J HEALTH POPUL NUTR 2002 Mar;20(1):26-30
ISSN 1606-0997 $ 5.00+0.20

Impact of Lactational Performance on Bone Mineral Density in Marginally-nourished Bangladeshi Women

S. Chowdhury[1], N.R. Sarkar[2], and S.K. Roy[3]

[1]Department of Obstetrics and Gynecology, Institute of Child and Mother Health, Matuail, Dhaka 1362; [2]Helen Keller International, Dhanmondi, Dhaka 1209; and [3]ICDDR,B: Centre for Health and Population Research, GPO Box 128, Dhaka 1000, Bangladesh

ABSTRACT

This cross-sectional study, carried out during July 1997-June 1998, evaluated the effects of prolonged breast-feeding and lactational amenorrhoea on bone mineral density (BMD) in 400 marginally-nourished Bangladeshi women aged 20-81 years. A bone densitometer was used for measuring BMD in the distal and ultra-distal end of radius and ulna. The results showed that the women who breastfed for 60 months or less had a higher mean BMD compared to those who breastfed for 61-120 months and for over 120 months. There was a significantly higher BMD in the women who had a shorter duration of lactational amenorrhoea compared to those having a longer duration of lactational amenorrhoea. BMD was significantly and negatively correlated with total duration of lactational amenorrhoea (slope -0.024, $p<0.05$) after controlling for parity, physical workload, and total duration of breast-feeding. The study concluded that there was a negative correlation between longer duration of breast-feeding and BMD, but it was not found when other factors were controlled in multivariate analysis. The duration of lactational amenorrhoea, which is a proxy indicator of breast-feeding, showed a negative correlation with BMD. It is recommended that all lactating women be given diet with adequate calcium to support breast-feeding for maintaining good nutrition of their bones.

Key words: Breast-feeding; Nutrition disorders; Lactation; Amenorrhoea; Bone density; Cross-sectional studies; Bangladesh

INTRODUCTION

In developing countries, like Bangladesh, many people believe that women who predominantly breastfeed their children may become more malnourished for nursing their infants with prolonged breast-feeding over their reproductive life (1). A cumulative effect of supply of calcium through breastmilk may reduce the calcium store of marginally-nourished women where dietary inadequacy of calcium is frequent (2).

Correspondence and reprint requests should be addressed to: Dr. S.K. Roy
Clinical Sciences Division
ICDDR,B: Centre for Health and Population Research
GPO Box 128, Dhaka 1000
Bangladesh
Tel: 880-2-8811751 Fax: 880-2-8823116
Email: skroy@icddrb.org

Results of several studies showed that there is an inconsistent relationship between breast-feeding and bone mineral density (BMD). A study on 36 healthy women aged 24-31 years, conducted by the University of Federico of Naples, Italy, has shown that BMD is significantly reduced during lactation and is only partially recovered after discontinuation of breast-feeding (3). Sowers *et al.* have also observed similar findings (4). In Japan, a hospital-based longitudinal study on 571 healthy postpartum women has shown that lactation and amenorrhoea decrease BMD (5). Results of another study on 19 healthy postpartum hospitalized women at the Walter Reed Army Medical Center for labour and delivery in Washington, DC, USA, showed that, at six months postpartum, breast-feeding women had a

significantly lower mean BMD in the lumber spine than those who did not breastfeed. However, this difference was not seen in the mid- or distal radius (6). Another study at Salt Lake City in the USA on women aged 30-35 years has shown that even when women consume the recommended daily allowance for calcium, long-term lactation depletes ultra-distal bone mass in the fore-arm (7). Other studies have also shown a similar negative relationship (8-11).

Contrary to these findings, a study in southern California on 742 women aged 60-89 years reported no association between breast-feeding and BMD (12). A similar finding was also observed by Koetting *et al*. who showed that a history of long-term lactation might not be associated with low-peak adult bone mass (13). On the other hand, some investigators have reported a positive association between breast-feeding and BMD (14-16).

No study in Bangladesh was conducted to show the relationship between breast-feeding and BMD. This study was, therefore, carried out on Bangladeshi women to evaluate the effects of prolonged breast-feeding on BMD.

MATERIALS AND METHODS

Study patients

This cross-sectional study was undertaken on 400 Bangladeshi women who attended the Obstetrics and Gynaecology Outpatient Department in private clinics and in the Institute of Post-Graduate Medicine and Research (presently Bangabandhu Sheikh Mujib Medical University), Dhaka, Bangladesh, during July 1997-June 1998. Non-pregnant and non-lactating women, aged 20-81 years, who stopped breast-feeding at least six months earlier and who did not use any hormone as contraceptive or hormonal replacement therapy, were included in the study. Women with chronic diseases affecting bone metabolism were excluded from the study. Hysterectomized, smoker and alcoholic women were also excluded.

Measurement of bone mineral density

Secca Balance (Columbia, USA) with a precision of 100 g was used for measuring body weight of the subjects. A locally-constructed scale with 1 mm sensitivity was used for measuring their heights. BMD of distal end of the radius and ulna was measured at two sites defined as distal BMD if taken at the distal third of the fore-arm and ultra-distal BMD if evaluated over the wrist of the non-dominant arm. A bone densitometer (Single x-ray absorptiometry, DTX100, USA) was used for measuring BMD. The results were expressed in g/cm^2 by taking the mean of the distal and ultra-distal sites of both radius and ulna.

Definitions

Total duration of breast-feeding: Total duration of breast-feeding was estimated by recall and included both exclusive and partial breast-feeding to all children born to a woman.

Total duration of lactational amenorrhoea: Total duration of lactational amenorrhoea was defined as the total duration of amenorrhoea due to breast-feeding for all children up to the current age of subjects.

Moderate workload: Moderate workload was defined as workload of those who earn their living on physical labour.

Light workload: Light workload was defined in terms of domestic work or sedentary service.

Body mass index: Body mass index (BMI) was calculated using the formula $wt\ (kg)/ht(m)^2$.

Trained physicians filled up a pre-designed questionnaire on age, parity, number of family members, and family income. Information on duration of breast-feeding and lactational amenorrhoea was also recorded. Written consents were obtained from the subjects prior to their enrollment into the study.

Statistical Analysis

SPSS/PC+ and EPISTAT were used for data cleaning, validation, and analysis. For the differences between groups, unpaired Student's *t*-tests and one-way ANOVA were performed. Multiple linear regression was performed to identify the relationship of BMD with other biological factors. Statistical significance was considered at 5% level.

RESULTS

General characteristics of the study subjects are presented in Table 1. The mean age of the subjects was about 42 years ranging from 20 to 81 years. On an average, five children were breastfed by these groups of women. The median total breast-feeding period for each mother was equivalent to seven years. Each woman had about nine

months of lactational amenorrhoea at the time of interview. The mean body mass index was 21.4±4.

higher BMD than those who had a longer duration of lactational amenorrhoea (0.45 vs 0.37, p<0.01). There

Table 1. Characteristics of study subjects (n=400)

Characteristics	Mean±SD	Median (range)
Age (in years)	41.9±14.6	39 (20-81)
Menopause (in years)	48.8±3.2	50 (40-55)
Parity	4.5±2.9	4 (1-14)
No. of breastfed children	4.5±3.0	4 (1-8)
Total no. of months breastfed	82.8±44.2	84 (2-198)
Total no. of months of lactational amenorrhoea	13.6±17.3	9 (1-101)
Body mass index	21.4±4	20.9 (12.8-35.7)
Family income per month (Taka)	6,400±4,600	5,000 (1,000-50,000)*

* 1 US$=56 Taka

The effects of breast-feeding (both exclusive and partial) on BMD are shown in Table 2. The mothers who breastfed for about 60 months or less had higher BMD compared to those who breastfed for more than 60 months. A significant variation was found in BMD between and within the groups according to the duration of breast-feeding (p<0.001).

was a significant variation in BMD within the groups according to the duration of lactational amenorrhoea (p<0.001).

Table 4 shows the relationship of BMD with other biological factors using multiple linear regression analysis. After controlling for parity, physical workload, and total duration of breast-feeding, BMD was

Table 2. Effect of total duration of breast-feeding (both exclusive and partial) on bone mineral density

Total no. of months	Bone mineral density g/cm^2 (mean±SD)
A=Up to 60 months (n=95)	0.61±0.08^a
B=61-120 months (n=81)	0.55±0.08^b
C=>120 months (n=62)	0.49±0.11^c

Between and within groups significant (ANOVA), p<0.001
^{abc} Significantly different with one another (Student's *t*-test), p<0.01

Table 3. Effect of total duration of lactational amenorrhoea on bone mineral density

Total no. of months	Bone mineral density g/cm^2 (mean±SD)
A=Up to 5 months (n=33)	0.45±0.05^a
B=6-12 months (n=36)	0.42±0.06^b
C=>12 months (n=25)	0.37±0.07^c

Between and within groups significant (ANOVA), p<0.001
^{abc} Significantly different with one another (Student's *t*-test), p<0.01

There was a significantly higher BMD in women who had a shorter duration of lactational amenorrhoea compared to those who had a longer duration of amenorrhoea (Table 3). The women who had amenorrhoea for less than six months had a significantly

significantly and negatively correlated with age (slope -0.004, p<0.001) and total duration of lactational amenorrhoea (slope -0.024, p<0.05). BMD was well-correlated with nutritional status, i.e. BMI (p<0.05), and education (p<0.05).

Table 4. Relationship of bone mineral density with other biological factors in a multiple linear regression analysis

	Dependent variable=Bone mineral density		
Independent variable	Slope beta	Standard error	Significance (p value)
Age (in years)	-0.004	0.001	<0.001
Parity	0.015	0.020	0.44
At least one year of schooling	0.033	0.016	<0.05
Moderate workload	0.051	0.068	0.45
Total no. of months of breast-feeding	0.000	0.000	0.91
Total no. of months of lactational amenorrhoea	-0.024	0.010	<0.05
Body mass index	0.004	0.002	<0.05
Constant	0.700	0.051	<0.001

R^2= 0. 57, p<0.001

DISCUSSION

This study was designed to assess the association between the longer duration of breast-feeding and BMD. The results of this study showed the impact of prolonged breast-feeding (i.e. five years and above) on BMD in univariate analysis. A significant decrease in BMD associated with increased duration of breast-feeding could be related to the cumulative loss of calcium through breastmilk, which could not be replaced with dietary calcium of the marginally-nourished mother (BMI=21.4). How lactation affects BMD is not clear, but the suppression of ovarian hormones causes bone resorption which affects BMD. But this relationship was diluted in multiple regression analysis.

Women who breastfed for a longer period had a significant lower BMD in the ultra-distal fore-arm than had women who breastfed for a shorter period was also reported by Wardlaw *et al*. (7). Hayslip *et al*. found a significant decrease (6.5%) in the vertebral (L_2-L_4) bone mineral content of lactating women at six months postpartum (6). The effect of total duration of lactational amenorrhoea which is a proxy indicator of breast-feeding significantly and negatively correlated with BMD in multivariate analysis. Honda *et al*. reported a similar finding (5). Lactation is associated with prolonged postpartum suppression of hypothalamic-pituitary-ovarian axis and resultant amenorrhoea. The resultant hypoestrogenaemia causes bone resorption.

Results of our study also showed that age was negatively correlated with BMD and positively correlated with education and BMI. The positive correlation with BMI suggests a role of adipose tissue (and, therefore, fat-dependent estrogen production) in maintaining bone mass. Maximum part of estrogen is derived from the conversion of androstenedione, occurring in the adipose tissue (17). Better nutritional status of women is reflected by a better BMI. Therefore, an overall calcium balance may be better with a better nutritional status.

It is concluded that, although a negative correlation between BMD and longer duration of breast-feeding was found in univariate analysis, it was not significant when other factors were controlled. The duration of lactational amenorrhoea showed a negative correlation with BMD. We, therefore, recommend that all lactating women be given diet with adequate calcium to support breast-feeding and for maintaining good nutrition of their bones.

ACKNOWLEDGEMENTS

This study was funded by the Bangladesh Medical Research Council. We are grateful to the women who had participated in the study. We express our thanks to the Department of Obstetrics and Gynaecology, Institute of Post-Graduate Medicine and Research (presently Bangabandhu Sheikh Mujib Medical University), Dhaka, for allowing us to use the bone densitometer.

REFERENCES

1. Haque MT. Study on knowledge, attitude and practice of rural Bangladeshi mothers towards breastfeeding. Dhaka: National Institute of Preventive and Social Medicine, 1984:36-48**.** (DPH dissertation).
2. Ho SC, Leung PC, Swaminathan R, Chan C, Chan SS, Fan YK, Lindsay R. Determinants of bone mass in Chinese women aged 21-40 years. II. Pattern of dietary calcium intake and association with bone mineral density. *Osteoporos Int* 1994;4:167-75.
3. Affinito P, Tommaselli GA, di Carlo C, Guida F, Nappi C. Changes in bone mineral density and calcium metabolism in breastfeeding women: a one year follow-up study. *J Clin Endocrinol Metab* 1996;81:2314-8.
4. Sowers M, Corton G, Shapiro B, Jannausch ML, Crutchfield M, Smith ML *et al*. Changes in bone density with lactation. *JAMA* 1993;269:3130-5 [comment appears in: *JAMA* 1993;270:2300 and 1994;272:1003-4].
5. Honda A, Kurabayashi T, Yahata T, Tomita M, Takakuwa K, Tanaka K. Lumbar bone mineral density changes during pregnancy and lactation. *Int J Gynaecol Obstet* 1998;63:253-8.
6. Hayslip CC, Klein TA, Wray HL, Duncan WE. The effects of lactation on bone mineral content in healthy postpartum women. *Obstet Gynecol* 1989;73:588-92.
7. Wardlaw GM, Pike AM. The effect of lactation on peak adult shaft and ultra-distal forearm bone mass in women. *Am J Clin Nutr* 1986;44:283-6.
8. Lissner L, Bengtsson C, Hansson T. Bone mineral content in relation to lactation history in pre- and postmenopausal women. *Calcif Tissue Int* 1991; 48:319-25.
9. Goldsmith NF, Johnston JO. Bone mineral: effects of oral contraceptives, pregnancy and lactation. *J Bone Joint Surg Am* 1975:57:657-68.
10. Atkinson PJ, West RR. Loss of skeletal calcium in lactating women. *J Obstet Gynaecol Br Commonw* 1970;77:555-60.

11. Chan GM, Slater P, Ronald N, Roberts CC, Thomas MR, Folland D *et al*. Bone mineral status of lactating mothers of different ages. *Am J Obstet Gynecol* 1982;144:438-41.
12. Kritz-Silverstein D, Barrett-Connor E, Hollenbach KA. Pregnancy and lactation as determinants of bone mineral density in postmenopausal women. *Am J Epidemiol* 1992;136:1052-9 [comment appears in: *Am J Epidemiol* 1993;138:1020-1].
13. Koetting CA, Wardlaw GM. Wrist, spine, and hip bone density in women with variable histories of lactation. *Am J Clin Nutr* 1988;48:1479-81.
14. Aloia JF, Vaswani AN, Yeh JK, Ross P, Ellis K, Cohn SH. Determinants of bone mass in postmenopausal women. *Arch Intern Med* 1983;143:1700-4.
15. Hreshchyshyn MM, Hopkins A, Zylstra S, Anbar M. Associations of parity, breast-feeding, and birth control pills with lumbar spine and femoral neck bone densities. *Am J Obstet Gynecol* 1988;159:318-22.
16. Stevenson JC, Lees B, Devenport M, Cust MP, Ganger KF. Determinants of bone density in normal women: risk factors for future osteoporosis? *Br Med J* 1989;298:924-8.
17. Suzuki N, Yano T, Nakazawa N, Yoshikawa H, Taketani Y. A possible role of estrone produced in adipose tissues in modulating postmenopausal bone density. *Maturitas* 1995;22:9-12.