. Bone. 2017;101:70–6. https://doi.org/10.1016/j.bone.2017.04.013
9. To WW, Wong MW. Changes in bone mineral density of the os calcis as measured by quantitative ultrasound during pregnancy and 24 months after delivery. Aust N Z J Obstet Gynaecol. 2011;51(2):166–71. https://doi.org/10.1111/j.1479-828X.2010.01266.x
10. Kauppi M, Heliovaara M, Impivaara O, Knekt P, Jula A. Parity and risk of hip fracture in postmenopausal women. Osteoporos Int. 2011;22(6):1765–71. https://doi.org/10.1007/s00198-010-1392-1
11. Hiz O, Ediz L, Tekeoglu I. Effect of number of pregnancies on bone mineral density. J Int Med Res. 2010;38(5):1816–23. https://doi.org/10.1177/147323001003800529
12. Terzi H, Terzi R, Kale E, Kale A. Effect of multiparity on bone mineral density, evaluated with bone turnover markers. Rev Bras Rheumatol. 2017;57(5):371–7. https://doi.org/10.1016/j.rbre.2015.09.002.
13. Sharma N, Natung T, Barooah R, Ahanthem SS. Effect of multiparity and prolonged lactation on bone mineral density. J Menopausal Med. 2016;22(3):161–6. https://doi.org/10.6118/jmm.2016.22.3.161
14. Hwang IR, Choi YK, Lee WK, Kim JG, Lee IK, Kim SW, et al. Association between prolonged breastfeeding and bone mineral density and osteoporosis in postmenopausal women: KNHANES 2010–2011. Osteoporos Int. 2016;27(1):257–65. https://doi.org/10.1007/s00198-015-3292-x
15. Yun BH, Chon SJ, Choi YS, Cho S, Lee BS, Seo SK. The effect of prolonged breastfeeding on the development of postmenopausal osteoporosis in population with insufficient calcium intake and vitamin D level. Osteoporos Int. 2016;27(9):2745–53. https://doi.org/10.1007/s00198-016-3585-8
16. Chowdhury R, Sinha B, Sankar MJ, Taneja S, Bhandari N, Rollins N, et al. Breastfeeding and maternal health outcomes: a systematic review and meta-analysis. Acta Paediatr. 2015;104(S467):96–113. https://doi.org/10.1111/apa.13102
17. The Korean Nutrition Society. Dietary reference intakes for Koreans. Seoul, Korea: The Korean Nutrition Society; 2010. p. 634p. Korean.
18. Lenora J, Lekamwasam S, Karlsson MK. Effect of multiparity and prolonged breastfeeding on maternal bone mineral density: a community-based cross-sectional study. BMC Womens Health. 2009;9:19. https://doi.org/10.1186/1472-6874-9-19
19. Jang SN, Choi YH, Kang SH, Jeong JY, Choi YJ, Kim SH. Prevalence and associated factors of osteoporosis among postmenopausal women in Chuncheon: Hallym Aging Study (HAS). J Prev Med Public Health. 2006;39(5):389–96. Korean.
20. Keramat A, Patwardhan B, Larijani B, Chopra A, Mithal A, Chakravarty D, et al. The assessment of osteoporosis risk factors in Iranian women compared with Indian women. BMC Musculoskel Disord. 2008;9:28. https://doi.org/10.1186/1471-2474-9-28
21. Derakhshan S, Mahmoudi M, Shahsawari S. Effects of multiparity and duration of breast-feeding on maternal bone mineral density in post-menopausal Kurdish women: a retrospective study. Iran J Nucl Med. 2017;25(1):43–50.
22. Singh R, Gupta S, Awasthi A. Differential effect of predictors of bone mineral density and hip geometry in postmenopausal women: a cross-sectional study. Arch Osteoporos. 2015;10:39. https://doi.org/10.1007/s11657-015-0246-z
23. Shin CS, Choi HJ, Kim MJ, Kim JT, Yu SH, Koo BK, et al. Prevalence and risk factors of osteoporosis in Korea: a community-based cohort study with lumbar spine and hip bone mineral density. Bone. 2010;47(2):378–87. https://doi.org/10.1016/j.bone.2010.03.017
24. Salari P, Abdollahi M. The influence of pregnancy and lactation on maternal bone health: a systematic review. J Family Reprod Health. 2014;8(4):135–48.
25. 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(3):270–5. https://doi.org/10.1016/j.maturitas.2012.12.014
26. Yılmaz H, Erkin G, Polat HA, Küçükşen S, Sallı A, Uğurlu H. Effects of reproductive factors on bone mineral densitometry. Turk J Osteoporos. 2012;18:8–12. https://doi.org/10.4274/tod.00719
27. Hadji P, Ziller V, Kalder M, Gottschalk M, Hellmeyer L, Hars O, et al. Influence of pregnancy and breast-feeding on quantitative ultrasonometry of bone in postmenopausal women. Climacteric. 2012;5(3):277–85. https://doi.org/10.1080/cmt.5.3.277.285
28. Yazici S, Korkmatz U, Erkan M, Korkmaz N, Baki AE, 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(3):486–92. https://doi.org/10.5114/aoms.2011.23416