cnr
CLINICAL NUTRITION RESEARCH

Original Article

Check for updates

Breastfeeding for One Month or Longer is Associated with Higher Risk of Osteoarthritis in Older Adults: NHANES 1999–2012

Clara Yongjoo Park

Division of Food and Nutrition, Chonnam National University, Gwangju 61186, Korea

OPEN ACCESS

Correspondence to
Clara Yongjoo Park
Division of Food and Nutrition, Chonnam National University, Room 319, 77 Yongbong-ro, Bukgu, Gwangju 61186, Republic of Korea.
Tel: +82-62-530-1354
Fax: +82-62-530-1339
E-mail: parkcy@jnu.ac.kr

Conflict of Interest
The authors declare that they have no competing interests.

ABSTRACT

Breastfeeding is associated with many health benefits to the mother but the association between osteoarthritis (OA) is not known. Menopause, a state of rapid estrogen loss, is associated with OA. To test whether lactation, another physiological state of low estrogen status, is associated with OA, a nationally representative dataset National Health and Nutrition Examination Survey (NHANES) 1999–2012 was analyzed. Information of OA diagnosis history and lactation for at least one month was self-reported by women 50 years and older that had given birth to at least one child. Women that breastfed for less than one month had a higher proportion of those that were 60 years and older, Hispanic (than non-Hispanic Black), and higher current/self-reported greatest body mass index. Women that breastfed for one month or longer had a higher proportion of those that had 3 or more children, higher poverty-income ratio, were post-menopausal and performed vigorous physical activity. Weighted percentage of OA patients was 22%, and did not differ between the two groups. However, when logistic regression was performed adjusting for multiple covariates, lactation for one month or longer was positively associated with OA. Women that breastfed for one month or longer had an adjusted odds ratio of 1.21 (95% confidence interval, 1.05–1.40) for OA compared to those that breastfed for less than one month. The results indicate that women that breastfed for at least one month have a higher risk of OA than women that delivered a child but breastfed for less than one month.

Keywords: Lactation; Breast feeding; Osteoarthritis; NHANES; Epidemiology

INTRODUCTION

Due to the benefits of breastfeeding, the World Health Organization recommends exclusive breastfeeding for six months and continuation of breastfeeding until at least one year of age [1]. Though 75% of mothers initiate breastfeeding in the US, 43% continue breastfeeding for 6 months and only 14% exclusively breastfeed for six months [2]. Worldwide, about 38% of infants are exclusively breastfed for six months. Breastfeeding is known to benefit both the infant and mother. Nursing infants have lower rates of infections, diarrhea, food allergies, celiac disease, asthma, obesity in adulthood, etc. [3]. Benefits to the mother include decreased blood loss following delivery, better uterus shrinkage and weight loss, and lower risk of postpartum depression [3]. In the long run, breastfeeding mothers have lower rates of

Generated by KAMJE PRESS

CLINICAL NUTRITION RESEARCH

breast cancer, cardiovascular disease, and rheumatoid arthritis [3,4]. However, the effect of lactation on osteoarthritis (OA) has not yet been examined.

Osteoarthritis is a degenerative disease affecting 5 million Koreans, 27 million Americans, and 10%–15% of the world population [5,6]. No cure is currently available for OA, and patients must endure this condition until the joint is severely damaged and qualifies for joint replacement surgery. Despite the high prevalence of OA, the etiology is not known. For decades OA was thought to be a 'wear and tear' disease, induced by severe use of joints, high body weight, and old age. However, recent findings point to additional genetic and other potential mechanisms involved in bone formation. Characteristics of OA include narrowing of joint space, disorientation and calcification of articular cartilage, destruction of subchondral bone, osteophytes, joint pain and decreased function [7]. More research of the mechanism of OA is required.

Estrogen loss, through menopause or hysterectomy, is known to be associated with OA in humans and animals [8], but the precise mechanism is unclear. Prevalence and severity of OA is greater in postmenopausal women than premenopausal women or men [9]. Lactation is another physiological state of low estrogen status [10]. Therefore, this study tested the hypothesis that women that breastfed children for at least one month are more likely to have OA than women that bore children but breastfed for less than one month.

MATERIALS AND METHODS

Study population
National Health and Nutrition Examination Survey (NHANES) data 1999–2012 was compiled [11]. NHANES is a nationally representative database of health and nutrition- related behaviors of non-institutionalized US population. The study population was limited to females 50 years and older. Females that did not bear children or did not have lactation data (n = 1,769) were excluded. Participants that were not classified as non-Hispanic White, non-Hispanic Black, or Mexican American/other Hispanics were also excluded (n = 478). A total of 6783 females were included in the analysis. The National Center for Health Statistics Research Ethics Review Board approved the protocol for all NHANES content [12].

Assessment and classification of subject characteristics
Age was categorized as 50–59 and ≥ 60 years. Race was categorized as non-Hispanic White, non-Hispanic Black, and Mexican American/other Hispanics. Non-Hispanic Asians were surveyed since 2011, but were excluded from this analysis due to the small sample size. Survey years were categorized by each two-year cycle. One's highest body mass index (BMI) was calculated using self-reported greatest weight (excluding pregnancy weight) and standing height measured at the mobile examination center (MEC). Current BMI was obtained from variable BMXBMI, which was provided by the Centers for Disease Control and Prevention (CDC) using height and weight measured at the time of examination. Categories for BMI followed the WHO guidelines as underweight (< 18.5), normal (18.5–24.9), overweight (25–29.9), and obese (≥ 30). Household income was determined as poverty income ratio (PIR), and categorized as 0%–129%, 130%–299%, and ≥ 300%. Education was categorized as less than high school or high school graduate/General Educational Diploma (GED) and higher. Parity was determined as the number of self-reported previous live births. Postmenopausal women were determined as no self-reported menstrual period during the past 12 months.

Categories for physical activity were no exercise, moderate activity < 150 minutes per week (and not performing vigorous activity), moderate exercise ≥ 150 minutes per week (and not performing vigorous activity), and performing vigorous physical activity over the past 30 days. Moderate activity was defined as "activities that require moderate physical effort and cause small increases in breathing or heart rate" for more than 10 minutes including brisk walking, carrying light loads, swimming, bicycling for pleasure, golf, and dancing. Moderate activity was calculated by multiplying the frequency and duration of moderate physical activities from work, recreation, and walking/riding a bike for transportation. Vigorous physical activity was determined by self-reported performance of vigorous activity over the past 30 days (yes/no). Vigorous activity was defined as "activities that require hard physical effort and cause large increases in breathing or heart rate" for more than 10 minutes including carrying or lifting heavy loads, digging or construction work, running, lap swimming, basketball, aerobics classes or fast bicycling. The average minutes per week of vigorous activity was not calculated due to the lack of relevant questions for years 1999–2006. For activity measures that the participant refused to answer or did not know, the participant was assumed to have performed no activity for that component. The weighted mean duration of moderate activity per week was calculated both including and excluding those that perform vigorous activity. Lactation status determined by combining questions RHQ210 (breastfed any of your children?) and RHD230 (number of children breastfed at least 1 month) for years 1999–2004 to match the 2005–2012 question RHQ205 (breastfed any of your children for at least one month?). Those that refused to answer/did not know/missing lactation information were excluded from the analysis. Subset analysis for years 1999–2006 was performed on the number of children reported to be breastfed for at least one month, as data was unavailable for years 2007–2012. Number of children breastfed for at least 1 month were categorized by 2 methods: 1) 0, 1, 2, and ≥ 3, and 2) 0, 1, 2, 3, 4–5, and ≥ 6. Diagnosis of OA was determined by self-report during the MEC questionnaire. The 2011–2012 answer option for OA includes degenerative arthritis ('osteoarthritis and degenerative arthritis') [13].

Statistical analysis

The t-tests were performed to compare means of baseline characteristics following the proc surveyreg procedure according to the CDC guidelines. Difference in distribution of characteristics was determined by Rao-Scott χ^2 analysis. Logistic regression analysis determined the odds of OA according to lactation status. All logistic regression models were adjusted for age, race, survey year, PIR, education level, menopausal status, parity, physical activity, and greatest or current BMI. MEC weights were applied to the models. SAS 9.4 (SAS Institute Inc., Cary, NC, USA) was used to perform the analysis. The null hypothesis was rejected when $p < 0.05$.

RESULTS

Mean age of women that breastfed for at least one month did not differ from those that breastfed for less than one month, but age distribution differed in that a larger proportion of women that breastfed for one month or longer were younger than 60 years of age compared to those that breastfed for a shorter period (**Table 1**). The majority of the subjects were non-Hispanic White, but women that breastfed for one month or longer had a higher proportion of Hispanic origin than women that did not breastfeed for at least one month. Current body weight, current BMI, and greatest BMI were lower in women that breastfed for at least one month. Distribution of PIR in women that breastfed for at least one month was skewed

Table 1. Characteristics of women 50 years and older according to breastfeeding history (*n* = 6,783)

Characteristic	Breastfed < 1 month (*n* = 3,296)			Breastfed ≥ 1 month (*n* = 3,487)			Weighted p values*
	n	Percentage		*n*	Percentage		
		Unweighted	Weighted		Unweighted	Weighted	
Age (y), mean ± SEM			64.4 ± 0.2			64.5 ± 0.3	0.72
50–59.9	931	28	37	977	28	41	0.004
≥ 60	2,365	72	63	2,510	72	59	
Race							< 0.001
Non-Hispanic White	1,859	56	81	1,801	49	81	
Non-Hispanic Black	857	26	13	574	16	8	
Mexican American/other Hispanics	580	18	6	1,112	32	11	
Survey year							0.54
1999–2000	425	13	13	477	14	12	
2001–2002	443	13	14	480	14	15	
2003–2004	434	13	13	494	14	13	
2005–2006	421	13	15	402	12	14	
2007–2008	603	18	15	570	16	14	
2009–2010	511	16	14	597	17	15	
2011–2012	459	14	15	467	13	17	
Height (cm)†, mean ± SEM			160.8 ± 0.2			160.9 ± 0.2	0.61
Weight (kg)‡, mean ± SEM			76.1 ± 0.4			74.6 ± 0.4	0.024
BMI from greatest weight§							
Underweight/normal	460	14	17	483	14	19	0.029
Overweight	954	29	30	1,012	29	32	
Obese	1,749	53	50	1,783	51	46	
Missing	133	4	3	209	6	4	
Current BMI							
Underweight	44	1	2	44	1	1	0.046
Normal	791	24	27	870	25	30	
Overweight	990	30	30	1,105	32	32	
Obese	1,392	42	40	1,384	40	35	
Missing	79	2	2	84	2	2	
PIR (%)							< 0.001
0–129	877	27	20	1,006	29	18	
130–299	1,081	33	32	1,030	30	27	
≥ 300	1,040	32	40	1,097	31	47	
Missing	298	9	8	354	10	8	
Education level‖							0.44
≥ High school/GED	2,304	70	77	2068	59	76	
Parity¶							< 0.001
1	612	19	20	306	9	12	
2	1,007	31	34	841	24	32	
≥ 3	1,676	51	46	2,340	67	56	
Menopause**							< 0.001
Post-menopause	134	4	5	217	6	9	
Physical activity							< 0.001
No activity	2,226	68	61	2,324	67	58	
< 150 min/wk moderate activity	158	5	6	148	4	5	
> 150 min/wk moderate activity	503	15	19	515	15	17	
Vigorous activity	409	12	15	500	14	20	
Mean of moderate activity of those that do not do vigorous exercise, mean ± SEM			243 ± 22			200 ± 18	0.088
Mean of moderate activity of all subjects, mean ± SEM			334 ± 30			320 ± 26	0.66

SEM, standard error of the mean; BMI, body mass index; PIR, poverty-income ratio; GED, general educational diploma.

*t-tests were performed to compare means, χ^2 analyses was performed to compare distribution of characteristics among groups; †92 subjects missing height information; ‡72 subjects missing weight information; §BMI greatest weight was determined by self-reported greatest weight (excluding pregnancy weight) (kg)/height (m)². Underweight: BMI < 18.5; normal: 18.5 ≤ BMI < 25; overweight: 25 ≤ BMI < 30; obese: 30 ≤ BMI. Few subjects had BMI less than 18.5 at their greatest weight; ‖13 missing education information; ¶1 subject missing parity information; **7 subjects missing menopausal status.

Table 2. Percentage and odds ratio of OA diagnosis according to breastfeeding history*

Subject	n	Percentage		Weighted χ^2 p value	Odds ratio (95% confidence interval)
		Unweighted	Weighted		
Breastfed < 1 month (n = 3,296)	663	20	21	0.17	1 (reference)
Breastfed ≥ 1 month (n = 3,487)	683	20	23		1.21 (1.05–1.40)

OA, osteoarthritis; PIR, poverty-income ratio; BMI, body mass index; MEC, mobile examination center.
*Model was adjusted for age, race, survey year, PIR, education level, menopausal status, parity, physical activity, and greatest BMI. MEC weights were applied to the model.

toward higher income compared to those that breastfed for a shorter period. Women that breastfed for one month or longer were more likely to have had more children. Distribution of physical activity differed between the two groups, but mean duration of moderate physical activity did not differ. Mean heights and the distribution of education level were similar between the two groups.

Weighted percentage of OA patients was 22% in all subjects and proportion of OA patients did not differ between groups (**Table 2**). However, after adjustment for potential confounding factors, logistic regression results indicate that lactation for one month or longer is significantly associated with OA (p = 0.014). Women that breastfed for at least one month had an adjusted odds ratio of 1.21 (95% confidence interval, 1.05–1.40) compared to those that breastfed for a shorter period. Age, race, menopausal status, and greatest BMI were significant confounders (all p < 0.01). Education, PIR, current BMI, parity, and physical activity were not significantly associated with OA. The number of children breastfed for at least one month and OA were not associated when subset analyses was performed, regardless of the categorization of breastfed children (data not shown).

DISCUSSION

In this nationally representative cross-sectional analysis of US women 50 years and older that have given birth to at least one child, women that breastfed for at least one month were more likely to have OA, compared to women that breastfed for less than one month. To my knowledge, this is the first study to investigate the relationship between lactation and OA.

The positive relationship between breastfeeding and OA may be alarming as women that breastfed for at least one month tended to have a healthier lifestyle and higher PIR compared to women that breastfed for less than one month. A larger proportion of women that breastfed for one month or longer participated in vigorous physical activity and had lower current and greatest BMI than those that breastfed for less than one month. Breastfeeding has been advocated for decades by the American Academy of Pediatrics as early as 1948 due to its health benefits to the mother and offspring [14]. Those that are alert to healthy lifestyles around the time of childbirth may be more likely to breastfeed for one month or longer, and this tendency may continue to older adulthood. On the other hand, lactation has been reported to assist weight loss during the postpartum period [3], possibly leading to sustained lower weight during older adulthood. Though the causality of healthy habits and lactation cannot be explained through the current analysis, an association exists between lactation status and physical activity and weight in later life. Despite the lower weight and more participation in vigorous exercise of women that breastfed for at least one month, the positive association between lactation and OA indicates that breastfeeding itself may have a physiologic effect on initiation and progression of OA.

The increased risk of OA associated with breastfeeding for at least one month may be related to prolonged estrogen deficiency. Estrogen deficiency is reported to be associated with OA in humans and animals [8] but the effect of estrogen or estrogen deficiency on the joint is not fully understood. Estrogen receptors are expressed in many cells of the joint including chondrocytes [15], subchondral bone cells [16], and synoviocytes [17] and expression of estrogen receptors is increased in OA patients [18]. Results of this study indicate that physiological states associated with decreases in estrogen status — lactation and menopause — are both positively associated with OA. Postmenopausal women have continuously low levels of estrogen compared to premenopausal women [19]. Estrogen decreases prior to birth and throughout breastfeeding though it gradually recovers to reach normal levels by about 6 months or at cessation of lactation [10]. The number of times estrogen status persists at low levels for several weeks does not seem to be associated with OA. Neither parity nor number of children breastfed for at least one month were associated with OA in this analysis. Rather, prolonged estrogen deficiency may affect joint health. However, the lack of data on length of breastfeeding limits our ability to assess the association between length of breastfeeding and OA. In addition, a thorough investigation of serum estrogen status, and/or use of estrogen pills or patches is needed to test whether duration of change in estrogen levels is associated with OA.

The positive association between breastfeeding and OA indicates the need to provide prevention information especially for women that breastfeed for one month or longer. Breastfeeding is promoted for its several physical and psychological health benefits for both the mother and child in addition to its economic advantage [3]. In addition, breastfeeding may be the safest mode of feeding especially in under-developed countries. The known benefits of breastfeeding outweigh its potential risks. As observed in this study, women that breastfed for one month or longer seem to be more health cautious and may be more likely to adhere to suggestions to protect joint health. However, the lack of knowledge on the cause of OA, in addition to the lack of treatment options, limits the ability to provide preventative guidelines. Thus, more research on the etiology of OA and the association between lactation and OA is required.

The current analysis has several limitations. First, this cross-sectional study investigates the association of lactation and OA but does not confirm a causal relationship. However, the results provide a basis for further research in the physiology of lactation and its possible effect on OA. Second, most data were self-reported, which can introduce reporting bias, especially regarding lactation duration as this relied on the participants' memory. A prospective cohort study may generate more reliable results, but ensuring decades of follow-up can be challenging. Third, duration of vigorous physical activity was not available for years 1999–2006. Therefore, it was not possible to determine whether those that performed vigorous exercise met the recommendations of 150 minutes per week of moderate exercise or 75 minutes per week of vigorous exercise. Additionally, previous physical activity, rather than current physical activity, may have a causal effect and be more strongly correlated to OA incidence, but this was not examined in NHANES. Fourth, the duration of lactation was not assessed in the current analysis. Taking into account whether the mother exclusively breastfed or provided mixed feeding and total length of breastfeeding may provide more information on the physiological events during breastfeeding and its possible causality on OA. However, the NHANES database only provides information on the number of children breastfed for years 1999–2006 and no information is available on the total length of breastfeeding.

CONCLUSION

Among women that gave birth to at least one child, self-reported breastfeeding for at least one month had 21% higher risk of OA later in life (age 50 years or older) compared to women that did not breastfeed for at least one month. A causal relationship cannot be determined by these results, and more detailed analysis on the length of breastfeeding and use of estrogen products may point to a possible physiological explanation.

REFERENCES

1. World Health Organization. Infant and young child feeding [Internet]. Geneva: World Health Organization; 2017 [cited 2017 August 26]. Available from: http://www.who.int/mediacentre/factsheets/fs342/en/.

2. Centers for Disease Control and Prevention (US). Healthy People 2020 Objectives for the Nation [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2016 [cited 2017 August 26]. Available from: https://www.cdc.gov/breastfeeding/policy/hp2020.htm.

3. American Academy for Pediatrics, Section on Breastfeeding. Breastfeeding and the use of human milk. Pediatrics 2012;129:e827-41.
   PUBMED | CROSSREF

4. Victora CG, Bahl R, Barros AJ, França GV, Horton S, Krasevec J, Murch S, Sankar MJ, Walker N, Rollins NCLancet Breastfeeding Series Group. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. Lancet 2016;387:475-90.
   PUBMED | CROSSREF

5. Arthritis Foundation (US). What is osteoarthritis? [Internet]. Atlanta (GA): Arthritis Foundation; [cited 2017 August 26]. Available from: http://www.arthritis.org/about-arthritis/types/osteoarthritis/what-is-osteoarthritis.php.

6. Shin DW, Nam S, Bang YS, Lee JY. Estimation of the prevalence of Korean adults aged 50 years or more with knee osteoarthritis based on the data from fifth Korea National Health and Nutrition Examination Survey. J Korean Med Assoc 2013;56:431-6.
   CROSSREF

7. Centers for Disease Control and Prevention (US). Osteoarthritis Fact Sheet [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2017 [cited 2017 July 24]. Available from: https://www.cdc.gov/arthritis/basics/osteoarthritis.htm.

8. Roman-Blas JA, Castañeda S, Largo R, Herrero-Beaumont G. Osteoarthritis associated with estrogen deficiency. Arthritis Res Ther 2009;11:241.
   PUBMED | CROSSREF

9. Srikanth VK, Fryer JL, Zhai G, Winzenberg TM, Hosmer D, Jones G. A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. Osteoarthritis Cartilage 2005;13:769-81.
   PUBMED | CROSSREF

10. Battin DA, Marrs RP, Fleiss PM, Mishell DR Jr. Effect of suckling on serum prolactin, luteinizing hormone, follicle-stimulating hormone, and estradiol during prolonged lactation. Obstet Gynecol 1985;65:785-8.
    PUBMED

11. Centers for Disease Control and Prevention (US). National Health and Nutrition Examination Survey. Questionnaires, datasets, and related documentation [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2015 [cited 2017 August 1]. Available from: https://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm.

12. Centers for Disease Control and Prevention (US). NCHS Research Ethics Review Board (ERB) Approval [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2017 [cited 2017 September 4]. Available from: https://www.cdc.gov/nchs/nhanes/irba98.htm.

13. Centers for Disease Control and Prevention (US). National Health and Nutrition Examination Survey: 2011–2012 data documentation, codebook, and frequencies [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2013 [cited 2017 August 1]. Available from: https://wwwn.cdc.gov/Nchs/Nhanes/2011-2012/MCQ_G.htm#MCQ195.

14. American Academy of Pediatrics, Work Group on Breastfeeding. Breastfeeding and the use of human milk. Pediatrics 1997;100:1035-9.
    PUBMED | CROSSREF

15. Ushiyama T, Ueyama H, Inoue K, Ohkubo I, Hukuda S. Expression of genes for estrogen receptors alpha and beta in human articular chondrocytes. Osteoarthritis Cartilage 1999;7:560-6.
    PUBMED | CROSSREF

16. Braidman IP, Hainey L, Batra G, Selby PL, Saunders PT, Hoyland JA. Localization of estrogen receptor beta protein expression in adult human bone. J Bone Miner Res 2001;16:214-20.
    PUBMED | CROSSREF

17. Dietrich W, Haitel A, Holzer G, Huber JC, Kolbus A, Tschugguel W. Estrogen receptor-beta is the predominant estrogen receptor subtype in normal human synovia. J Soc Gynecol Investig 2006;13:512-7.
    PUBMED | CROSSREF

18. Sciore P, Frank CB, Hart DA. Identification of sex hormone receptors in human and rabbit ligaments of the knee by reverse transcription-polymerase chain reaction: evidence that receptors are present in tissue from both male and female subjects. J Orthop Res 1998;16:604-10.
    PUBMED | CROSSREF

19. Petrakis NL, Wrensch MR, Ernster VL, Miike R, Murai J, Simberg N, Siiteri PK. Influence of pregnancy and lactation on serum and breast fluid estrogen levels: implications for breast cancer risk. Int J Cancer 1987;40:587-91.
    PUBMED | CROSSREF