Relationship of Breastfeeding Duration with Joint Pain and Knee Osteoarthritis in Middle-aged Korean Women: A Cross-sectional Study using the Korea National Health and Nutrition Examination Survey

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· We used Korea National Health and Nutrition Examination Survey data on Women age ≥ 50.

· We surveyed lactation, joint pain, and we defined knee arthritis on X-ray images.

· Long-term breastfeeding is associated with joint pain and knee osteoarthritis.
Abstract

Background
The effect of joint health on quality of life in middle-aged and older women is becoming more widely recognized with the aging of the world’s population. However, the association of long-term breastfeeding with joint pain and knee osteoarthritis has not been fully examined. The aim of this study was to determine the association of long-term breastfeeding with joint pain and knee osteoarthritis in middle-aged Korean women.

Methods
A cross-sectional study was conducted among 3,454 women aged ≥50 years who underwent knee radiography and answered a questionnaire on breastfeeding and joint pain for the 5th Korean National Health and Nutrition Examination Survey (2010–2011). After adjusting for confounding sociodemographic, medical history, and obstetric and gynecologic variables, logistic regression analysis was conducted to analyze the incidence of joint pain and knee osteoarthritis according to breastfeeding and its duration. Among the 3,454 participants, 298 had not breastfed and 1,042, 815, and 1,299 had breastfed for 1–24, 25–48, and ≥49 months, respectively. Of all participants, 1,731 had joint pain and 739 were diagnosed with knee osteoarthritis after radiography.

Results
The odds ratio (OR) for joint pain among women who breastfed was 1.493 times higher than that among women who did not (p=0.044). As breastfeeding duration increased, the OR of joint pain incidence also increased (p for trend; p=0.002). For knee osteoarthritis, the OR was significantly different between the 25–48 and ≥49 months groups (2.299 [p=0.03] and 2.166 [p=0.047], respectively). Reanalysis after selecting only participants aged ≥60 years showed that the prevalence of joint pain and knee osteoarthritis was more positively correlated with extended breastfeeding duration (joint pain, p for trend; p=0.005) (knee osteoarthritis, p for trend; p=0.012).

Conclusions
Long-term feeding of more than 25 months was associated with an increased prevalence of arthralgia and degenerative arthritis after menopause in Korean elderly women.

Abbreviations
BMI, body mass index; CI, confidence interval; KNHANES, Korea National Health and Nutrition Examination Survey; OR, odds ratio

Keywords
KNHANES, Lactation, Menopause, Knee Osteoarthritis, Arthralgia
**Background**

Breast milk has species specificity and is superior to artificial compounds in providing nutrition, promoting physical development, and boosting the immune system in neonates [1]. Breastfeeding also offers numerous benefits for mothers, preventing depression and stress, promoting recovery to the prenatal state, and reducing the incidence of breast cancer, ovarian cancer, and type 2 diabetes mellitus [2]. Thus, WHO and UNICEF recommend exclusively breastfeeding during the first 6 months and continuing breastfeeding while providing a supplemented diet up till 2 years after birth [3]. Worldwide, approximately 38% of newborns are exclusively breastfed for 6 months [3].

Approximately one-third of the population aged ≥65 years has osteoarthritis, and this disease affects approximately 5 million individuals in Korea [4] and 100 million worldwide [5]. Women are more susceptible to osteoarthritis. The risk of osteoarthritis in the hands, knees, and hips increases after menopause [6, 7], likely owing to estrogen deficiency [8]. However, long-term estrogen deficiency can occur not only after menopause but also during breastfeeding [9]. Therefore, there may be an association between joint health in women and breastfeeding duration.

Until recently, studies of the effects of breastfeeding on musculoskeletal systems in women have focused on transient osteoporosis caused by changes in bone metabolism [10], osteoporosis linked to menopause [11] and rheumatoid arthritis [12]. The effect of joint health on quality of life in middle-aged and older women is becoming more widely recognized with the aging of the world’s population [13]. However, the association of long-term breastfeeding with joint pain and knee osteoarthritis has not been fully examined.
Methods

Aim

To determine whether the risk of joint pain and knee osteoarthritis changes according to breastfeeding and its duration, we conducted an analysis among Korean women using Korean National Health and Nutrition Examination Survey (KNHANES) data.

Study participants and examined variables

Participant selection

KNHANES is a sample database representing health and nutrition-related behaviors of Korean individuals nationwide. The number of subjects in the 5th KNHANES was 10,938 in 2010 and 10,589 in 2011, and the actual numbers of participants were 8,958 and 8,518, respectively. For this study, we included women aged ≥50 years who underwent osteoarthritis radiography examination and answered the self-administered questionnaire on breastfeeding. Overall, 3,454 women were included (Figure 1).

Breastfeeding duration

Participants who answered “no” to “(adult) presence of breastfeeding experience” in the health survey were categorized into the non-breastfeeding group. Those who answered “yes” were asked to provide their two-digit “(adult) breastfeeding duration” in months. The participants were further divided into 1–24, 25–48, and ≥49 months breastfeeding groups.

Joint pain

The presence of perceived knee, hip, and lower back pain was determined in the survey. Those who answered “yes” to “Have you experienced knee joint pain/hip joint pain/lumbar pain for longer than 30 days in the past 3 months?” were classified into the knee joint, hip joint, and lumbar pain joint groups. In the overall analysis, "joint pain" was defined as the case where there was more than one joint pain in three sites.

Knee osteoarthritis

Radiography for osteoarthritis diagnosis was conducted for participants aged ≥50 years. The radiological osteoarthritis diagnostic values for the knee joint were classified based on the Kellgren-Lawrence Grading Scale, as follows: 0, normal; 1, suspicion of osteoarthritis; 2, mild osteoarthritis; 3, moderate osteoarthritis; and 4, severe osteoarthritis [14]. Those diagnosed with mild, moderate, and severe osteoarthritis were considered to have knee...
osteoarthritis.

Confounding variables

Sociodemographic variables

Numerical variables were used to express participant ages. Income level was divided into four categories (low, middle-low, middle-high, high) according to the average monthly equivalized household income (monthly household income/√number of household members).

Lifestyle variables

BMI (kg/m²) was used to divide participants into three groups: underweight (<18.5), normal (18.5–24.9), and overweight (≥25). Based on smoking status, participants were classified as non-smokers (never smoked), ex-smokers, and current smokers. Second-hand smoke exposure was defined as “exposure to indoor second-hand smoke at the workplace or in the house for one hour or longer per day.” Based on alcohol consumption, participants were divided into three groups: less than once a month, 1-4 times a month, and ≥5 times or more per month.

The level of daily activities was classified into resting, light activities, moderate or intense activities according to the amount of physical activities performed in the week before the survey. Those who “performed walking and moderate physical activities for 30 minutes or longer a day for 5 times or more per week” were categorized into the moderate or intense activities group, and those who did neither were categorized into the resting group. The rest of the participants were included in the light activities group. Occupational and physical activities such as slow swimming, tennis doubles, badminton, table tennis, and carrying light objects were considered moderate physical activities.

Medical history

Participants answered about their current dyslipidemia, diabetes, hypertension, and osteoporosis status. In case of diabetes, impaired fasting glucose levels were also included. Hypertension was defined as “the presence of systolic blood pressure of ≥140 mmHg or diastolic blood pressure of ≥90 mmHg or treatment with medication for hypertension.”

Obstetric and gynecological variables

The numbers of natural birth, cesarean section, and preterm birth were combined to obtain the
total number of children, whereas the numbers of spontaneous and induced miscarriages were combined to obtain the number of miscarriages. Participants were asked to provide a two-digit number for age at menopause (in years). The length of postmenopause was measured by subtracting this number from the age at the time of the survey. Women who took hormone supplementation were checked, and the groups were categorized into 1-11 and ≥12 months.

Data analysis

KNHANES uses stratified cluster sampling and weighted values. In this study, complex sampling design analysis was conducted using stratified, cluster, and weighted variables. All data analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

The participants’ sociodemographic, lifestyle, medical history, and obstetric and gynecological characteristics were analyzed according to breastfeeding duration. The T-test and Rao-Scott chi-squared test were conducted to compare continuous and categorical variables among the non-breastfeeding (control) group and the 1–24, 25–48, and ≥49 months breastfeeding groups. The missing values of the corrected confounding variables were excluded in analysis.

To calculate the OR and 95% CI of joint pain and knee osteoarthritis, logistic regression analysis was conducted with the non-breastfeeding group as the standard baseline, after adjusting for confounders. As knee osteoarthritis is largely affected by age, and the differences in mean age among the breastfeeding groups were fairly large, a secondary analysis was conducted after re-selecting the participants aged ≥60. The OR and 95% CIs of knee osteoarthritis were calculated in groups aged ≥60 years after adjusting for the same confounding variables. In all tests, p<0.05 indicated statistical significance.
Results

Among the 3,454 women aged ≥50 years, 298 were included in the non-breastfeeding group, and 1,042, 815, and 1,299 were included in the 1–24, 25–48, and ≥49 months breastfeeding groups, respectively. Among those who answered the questionnaire, 1,731 participants had joint pain and 739 had knee osteoarthritis diagnosed by radiography (Table 1).

The percentage of participants with a high income was high (approximately 31%) in the non-breastfeeding group and 1–24 months breastfeeding group, and the percentage with a low income was high in the 25–48 and ≥49 months breastfeeding groups. showing the likely association between lower income and longer breastfeeding duration. The non-breastfeeding group showed higher current and ex-smoking rates than the breastfeeding groups, and the no alcohol consumption rate was 40% or higher in all groups. The long-term breastfeeding groups (≥25 months) had high overweight rates (BMI >25 kg/m²). The longer the lactation period, the higher the average number of children.

The prevalence of hormone supplementation was low in the ≥49 months breastfeeding group, and the duration was short. The percentage of those having experienced menopause was high in the ≥25 months breastfeeding groups, and 99.3% of the ≥49 months breastfeeding group had experienced menopause. The prevalence of diabetes and the percentage of joint pain complaints also increased with breastfeeding duration (Table 1).

As a result of analyzing the incidence of joint pain in the non-breastfeeding group and breastfeeding group over 1 month, the odds ratio among all women who breastfed was significantly higher (OR 1.493; p=0.044). The longer lactation period, the higher the odds ratio of joint pain (p for trend; p=0.002). (Table 2). When age and all other factors were adjusted for, the ≥25 and ≥49 months breastfeeding groups showed a higher onset of knee osteoarthritis than the non-breastfeeding group (OR 2.299 [p=0.03], OR 2.166 [p=0.047] ) (Table 3).

Differences in the prevalence of joint pain between the non-breastfeeding group and breastfeeding groups were more notable in women aged ≥60 years. After adjusting for all confounding variables, the OR of joint pain was 2.614 times higher in the breastfeeding groups than in the non-breastfeeding group (95% CI 1.417–4.821, p=0.002), and the OR increased significantly with breastfeeding duration (p for trend; p=0.005) (Table 4). The prevalence of knee osteoarthritis also increased in those aged ≥60 years in all breastfeeding groups (OR 2.751, 95% CI 1.165–6.495) (p=0.021). The tendency of OR to increase with
breastfeeding duration was also significant (p for trend; p=0.012), and the OR of knee osteoarthritis in the ≥49 months breastfeeding group was 3.18 (95% CI 1.349–7.498, p=0.008) (Table 5).
Discussion

Taken together, our data showed that breastfeeding experience was associated with increases in complaints of subjective joint pain and diagnostic rates (by radiography) of knee osteoarthritis in Korean women aged ≥50. In addition, we found that the prevalence of joint pain significantly increased with a breastfeeding duration longer than 25 months.

In this study, longer breastfeeding duration was clearly associated with higher mean age. Osteoarthritis is greatly influenced by age [15]. Hence, during logistic regression analysis, age was the primary factor adjusted for, and participants aged ≥60 were separated and included in a sub-analysis. The results showed more significant correlations between breastfeeding duration and joint pain and knee osteoarthritis. When compared to the total participants aged ≥50 years, the OR of knee osteoarthritis in the breastfeeding groups aged ≥60 years increased from 1.493 to 2.614 (Tables 2, 4). The OR of knee osteoarthritis was 1.92 in the breastfeeding groups aged ≥50 and 2.751 in the breastfeeding groups aged ≥60, showing a marked increase in older participants (Tables 3, 5).

The effects of breastfeeding on osteoarthritis have not been fully elucidated. Park’s study (2017) was the first investigation of the association between breastfeeding and osteoarthritis [3]. It analyzed 6,783 women aged ≥50 years using 1999–2012 National Health and Nutrition Examination Survey (NHANES) data, and showed an association between breastfeeding experience >1 month and an increased risk of osteoarthritis in older women. In this study, Park considered the “intensity of activities” that induces arthritis in detail. However, variables related to exposure to female hormones that are considered risk factors of osteoarthritis in women with breastfeeding experience, such as number of pregnancies and number of children, did not show a significant association with the increased risk of osteoarthritis, and breastfeeding duration could not be determined from the NHANES data.

Until recently, studies on the effects of accumulated breastfeeding duration on the musculoskeletal system in women after menopause have mainly focused on changes in bone density and rheumatoid arthritis. There is still controversy over the association of breastfeeding with bone density [16]. Some studies reported that the bone density of women who are breastfeeding or have just finished breastfeeding is higher than that of non-breastfeeding women [17, 18]. However, other studies investigating bone density among postmenopausal women showed a higher incidence of osteoporosis in those with long-term breastfeeding experience [19]. In a cohort study on 500 women aged 35–55 years, long-term breastfeeding showed significant associations with a decrease in spine bone mineral density after menopause [20].
Numerous studies have reported a negative association between breastfeeding and rheumatoid arthritis. A cohort study of 121,700 women from the Nurses’ Health Study showed that the relative risk of rheumatoid arthritis was significantly lower in those with longer breastfeeding durations [12]. In a cohort study of 18,326 participants from Sweden, the administration of oral birth control pills was not found to lower the risk of rheumatoid arthritis, but breastfeeding did, in proportion to its duration [21].

There are various risk factors for knee osteoarthritis, such as old age, female sex, high level of activities, consistent exercise, past knee joint injuries, and obesity [15]. In middle-aged or older women in particular, age and female hormone deficiency can simultaneously act as risk factors of joint degeneration [7]. Estrogen deficiency is also associated with osteoarthritis in humans and animals [22]. Estrogen receptors are present in several cells in the joints, including cartilage cells, subchondral bone cells, and synovial cells, and the expression of estrogen receptors increases in osteoarthritis patients [22-24]. Experiments using ovariectomized animal models showed that a continued state of low estrogen concentration leads to decreased intra-articular subchondral bone mass, increased interface of the subchondral cavity, and progression of severe cartilage degradation [25]. Altogether, women experience rapid joint degeneration around the ages of 50–75 years after menopause, and show higher prevalence, frequency, and severity of osteoarthritis than men [6, 15].

Changes in female hormones after childbirth are partially similar to the changes noted after menopause. Estradiol, which is secreted from the placenta and increases up to 100-fold during pregnancy, instantaneously decreases during childbirth along with placenta extraction, and its concentration is maintained at a low level during breastfeeding as ovulation is delayed [9]. Hence, extended breastfeeding leads to long-term estrogen deficiency [9]. The level of female hormones increases during pregnancy, but breastfeeding can be associated with sex hormone deficiency for several years after childbirth [26].

The long-term breastfeeding experience in a high percentage of Korean women aged ≥60 or older can be attributed to historical and cultural circumstances in Korea. According to a breastfeeding status survey conducted by the Korea Institute for Health and Social Affairs, the breastfeeding rate was 95% in the 1960s and rapidly decreased to 46–68.9% in the 1970s [27]. In the 1960s and 1970s, when women who are currently in their 60s and 70s were likely experiencing childbirth and breastfeeding, Korea was going through rapid economic development after the Korean war, and breast milk supplements were not yet widely marketed [28]. Thus, the period before extensive economic development and the growth of
the formula market likely affected long-term breastfeeding among those aged \( \geq 60 \).

Furthermore, the rapid transition from an extended family to nuclear family and a declining birthrate caused by rapid industrialization and modernization are also speculated to have decreased the number of children and lifetime breastfeeding duration among this cohort [29].

In this study, economic factors, number of children, and level of physical activities including occupational activities were considered confounding variables. However, residence type (sedentary or stand-up) or lifestyle were not assessed in the survey. The residence type of Korea was mainly sedentary in the past, and hence the population that is now elderly likely spent a huge amount of time kneeling down on the floor rather than sitting down on the bed or chairs [30]. It is possible that such a sedentary lifestyle became a risk factor for knee osteoarthritis. As various sociocultural characteristics affect the prevalence of knee osteoarthritis in the older population, the association between breastfeeding duration and knee osteoarthritis can be different in different cultures and age groups.

This study has several strengths. To our knowledge, this study is the first to investigate the association between breastfeeding duration and the prevalence of knee osteoarthritis. The self-administered questionnaire answered by participants was systematically created by skilled experts, and the study was conducted among a large-scale group representative of Korea. Through the analysis of joint pain (a subjective symptom) as a dependent variable and knee osteoarthritis diagnosed by radiography, the target condition was subdivided and the accuracy of analysis was increased. In addition, various confounding variables that can affect breastfeeding and the onset of osteoarthritis were adjusted for.

The study also has some limitations. This was a cross-sectional study collecting two data variables from the same period. Thus, only the association between the two variables could be determined and the cause-and-effect relationship could not, in principle, be deduced. However, as breastfeeding is often experienced by women in their 20s and 30s and osteoarthritis increases upon aging, it can be speculated that breastfeeding affects the onset of osteoarthritis. The data used in this study were responses from self-administered questionnaires, and there could be individual response errors due to the nature of the survey. Additionally, as the study participants were women aged \( \geq 50 \) years, their memory of breastfeeding from decades ago might have been biased. Individual differences in the subjective perception of joint pain may have also existed. Furthermore, interpretation of our study results should take into account unique historical and cultural characteristics of Korea.

**Conclusion**

This cross-sectional study examined breastfeeding experience, joint pain, and knee...
osteoarthritis simultaneously. After adjusting for age variables, we showed significant associations between joint pain symptoms and knee osteoarthritis, and long-term breastfeeding (≥25 months). The risk of exposure to disease showed a tendency to increase with breastfeeding duration. When all other confounding factors were adjusted for, breastfeeding for 25 months or longer still showed a positive correlation with joint pain and knee osteoarthritis.

Despite the findings of this study, breastfeeding has species-specific superiority as a source of nutrients and immune factors that existing breastmilk substitutes cannot surpass, and it has the effect of formation of attachment between mother and infants and preventing long-term and short-term disease. Therefore, breastfeeding should not be excluded unconditionally as a result of this study, and additional research should be taken carefully in other cultures and races.

Declarations

Ethics approval and consent to participate

The KNHANES 5th was conducted by the Korea Center for Disease Control and Prevention (KCDC). All survey protocols were approved by the institutional review board (IRB) of the KCDC. Informed consent was obtained from all participants when the surveys were conducted. Approval of IRB was not required because the study did not deal with any sensitive information, but rather accessed only publicly available data from the KNHANES (JASENG IRB File No. 2019-09-001).

Availability of data and materials

Original data are publicly available for free in the KNHANES website (http://knhanes.cdc.go.kr) for purposes such as academic research. The data used in this article are open access, available online at https://knhanes.cdc.go.kr/knhanes/eng/index.do.

Competing interests

The authors declare that they have no conflict of interest.

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**Authors’ contributions**

MY Kim, SA Kim: Conceptualization, Methodology, Writing- Original draft preparation

HJ Kim, JH Noh: Data curation, Investigation

IH Ha: Project administration, Supervision, Writing- Reviewing and Editing

DS Hwang, CH Lee: Validation

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**Provenance and peer review**

This article has undergone peer review.

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**Figure legends**

Figure 1. Flow chart for study population selection
Table 1. Characteristics of the study population according to duration of breastfeeding above 50 years (n=3,454)

| Variables                          | All women (n=3,454) | Duration of breastfeeding (months) | P-value* |
|------------------------------------|---------------------|------------------------------------|----------|
|                                    |                     | None (n=298)               | 1-24 mths (n=1042) | 25-48 mths (n=815) | ≥49 mths (n=1299) |          |
| Age(years) (mean±sd)               | 3454                | 57.5±7.6                     | 56.5±6.5 | 61.6±7.5 | 70.7±8.4 | <.001  |
| Household income                   | 3417                | Low 1184                     | 67 (23)  | 199 (19.3) | 241 (29.8) | 677 (52.8) | <.001  |
|                                    |                     | Middle-low 850               | 75 (25.7) | 262 (25.3) | 226 (28) | 287 (22.4) |          |
|                                    |                     | Middle- High 674             | 58 (19.9) | 251 (24.3) | 190 (23.5) | 175 (13.6) |          |
|                                    |                     | High 709                     | 92 (31.5) | 322 (31.1) | 151 (18.7) | 144 (11.2) |          |
| Smoking status                     | 3453                | Never smoker 2668            | 217 (72.8) | 757 (72.7) | 639 (78.4) | 1055 (81.3) | <.001  |
|                                    |                     | Ex-smoker 102                | 14 (4.7)  | 24 (2.3)  | 14 (1.7)  | 50 (3.9)  |          |
|                                    |                     | Current smoker 131           | 21 (7.1)  | 49 (4.7)  | 20 (2.5)  | 41 (3.2)  |          |
|                                    |                     | Indirect smoking 552         | 46 (15.4) | 212 (20.4) | 142 (17.4) | 152 (11.7) |          |
| Drinking                           | 3438                | Non alcohol consumption 1789 | 149 (50.2) | 447 (43.2) | 399 (49.1) | 794 (61.4) | <.001  |
|                                    |                     | < 1 drinking episode per month 794 | 79 (26.6) | 252 (24.4) | 224 (27.6) | 239 (18.5) |          |
|                                    |                     | < 5 drinking episode per month 663 | 52 (17.5) | 262 (25.3) | 154 (18.9) | 195 (15.1) |          |
|                                    |                     | ≥ 5 drinking episodes per month 192 | 17 (5.7)  | 73 (7.1)  | 36 (4.4)  | 66 (5.1)  |          |
| BMI(kg/m2) (mean±sd)               | 3450                | 23.6±2.9                     | 24±3.1   | 24.6±3.2 | 24.4±3.4 | <.001  |
|                                    |                     | Underweight (<18.5) 92       | 8 (2.7)  | 16 (1.5)  | 15 (1.9)  | 53 (4.1)  | <.001  |
|                                    |                     | Normal (18.5~24.9) 2052      | 197 (66.1) | 688 (66.2) | 443 (54.5) | 724 (55.7) |          |
|                                    |                     | Obese (>25) 1306             | 93 (31.2) | 336 (32.3) | 355 (43.7) | 522 (40.2) |          |
| Children(n) (mean±sd)             | 3451                | 1.7±1.2                      | 2.2±0.9  | 3±0.9   | 4.7±1.7 | <.001  |
|                                    |                     | None 79                      | 75 (25.2) | 2 (0.2)  | 1 (0.1)  | 1 (0.1)  | <.001  |
|                                    |                     | 1-2 1262                     | 167 (56)  | 834 (80)  | 199 (24.5) | 62 (4.8)  |          |
|                                    |                     | 3-4 1395                     | 49 (16.4) | 184 (17.7) | 585 (71.9) | 577 (44.5) |          |
|                                    |                     | ≥5 715                       | 7 (2.4)  | 22 (2.1)  | 29 (3.6)  | 657 (50.7) |          |
| Abortion(n)                        | 3445                |                                |          |          |          |          |          |
|                          | None  | 1-2  | ≥3   | 975 (36.8) | 248 (23.9) | 202 (24.8) | 416 (32.1) | <.001 | 1664 (44.6) | 572 (55.1) | 383 (47.1) | 577 (44.5) | 0.592 | 806 (18.6) | 218 (21) | 229 (28.1) | 304 (23.4) | 0.592 |
|-------------------------|-------|------|------|------------|------------|------------|------------|-------|-------------|------------|------------|------------|-------|------------|---------|------------|------------|-------|
| Hormone replacement     |       |      |      |            |            |            |            |       | therapy (months) |            |            |            |       |            |         |            |            |       |
| None                    | 2945  | 255  | 843  | 660 (81.1) | 1187 (91.5) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| <6                      | 149   | 10   | 54   | 48 (5.9)   | 37 (2.9)   | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| <12                     | 29    | 3    | 14   | 6 (0.7)    | 6 (0.5)    | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| ≥13                     | 327   | 29   | 131  | 100 (12.3) | 67 (5.2)   | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Menopause               | 3452  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
| No                      | 216   | 37   | 133  | 37 (4.6)   | 9 (0.7)    | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Yes                     | 3236  | 261  | 909  | 777 (95.5) | 1289 (99.3) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Dyslipidemia            | 3454  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
| No                      | 2945  | 250  | 888  | 695 (85.3) | 1112 (85.6) | 0.592      |            |       |               |            |            |            |       |            |         |            |            |       |
| Yes                     | 509   | 48   | 154  | 120 (14.7) | 187 (14.4) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Diabetes                | 3152  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
| No                      | 2047  | 199  | 708  | 498 (65)   | 642 (57)   | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Yes                     | 1105  | 79   | 273  | 268 (35)   | 485 (43)   | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Hypertension            | 3446  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
| No                      | 1645  | 169  | 618  | 377 (46.4) | 481 (37.1) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Yes                     | 1801  | 128  | 421  | 436 (53.6) | 816 (62.9) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Knee joint pain         | 3454  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
| No                      | 2365  | 241  | 826  | 574 (70.4) | 724 (55.7) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Yes                     | 1089  | 57   | 216  | 241 (29.6) | 575 (44.3) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Hip joint pain          | 3454  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
| No                      | 2942  | 264  | 939  | 711 (87.2) | 1028 (79.1) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Yes                     | 512   | 34   | 103  | 104 (12.8) | 271 (20.9) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Low back pain           | 3454  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
| No                      | 2247  | 236  | 797  | 541 (66.4) | 673 (51.8) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Yes                     | 1207  | 62   | 245  | 274 (33.6) | 626 (48.2) | <.001      |            |       |               |            |            |            |       |            |         |            |            |       |
| Osteoarthritis          | 3454  |      |      |            |            |            |            |       |               |            |            |            |       |            |         |            |            |       |
|       | No     |        |        |        |        |        |
|-------|--------|--------|--------|--------|--------|--------|
|       | 2715   | 264 (88.6) | 934 (89.6) | 649 (79.6) | 868 (66.8) | <.001 |
| Yes   | 739    | 34 (11.4)  | 108 (10.4)  | 166 (20.4)  | 431 (33.2)  |        |

a. P-value from t-test or Rao-Scott chi-squared test for continuous or categorical variables.
Table 2 Association between duration of breastfeeding and joint pain (n=3,454)

| Factors                  | Unadjusted |       | Model 1 |       | Model 2 |       |
|-------------------------|------------|-------|---------|-------|---------|-------|
|                         | OR (95% CI)| p-value| OR (95% CI)| p-value| OR (95% CI)| p-value|
| Breastfeeding history   |            |       |         |       |         |       |
| Non-Breastfeed          | 1          |       | 1       |       | 1       |       |
| Breastfeed ≥ 1 mth      | 2.255 (1.683, 3.021) | <.001 | 1.593 (1.175, 2.16) | 0.003 | 1.493 (1.01, 2.206) | 0.044 |
| Breastfeeding history   |            |       |         |       |         |       |
| None                    | 1          |       | 1       |       | 1       |       |
| 1-24 mths               | 1.198 (0.865, 1.66) | 0.276 | 1.29 (0.928, 1.792) | 0.129 | 1.335 (0.891, 2.002) | 0.161 |
| 25-48 mths              | 2.13 (1.51, 3.005) | <.001 | 1.75 (1.228, 2.493) | 0.002 | 1.671 (1.069, 2.612) | 0.025 |
| ≥49 mths                | 4.099 (3.076, 5.462) | <.001 | 2.078 (1.528, 2.827) | <.001 | 1.97 (1.286, 3.017) | 0.002 |
| p for trend             | <.001      |       | <.001   |       | <.001   |       |

OR, odds ratio; 95% CI, 95% confidence interval

Model 1 was adjusted by age.

Model 2 was adjusted by age, BMI, household income, smoking, alcohol consumption, children, diabetes, hypertension, menopausal status, physical activity, abortion, hormone replacement therapy.
Table 3 Association between duration of breastfeeding and knee osteoarthritis (OA) (n=3,454)

| Factors               | Unadjusted |           | Model 1 |           | Model 2 |           |
|-----------------------|------------|-----------|----------|-----------|----------|-----------|
|                       | OR (95% CI)| p-value   | OR (95% CI)| p-value  | OR (95% CI)| p-value  |
| Breastfeeding history |            |          |          |          |          |          |
| Non-Breastfeed        | 1          |          | 1        |          | 1        |          |
| Breastfeed ≥ 1 mth    | 2.412 (1.542, 3.771) | 0.0001  | 1.443 (0.916, 2.274) | 0.114  | 1.92 (0.942, 3.915) | 0.072  |
| Breastfeeding history |            |          |          |          |          |          |
| None                  | 1          |          | 1        |          | 1        |          |
| 1-24 mths             | 0.929 (0.565, 1.526) | 0.769  | 1.049 (0.647, 1.702) | 0.845  | 1.598 (0.791, 3.227) | 0.191  |
| 25-48 mths            | 2.176 (1.345, 3.521) | 0.002  | 1.673 (1.033, 2.71) | 0.037 | 2.299 (1.086, 4.864) | 0.03   |
| ≥49 mths              | 4.374 (2.762, 6.925) | <.001  | 1.689 (1.028, 2.775) | 0.039 | 2.166 (1.011, 4.642) | 0.047  |
| p for trend           | <.001      |          |          |          | 0.004    |          |

OR, odds ratio; 95% CI, 95% confidence interval

Model 1 was adjusted by age

Model 2 was adjusted by age, BMI, household income, smoking, alcohol consumption, children, diabetes, hypertension, menopausal status, physical activity, abortion, hormone replacement therapy.
Table 4. Association between duration of breastfeeding and joint pain, above 60 years (n=2,102)

| Factors                        | Unadjusted | p-value | Model 2 | p-value |
|-------------------------------|------------|---------|---------|---------|
|                               | OR (95% CI)|         | OR (95% CI)|         |
| Breastfeeding history         |            |         |         |         |
| Non-Breastfeed                | 1          |         | 1       |         |
| Breastfeed ≥ 1 mth           | 1.912 (1.233, 2.963) | 0.004   | 2.614 (1.417, 4.821) | 0.002   |
| Breastfeeding history         |            |         |         |         |
| None                          | 1          |         | 1       |         |
| 1-24 mths                     | 1.275 (0.77, 2.109) | 0.344   | 2.39 (1.231, 4.639) | 0.01    |
| 25-48 mths                    | 1.526 (0.941, 2.475) | 0.086   | 2.352 (1.254, 4.409) | 0.008   |
| ≥49 mths                      | 2.331 (1.498, 3.628) | <.001   | 3.068 (1.625, 5.792) | 0.001   |
| p for trend                   | <.001      |         | 0.005   |         |

OR, odds ratio; 95% CI, 95% confidence interval

Model 2 was adjusted by age, BMI, household income, smoking, alcohol consumption, children, diabetes, hypertension, menopausal status, physical activity, abortion, hormone replacement therapy
Table 5. Association between duration of breastfeeding and knee osteoarthritis (OA), above 60 years (n=2,102)

| Factors                        | Unadjusted          | Model 2           |
|--------------------------------|---------------------|-------------------|
|                                | OR (95% CI)         | p-value           | OR (95% CI)         | p-value           |
| Breastfeeding history          |                     |                   |                    |                   |
| Non-Breastfeed                 | 1                   |                   | 1                   |                   |
| Breastfeed ≥ 1 mth             | 1.471 (0.853, 2.536)| 0.165             | 2.751 (1.165, 6.495)| 0.021             |
| Breastfeeding history          |                     |                   |                    |                   |
| None                           | 1                   |                   | 1                   |                   |
| 1-24 mths                      | 0.872 (0.464, 1.641)| 0.671             | 2.14 (0.851, 5.385)| 0.106             |
| 25-48 mths                     | 1.215 (0.69, 2.137)| 0.499             | 2.705 (1.147, 6.382)| 0.023             |
| ≥49 mths                       | 1.757 (1.004, 3.078)| 0.049             | 3.18 (1.349, 7.498)| 0.008             |
| p for trend                    | <.001               |                   | 0.012               |                   |

OR, odds ratio; 95% CI, 95% confidence interval

Model 2 was adjusted by age, BMI, household income, smoking, alcohol consumption, children, diabetes, hypertension, menopausal status, physical activity, abortion, hormone replacement therapy.