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*Original Article*

# Effects of Breastfeeding, Menopause Age, and Oral Health Behaviors on the Quality of Life among Middle-Aged and Older Women: An Analysis Based on the Korea National Health and Nutrition Examination Survey

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## ABSTRACT

**Objectives:** This study examined the associations of breastfeeding experience, menopause age, and oral health behaviors with health-related quality of life (HRQoL), assessed using the EQ-5D index, among middle-aged and older Korean women. **Methods:** Data from 3,634 women aged ≥40 years who participated in the 2019, 2020, and 2022 Korea National Health and Nutrition Examination Survey were analyzed. Breastfeeding experience, menopause age, oral health behaviors, and functional oral health indicators were included as independent variables. **Results:** Breastfeeding experience was positively associated with HRQoL in unadjusted and partially adjusted models, but the association was not significant after full adjustment. Menopause age showed no significant association with HRQoL. In contrast, functional oral health indicators—particularly the absence of chewing discomfort and a greater number of remaining teeth—were consistently associated with higher HRQoL. **Conclusions:** Breastfeeding experience was not independently associated with HRQoL after accounting for socioeconomic and health-related factors, and menopause age showed no association with HRQoL. Functional oral health, especially chewing ability and tooth retention, emerged as a key determinant of HRQoL among middle-aged and older women.

*Keywords:* Breastfeeding, EQ-5D index, Health-related quality of life, Menopause age, Oral health behavior

## 1. Introduction

The quality of life (QoL) of women is significantly influenced by hormonal changes and health-related behaviors throughout the life course. Major physiological events such as pregnancy, breastfeeding, and menopause affect not only the biological system but also psychological and social functioning, thereby shaping overall well-being [1,2]. Hormonal fluctuations across these stages may lead to oral symptoms such as gingivitis and xerostomia, and these symptoms—through pain, discomfort, and impaired mastication—can negatively affect daily living and health-related quality of life (HRQoL) [3,4].

Breastfeeding has been associated with various benefits for maternal health, including physical recovery, psychological stability, and reduced risk of chronic diseases, ulti-

mately contributing to improved HRQoL. Previous studies have suggested that breastfeeding induces hormonal and metabolic adaptations—such as changes in prolactin, oxytocin, and estrogen levels—that may contribute to long-term physical and emotional health benefits for women, including reduced risks of chronic conditions and improved overall well-being. Moreover, from a life course perspective, breastfeeding has been conceptualized as an early-life health-related behavior that may exert cumulative effects on women's long-term health trajectories and quality of life through interconnected biological, behavioral, and psychosocial pathways [5,6]. Accordingly, breastfeeding experience was selected as a key life course reproductive factor in this study, as it reflects both hormonal exposure and health-related behaviors during early adulthood that may have long-term implications for women's health and HRQoL. However, the long-term impact of breastfeeding-related hormonal and metabolic changes—such as alterations in calcium balance—on overall health and HRQoL remains inconclusive. Some studies suggest that prolonged breastfeeding may be associated with decreased bone mineral density and potential functional decline [7], whereas others argue that breastfeeding enhances immune and endocrine regulation, thus improving long-term well-being [8]. Many of these findings are based on small or specific population groups, indicating the need for comprehensive analyses using nationally representative data.

Menopause is another critical turning point closely linked to changes in HRQoL among middle-aged and older women. The decline in estrogen levels is known to cause various physical and psychological symptoms, including oral dryness, oral pain, and reduced masticatory function, which can significantly diminish HRQoL [1,2,9,10]. Furthermore, menopausal age varies widely among individuals, and previous studies have reported that women who experience early menopause may have lower bone density, higher risk of chronic diseases, and reduced functional health, potentially leading to poorer HRQoL [11]. Based on this evidence, menopausal age was included as a major exposure variable to capture inter-individual differences in the timing of hormonal transition and its potential long-term impact on HRQoL. However, most existing studies have focused on the presence or absence of menopause rather than systematically examining how differences in menopausal age affect HRQoL.

Breastfeeding history and menopausal age are not independent events but may be linked through a woman's total hormonal exposure across her life span [12]. Integrating these factors in a single analytic framework can provide insight into how life course hormonal patterns collectively influence HRQoL in later life. Additionally, oral health behaviors constitute an essential determinant of HRQoL, as oral pain, chewing difficulty, and dry mouth directly affect functional and psychosocial well-being. Therefore, oral health behaviors (e.g., dental floss and interdental brush use, dental check-ups, and unmet dental needs) and functional oral health indicators (e.g., chewing discomfort, speaking difficulty, and number of remaining teeth) were selected as core explanatory variables, as they represent modifiable factors that directly reflect daily oral function and access to dental care. These behaviors may also change in response to life-stage transitions such as pregnancy, breastfeeding, and menopause, due to variations in living conditions, caregiving responsibilities, or psychological stress. Among middle-aged and older women, increases in xerostomia, masticatory impairment, and unmet dental care needs are particularly notable and are closely associated with reduced oral health–related and overall HRQoL [13-15].

The Korea National Health and Nutrition Examination Survey (KNHANES) provides nationally representative data that include information on breastfeeding experience, menopausal status and age, oral health behaviors, and HRQoL indicators such as the EQ-5D index. This dataset is well suited for investigating how life course factors and oral health behaviors interact to shape HRQoL among middle-aged and older women. Although several previous studies using KNHANES data have examined reproductive factors or oral health variables separately in relation to HRQoL, few studies have simultaneously integrated life course reproductive factors and functional oral health indicators within a single analytic framework, or directly compared their relative contributions to HRQoL.

Therefore, the present study aims to examine the combined effects of breastfeeding, menopausal age, and oral health behaviors on HRQoL among middle-aged and older women. By jointly analyzing life course reproductive factors and functional oral health indicators, this study seeks to clarify their relative influence on HRQoL and to identify whether functional oral health plays a more immediate or dominant role in shaping HRQoL than reproductive life-cycle characteristics. Through this integrated approach, the study seeks to provide evidence that can inform life course-based women's health management strategies and oral health promotion policies.

## 2. Methods

### 2.1. Research participants and data collection method



This study utilized raw data from the Korea National

Health and Nutrition Examination Survey (KNHANES). Data were combined from the 8th cycle (2019–2021), excluding 2021 due to disruptions in data collection caused by COVID-19, and from the first year of the 9th cycle (2022), resulting in a total of three survey years included in the analysis. In KNHANES cycles 8 and 9, sampling frames were stratified by region (cities and provinces), urbanization level (dong, eup/myeon), and housing type (general housing or apartment). Implicit stratification criteria included residential area proportion, age of household head, and single-person household rate. A total of 576 primary sampling units (PSUs) were selected over the three years of Cycle 8, and 576 PSUs were also selected across three years in Cycle 9, with 192 PSUs drawn annually. From each PSU, 25 sample households were selected, excluding facilities such as nursing homes, military bases, prisons, and households with foreign nationals.

Among 21,734 participants from the 2019, 2020, and 2022 surveys, the study included 4,290 women aged 40 years or older who provided information on natural or artificial menopause. After excluding individuals with missing, refused, or invalid responses to the EQ-5D items, a total of 3,634 women were included in the final analysis. Differences in total frequencies across variables were due to missing data. All statistical analyses accounted for the complex sampling design of KNHANES by applying sampling weights, stratification variables, and primary sampling units (PSUs) to ensure nationally representative estimates and valid variance estimation. As KNHANES is a government-designated statistical survey under Article 17 of the Statistics Act, all procedures received ethical approval from national institutional review boards.

### 2.2. Research tools

Oral examination data and health survey responses from KNHANES were used. Sociodemographic variables included sex, education level (≤elementary, ≤middle school, ≤high school, ≥college), household income quartile (1st = lowest, 4th = highest), and marital status (cohabiting vs. non-cohabiting, including separated, widowed, or divorced). Health-related variables included smoking status (current, former, non-smoker), alcohol consumption (yes/no), BMI categorized as underweight (<18.5 kg/m²), normal (18.5–22.9 kg/m²), overweight (23–24.9 kg/m²), and obese (≥25 kg/m²), and physician diagnosis of diabetes or hypertension.

Oral health variables included use of dental floss, interdental brushes, having had a dental check-up in the past year, and unmet dental needs in the past year, all categorized dichotomously (“yes” or “no”). Chewing discomfort and speaking difficulty were also assessed as dichotomous variables. Subjective oral health status was categorized as “good” if participants responded “very good,” “good,” or “moderate,” and “poor” if they responded “poor” or “very poor.” Periodontal disease status in the past year was classified as “yes,” “no,” or “no dental visit.”

The dependent variable was health-related quality of life (HRQoL), operationalized and measured using the EQ-5D index score. The EQ-5D consists of five dimensions—mobility, self-care, usual activities, pain/discomfort, and anxiety/depression—each rated on a three-level scale (“no problems,” “some problems,” “severe problems”). The EQ-5D index applies a quality weight to health states, and higher scores indicate better HRQoL.

### 2.3. Analysis methods

All analyses were performed using IBM SPSS version 27.0 (IBM Co., Armonk, NY, USA). Complex sampling analysis techniques were applied, incorporating stratification variables, clustering, and sampling weights. Descriptive statistics were used to examine participants’ characteristics, presenting unweighted frequencies and weighted percentages. To compare EQ-5D mean scores and standard errors by breastfeeding status and menopause age, descriptive statistics were conducted. Rao–Scott chi-square tests and t-tests were used to analyze oral health characteristics across combined breastfeeding and menopause age groups. Linear regression analyses were performed to assess the impact of breastfeeding and menopause age on EQ-5D. Model 1 conducted simple linear regression analyses for each variable; Model 2 included oral health variables identified as significant in the Rao–Scott and t-tests for multiple linear regression.

## 3. Results

### 3.1. General characteristics of research participants

Participants were categorized into four groups based on breastfeeding status and menopause age: breastfeeding/<45 years, breastfeeding/45–49 years, breastfeeding/50–54 years, and breastfeeding/≥55 years. Across the 3,634 participants, the distribution of the four groups was generally similar, although the proportion of women with breastfeeding experience slightly increased in younger menopause age groups (e.g., 87.5% in <45 years vs. 85.1% in ≥55 years). Education level showed that approximately 65–70% of participants in all groups had a high school education or below, whereas the proportion with a college

degree or higher was relatively higher in older menopause-age groups. Household income was evenly distributed across groups, though the lowest income quartile was most common in the <45-year group (28.2%).

Regarding health behaviors, current smoking rates ranged from 12.9% to 14.8% across the four groups, and alcohol consumption was consistently around 60%. BMI patterns indicated increasing proportions of overweight and obesity with increasing menopause age. Diagnosis of diabetes and hypertension was more common among women who experienced menopause at age 50 or older. Marital status patterns showed higher cohabitation rates in the 50–54-year group (70.8%), whereas the <45-year group had the highest proportion of separated, widowed, or divorced women (41.1%).

For oral health behaviors, use of dental floss and interdental brushes remained low in all groups (approximately 20% and 36–38%, respectively). The proportion of women who had a dental check-up in the past year decreased with increasing menopause age (<45 years: 45.7%; ≥55 years: 38.0%). Unmet dental needs were high across all groups, ranging from 46% to 54%, suggesting persistent barriers to dental-care access. Subjective oral health showed slightly higher rates of "good" responses with increasing menopause age, while periodontal disease was most prevalent in the 45–49-year group. Chewing discomfort ranged from 25% to 28% across groups, and speaking difficulty tended to decrease with higher menopause age.

In the EQ-5D subdomains, most participants reported "no problems" in mobility, self-care, and usual activities. However, mild pain or discomfort increased with menopause age. Across all groups, approximately 82–85% reported no anxiety or depression, demonstrating minimal variation among the four categories.

**Table 1. General characteristics of research participants**

| Variables | Breastfeeding/ <45 years | | Breastfeeding /45~49 years | | Breastfeeding /50~54 years | | Breastfeeding /≥55 years | |
|---|---|---|---|---|---|---|---|---|
| | Weight (%) | N=380 | Weight (%) | N=1,055 | Weight (%) | N=1,733 | Weight (%) | N=466 |
| Survey year (n=3,634) | | | | | | | | |
| 2019 | 37.4 | 163 | 39.6 | 467 | 39.7 | 751 | 35.5 | 187 |
| 2020 | 41.1 | 156 | 38.0 | 408 | 37.6 | 653 | 35.7 | 164 |
| 2022 | 21.5 | 61 | 22.4 | 180 | 22.7 | 329 | 28.7 | 117 |
| Breastfeeding (n=3,634) | | | | | | | | |
| No | 12.5 | 43 | 16.5 | 141 | 13.7 | 204 | 14.9 | 66 |
| Yes | 87.5 | 337 | 83.5 | 914 | 86.3 | 1529 | 85.1 | 400 |
| Education level (n=3,632) | | | | | | | | |
| ≤Elementary school | 35.5 | 156 | 33.7 | 415 | 34.9 | 697 | 34.2 | 179 |
| ≤Middle school | 14.1 | 62 | 15.6 | 167 | 15.6 | 281 | 11.9 | 66 |
| ≤High school | 37.6 | 117 | 32.4 | 299 | 32.9 | 497 | 34.9 | 146 |
| ≥College | 12.8 | 44 | 18.3 | 173 | 16.6 | 261 | 19.0 | 75 |
| Household income quartile (n=3,621) | | | | | | | | |
| 1st | 28.2 | 116 | 23.6 | 286 | 27.2 | 536 | 29.2 | 157 |
| 2nd | 23.8 | 101 | 27.1 | 281 | 24.8 | 446 | 24.4 | 116 |
| 3rd | 26.6 | 85 | 25.2 | 258 | 22.3 | 359 | 21.9 | 88 |
| 4th | 21.3 | 79 | 24.1 | 227 | 25.6 | 384 | 24.5 | 103 |
| Marital status (n=3,631) | | | | | | | | |
| Cohabiting | 58.9 | 224 | 65.4 | 685 | 70.8 | 1224 | 65.4 | 301 |
| Separated/Widowed/Divorced | 41.1 | 156 | 34.6 | 368 | 29.2 | 509 | 34.6 | 164 |
| Smoking (n=3,382) | | | | | | | | |
| Current smoker | 12.9 | 52 | 14.8 | 156 | 14.1 | 219 | 14.6 | 67 |
| Former smoker | 21.5 | 74 | 17.0 | 173 | 20.0 | 319 | 17.2 | 78 |
| Never smoker | 65.6 | 231 | 68.2 | 663 | 65.9 | 1063 | 68.2 | 288 |
| Alcohol consumption (n=3,383) | | | | | | | | |
| No | 39.1 | 137 | 36.8 | 356 | 38.8 | 624 | 42.3 | 177 |
| Yes | 60.9 | 220 | 63.2 | 635 | 61.2 | 978 | 57.7 | 256 |
| BMI (n=2289) | | | | | | | | |
| Underweight | 5.6 | 15 | 3.9 | 31 | 2.5 | 30 | 0.8 | 3 |
| Normal | 60.6 | 139 | 56.2 | 366 | 58.3 | 671 | 52.3 | 122 |
| Overweight | 33.1 | 83 | 38.4 | 257 | 38.4 | 423 | 46.4 | 127 |
| Obese | 0.8 | 2 | 1.5 | 8 | 0.8 | 10 | 0.5 | 2 |
| Physician-diagnosed diabetes (n=3,634) | | | | | | | | |
| No | 80.6 | 311 | 85.8 | 894 | 85.2 | 1451 | 86.1 | 397 |
| Yes | 19.4 | 69 | 14.2 | 161 | 14.8 | 282 | 13.9 | 69 |

**Table 1. Cont.**

| Variables | Breastfeeding/ <45 years | | Breastfeeding /45~49 years | | Breastfeeding /50~54 years | | Breastfeeding /≥55 years | |
|---|---|---|---|---|---|---|---|---|
| | Weight (%) | N=380 | Weight (%) | N=1,055 | Weight (%) | N=1,733 | Weight (%) | N=466 |
| Physician-diagnosed hypertension (n=3,634) | | | | | | | | |
| No | 63.2 | 236 | 61.3 | 626 | 61.5 | 1012 | 58.5 | 270 |
| Yes | 36.8 | 144 | 38.7 | 429 | 38.5 | 720 | 41.5 | 196 |
| Use of dental floss (n=3,634) | | | | | | | | |
| No | 76.2 | 301 | 79.3 | 845 | 79.1 | 1364 | 77.2 | 366 |
| Yes | 23.8 | 79 | 20.7 | 210 | 20.9 | 369 | 22.8 | 100 |
| Use of interdental brush (n=3,634) | | | | | | | | |
| No | 61.8 | 248 | 63.1 | 689 | 64.2 | 1156 | 62.5 | 301 |
| Yes | 38.2 | 132 | 36.9 | 366 | 35.8 | 577 | 37.5 | 165 |
| Dental check-up in past year (n=3,634) | | | | | | | | |
| No | 54.3 | 226 | 58.8 | 641 | 61.6 | 1090 | 62.0 | 301 |
| Yes | 45.7 | 154 | 41.2 | 414 | 38.9 | 643 | 38.0 | 165 |
| Unmet dental needs (past year) (n=3,634) | | | | | | | | |
| No | 30.4 | 114 | 30.6 | 308 | 29.0 | 504 | 36.0 | 163 |
| Yes | 54.3 | 205 | 52.3 | 555 | 52.0 | 891 | 46.3 | 213 |
| Not needed | 15.3 | 61 | 17.0 | 192 | 19.1 | 338 | 17.7 | 90 |
| Subjective oral health (n=3,319) | | | | | | | | |
| Good | 53.5 | 186 | 55.7 | 532 | 61.7 | 963 | 62.2 | 263 |
| Poor | 46.5 | 162 | 44.3 | 429 | 38.3 | 619 | 37.8 | 165 |
| Periodontal disease (past year) (n=3,634) | | | | | | | | |
| No | 50.0 | 180 | 44.6 | 473 | 46.8 | 779 | 47.0 | 216 |
| Yes | 17.1 | 67 | 19.0 | 195 | 14.7 | 272 | 13.5 | 60 |
| No dental visit | 32.9 | 133 | 36.4 | 387 | 38.5 | 682 | 39.5 | 190 |
| Chewing discomfort (n=3,634) | | | | | | | | |
| No | 74.1 | 271 | 72.9 | 764 | 71.2 | 1222 | 73.6 | 341 |
| Yes | 25.9 | 109 | 27.1 | 291 | 28.8 | 511 | 26.4 | 125 |
| Speaking difficulty (n=3,622) | | | | | | | | |
| Yes | 30.2 | 112 | 23.2 | 259 | 19.8 | 334 | 22.7 | 102 |
| No | 69.8 | 268 | 76.8 | 788 | 80.2 | 1396 | 77.3 | 363 |
| EQ-5D Mobility (n=3,634) | | | | | | | | |
| No problems walking | 79.5 | 284 | 74.7 | 769 | 75.5 | 1263 | 72.3 | 327 |
| Some problems | 20.2 | 95 | 24.7 | 275 | 23.9 | 458 | 27.6 | 138 |
| Unable to walk | 0.4 | 1 | 0.6 | 11 | 0.6 | 12 | 0.1 | 1 |
| EQ-5D Self-care (n=3,647) | | | | | | | | |
| No problems walking | 92.7 | 347 | 94.7 | 988 | 93.8 | 1620 | 96.2 | 441 |
| Some problems | 6.7 | 31 | 5.1 | 62 | 5.9 | 107 | 3.6 | 24 |
| Unable | 0.5 | 2 | 0.2 | 5 | 0.2 | 6 | 0.2 | 1 |
| EQ-5D Usual activities (n=3,647) | | | | | | | | |
| No problems walking | 88.2 | 326 | 86.9 | 906 | 87.8 | 1507 | 88.7 | 403 |
| Some problems | 10.9 | 49 | 12.5 | 141 | 11.6 | 215 | 11.0 | 60 |
| Unable | 0.9 | 5 | 0.5 | 8 | 0.6 | 11 | 0.3 | 3 |
| EQ-5D Pain/Discomfort | | | | | | | | |
| No pain | 65.5 | 245 | 65.3 | 677 | 62.2 | 1074 | 62.1 | 286 |
| Some pain | 30.5 | 118 | 31.6 | 336 | 33.8 | 583 | 34.5 | 162 |
| Severe pain | 4.0 | 17 | 3.1 | 42 | 4.0 | 76 | 3.3 | 18 |
| EQ-5D Anxiety/Depression | | | | | | | | |
| Not anxious/depressed | 82.0 | 306 | 85.0 | 900 | 83.8 | 1461 | 84.2 | 390 |
| Somewhat anxious/depressed | 17.1 | 70 | 14.3 | 145 | 15.5 | 257 | 14.2 | 69 |
| Severely anxious/depressed | 0.9 | 4 | 0.8 | 10 | 0.8 | 15 | 1.6 | 7 |

Values are presented as unweighted n and weighted %.
Complex-sample chi-square tests were used for group comparisons.

### 3.2. Health-related quality of life (EQ-5D Index) according to oral health–related variables by breastfeeding status and menopause age

When oral health–related indicators were compared across groups defined by the combination of breastfeeding status and menopause age, several variables showed statistically significant differences in health-related quality of life (HRQoL), as measured by the EQ-5D index. For dental floss and interdental brush use, users generally

**Table 2. Health-related quality of life (EQ-5D Index) according to oral health–related variables by breastfeeding status and menopause age**

| Variables | Breastfeeding/ <45 years | | | Breastfeeding /45~49 years | | | Breastfeeding /50~54 years | | | Breastfeeding /≥55 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SE | t(WaldF) /P | Mean | SE | t(WaldF) /P | Mean | SE | t(WaldF) /P | Mean | SE | t(WaldF) /P |
| Use of dental floss | | | | | | | | | | | | |
| No | 0.912 | 0.008 | 1.224 (0.269) | 0.909 | 0.005 | 6.337 (0.012) | 0.904 | 0.005 | 23.559 (0.000) | 0.907 | 0.006 | 1.702 (0.193) |
| Yes | 0.931 | 0.015 | | 0.933 | 0.008 | | 0.937 | 0.004 | | 0.926 | 0.012 | |
| Use of interdental brush | | | | | | | | | | | | |
| No | 0.907 | 0.010 | 3.294 (0.070) | 0.906 | 0.005 | 6.553 (0.011) | 0.900 | 0.004 | 21.174 (0.000) | 0.911 | 0.006 | 0.008 (0.929) |
| Yes | 0.932 | 0.008 | | 0.928 | 0.006 | | 0.931 | 0.005 | | 0.912 | 0.010 | |
| Dental check-up in past year | | | | | | | | | | | | |
| No | 0.905 | 0.011 | 3.206 (0.074) | 0.900 | 0.006 | 16.906 (0.000) | 0.900 | 0.005 | 16.226 (0.000) | 0.907 | 0.006 | 0.948 (0.331) |
| Yes | 0.931 | 0.009 | | 0.933 | 0.005 | | 0.928 | 0.004 | | 0.919 | 0.009 | |
| Unmet dental needs (past year) | | | | | | | | | | | | |
| No | 0.877 | 0.017 | 4.776 (0.009) | 0.891 | 0.009 | 6.743 (0.001) | 0.880 | 0.008 | 10.699 (0.000) | 0.901 | 0.009 | 0.966 (0.382) |
| Yes | 0.932 | 0.007 | | 0.927 | 0.005 | | 0.921 | 0.004 | | 0.919 | 0.008 | |
| Not needed | 0.940 | 0.013 | | 0.916 | 0.008 | | 0.930 | 0.006 | | 0.915 | 0.012 | |
| Subjective oral health | | | | | | | | | | | | |
| Good | 0.915 | 0.008 | 0.401 (0.527) | 0.919 | 0.005 | 1.571 (0.211) | 0.913 | 0.005 | 1.233 (0.268) | 0.914 | 0.007 | 0.316 (0.574) |
| Poor | 0.923 | 0.010 | | 0.908 | 0.007 | | 0.906 | 0.006 | | 0.907 | 0.009 | |
| Periodontal disease (past year) | | | | | | | | | | | | |
| No | 0.916 | 0.009 | 3.243 (0.040) | 0.920 | 0.006 | 1.658 (0.192) | 0.915 | 0.005 | 0.867 (0.421) | 0.914 | 0.008 | 0.630 (0.533) |
| Yes | 0.944 | 0.010 | | 0.920 | 0.008 | | 0.903 | 0.008 | | 0.895 | 0.017 | |
| No dental visit | 0.903 | 0.015 | | 0.904 | 0.007 | | 0.909 | 0.006 | | 0.915 | 0.007 | |
| Chewing discomfort | | | | | | | | | | | | |
| No | 0.938 | 0.006 | 15.800 (0.000) | 0.932 | 0.004 | 31.646 (0.000) | 0.932 | 0.003 | 73.617 (0.000) | 0.930 | 0.006 | 23.523 (0.000) |
| Yes | 0.855 | 0.020 | | 0.866 | 0.011 | | 0.859 | 0.008 | | 0.862 | 0.012 | |
| Speaking difficulty | | | | | | | | | | | | |
| Yes | 0.920 | 0.011 | 0.089 (0.766) | 0.914 | 0.008 | 0.001 (0.982) | 0.907 | 0.009 | 0.257 (0.613) | 0.917 | 0.010 | 0.334 (0.564) |
| No | 0.915 | 0.009 | | 0.914 | 0.005 | | 0.912 | 0.003 | | 0.910 | 0.006 | |
| Number of remaining teeth | 0.916 | 0.008 | 7.244 (0.007) | 0.914 | 0.004 | 11.399 (0.001) | 0.911 | 0.004 | 17.693 (0.000) | 0.912 | 0.006 | 4.137 (0.043) |

Values are presented as weighted means and standard errors (SE).
Group differences were examined using complex sample general linear models.

demonstrated higher HRQoL (EQ-5D index scores) than non-users across most menopause-age groups, with statistically significant differences observed in some groups. Similarly, participants who had undergone a dental check-up within the past year consistently exhibited higher HRQoL across all age groups, with particularly significant differences in the 45–49- and 50–54-year groups.

Contrary to the expected pattern, comparisons of HRQoL according to unmet dental needs did not show the lowest values among participants who reported needing but not receiving dental care. In some menopause-age groups—such as the <45-year group—the lowest HRQoL values were observed among participants who reported no unmet dental needs. Because this pattern is inconsistent and does not follow a linear gradient, the association between unmet dental needs and HRQoL (EQ-5D index) should be interpreted with caution. In addition, functional oral health indicators—such as periodontal disease experience, chewing discomfort, and speaking problems—were closely associated with HRQoL. Notably, chewing discomfort emerged as the factor showing the largest mean differences in HRQoL (EQ-5D index scores) across all four groups.

### 3.3. Health-related quality of life (EQ-5D Index) according to breastfeeding status and menopause age

When comparing health-related quality of life (HRQoL), as measured by the EQ-5D index, and its subdomains (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression), differences in HRQoL by breastfeeding status and menopause age were generally small; however, certain patterns emerged with increasing menopause age. The mean EQ-5D index ranged from 0.911 to 0.915,

**Table 3. Health-related quality of life (EQ-5D Index) according to breastfeeding status and menopause age**

| Variables | EQ-5D index | | EQ-5D Mobility | | EQ-5D Self-care | | EQ-5D Usual Activities | | EQ-5D Pain /Discomfort | | EQ-5D Anxiety /Depression | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mn | SE | Mn | SE | Mn | SE | Mn | SE | Mn | SE | Mn | SE |
| Breastfeeding /<45 years | 0.915 | 0.007 | 1.22 | 0.023 | 1.09 | 0.018 | 1.13 | 0.020 | 1.39 | 0.033 | 1.20 | 0.026 |
| Breastfeeding /45~49 years | 0.914 | 0.004 | 1.26 | 0.016 | 1.06 | 0.008 | 1.14 | 0.014 | 1.38 | 0.020 | 1.16 | 0.014 |
| Breastfeeding /50~54 years | 0.912 | 0.003 | 1.25 | 0.013 | 1.06 | 0.007 | 1.13 | 0.010 | 1.42 | 0.016 | 1.17 | 0.011 |
| Breastfeeding /≥55 years | 0.911 | 0.005 | 1.28 | 0.024 | 1.04 | 0.009 | 1.12 | 0.016 | 1.41 | 0.028 | 1.17 | 0.022 |

Values are presented as weighted means (Mn) and standard errors (SE).
EQ-5D index and dimension scores were analyzed using complex sample general linear models.

with slightly higher values observed among women who experienced menopause at a younger age. In the mobility domain, the ≥55-year group exhibited the highest mean score, whereas similar levels were observed across groups for the self-care and usual activities domains. In contrast, in the pain/discomfort domain, the prevalence of discomfort progressively increased with older menopause age.

### 3.4. Effects of breastfeeding, menopause age, and oral health behaviors on health-related quality of life

In Model 1, breastfeeding status and menopause age were included as independent variables to examine their basic associations with health-related quality of life (HRQoL), as measured by the EQ-5D index. The results showed that women who had not breastfed had significantly lower EQ-5D index scores, indicating lower HRQoL, compared with those who had breastfed (B = 0.032, p < 0.001). This association remained statistically significant after adjusting for basic covariates in Model 2 (B = 0.018, p = 0.010). In contrast, menopause age (<45, 45–49, and 50–54 years) did not differ significantly from the ≥55-year reference group, indicating that menopause age itself did not independently affect HRQoL.

In Model 2, which additionally adjusted for oral health variables that were significant in the Rao–Scott chi-square tests and t-tests, the association between breastfeeding and higher HRQoL persisted. Women who had not breastfed continued to show significantly lower HRQoL (EQ-5D index scores) than those who had breastfed (B = 0.018, p = 0.010), suggesting that breastfeeding experience was independently associated with HRQoL even after controlling for oral health factors. Again, menopause age categories did not show statistically significant differences compared with the reference group, reinforcing the finding that the timing of menopause did not independently influence HRQoL.

Model 3 further incorporated socioeconomic and health-behavior covariates—including education level, household income quartile, marital status, smoking, alcohol consumption, BMI, and physician diagnoses of diabetes and hypertension. After adjustment for these additional factors, neither breastfeeding nor menopause age showed a statistically significant association with HRQoL, as assessed by the EQ-5D index. The coefficient for non-breastfeeding (B = −0.002, p = 0.837) was not significant, and menopause age also showed no significant effects (<45 years: B = −0.005, p = 0.606; 45–49 years: B = 0.009, p = 0.342; 50–54 years: B = 0.001, p = 0.964). These findings suggest that when socioeconomic status and health behaviors are considered, neither breastfeeding history nor menopause timing independently contributes to differences in HRQoL.

In contrast, oral health–related variables remained significant predictors of HRQoL in Model 3. Chewing discomfort, in particular, showed the strongest positive association with HRQoL; individuals without chewing discomfort had substantially higher EQ-5D index scores, reflecting better HRQoL (B = 0.047, p < 0.001). The number of remaining teeth also demonstrated a significant positive association (B = 0.001, p = 0.015), indicating that functional oral health continued to influence HRQoL even after adjusting for socioeconomic characteristics. Collectively, Model 3 demonstrates that while breastfeeding and menopause age lost significance after full adjustment, functional oral health factors—such as chewing ability and number of remaining teeth—retained strong associations with HRQoL.

**Table 4. Effects of breastfeeding, menopause age, and oral health behaviors on health-related quality of life**

| Variables | Model 1 (Univariate linear regression) | | | | Model 2 (Multiple linear model) | | | | Model 3 (Multiple linear model) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | SE | t | p | B | SE | t | p | B | SE | t | p |
| Breastfeeding | | | | | | | | | | | | |
| ref. Yes | | | | | | | | | | | | |
| No | 0.032 | 0.006 | 5.354 | 0.000 | 0.018 | 0.007 | 2.577 | 0.010 | -0.002 | 0.008 | -0.206 | 0.837 |
| Menopause age | | | | | | | | | | | | |
| ref. ≥55 years | | | | | | | | | | | | |
| <45 years | 0.005 | 0.009 | 0.557 | 0.578 | 0.004 | 0.010 | 0.411 | 0.681 | 0.001 | 0.012 | 0.045 | 0.964 |
| 45~49 years | 0.002 | 0.007 | 0.342 | 0.732 | 0.002 | 0.008 | 0.296 | 0.767 | -0.005 | 0.009 | -0.517 | 0.606 |
| 50~54 years | 0.001 | 0.007 | 0.088 | 0.930 | -0.001 | 0.007 | -0.088 | 0.930 | -0.009 | 0.009 | -0.951 | 0.342 |
| Use of dental floss | | | | | | | | | | | | |
| ref. Yes | | | | | | | | | | | | |
| No | -0.029 | 0.005 | -6.000 | 0.000 | -0.013 | 0.005 | -2.378 | 0.018 | -0.007 | 0.007 | -1.016 | 0.310 |
| Use of interdental brush | | | | | | | | | | | | |
| ref. Yes | | | | | | | | | | | | |
| No | -0.023 | 0.004 | -5.309 | 0.000 | -0.007 | 0.005 | -1.504 | 0.133 | 0.011 | 0.006 | 1.838 | 0.067 |
| Dental check-up in past year | | | | | | | | | | | | |
| ref. Not needed | | | | | | | | | | | | |
| No | -0.024 | 0.004 | -5.552 | 0.000 | -0.012 | 0.005 | -2.301 | 0.022 | -0.011 | 0.006 | -1.690 | 0.092 |
| Unmet dental needs (past year) | | | | | | | | | | | | |
| ref. Not needed | | | | | | | | | | | | |
| Yes | -0.035 | 0.007 | -4.739 | 0.000 | -0.026 | 0.009 | -3.049 | 0.002 | -0.024 | 0.008 | -2.807 | 0.005 |
| No | 0.001 | 0.005 | 0.192 | 0.848 | -0.008 | 0.007 | -1.173 | 0.242 | -0.011 | 0.008 | -1.338 | 0.182 |
| Chewing discomfort | | | | | | | | | | | | |
| ref. Yes | | | | | | | | | | | | |
| No | 0.070 | 0.006 | 11.983 | 0.000 | 0.058 | 0.007 | 8.869 | 0.000 | 0.047 | 0.008 | 5.881 | 0.000 |
| Number of remaining teeth | 0.003 | 0.000 | 7.180 | 0.000 | 0.001 | 0.000 | 3.995 | 0.000 | 0.001 | 0.000 | 2.437 | 0.015 |

Model 1: Included breastfeeding status and menopause age, Model 2: Adjusted for variables that were statistically significant in the Rao–Scott analysis and t-tests, Model 3: Adjusted for education level, household income quartile, marital status, smoking, alcohol consumption, BMI, and physician diagnoses of diabetes and hypertension.

## 4. Discussion

This study used data from the Korea National Health and Nutrition Examination Survey (KNHANES) to examine how breastfeeding experience and menopause age influence oral health and health-related quality of life (HRQoL), as measured by the EQ-5D index, among middle-aged and older women. In Model 1, breastfeeding experience showed a significant association with HRQoL ($p < 0.001$), and this relationship remained significant after adjusting for oral health variables in Model 2 ($p = 0.010$). However, after further adjustment for socioeconomic and health-behavioral factors in Model 3, the effect of breastfeeding on HRQoL was no longer statistically significant ($p = 0.837$).

Rather than indicating the absence of a meaningful relationship, this attenuation suggests that the association between breastfeeding and HRQoL may operate through indirect or mediated pathways across the life course. Breastfeeding, as an early-life reproductive behavior, may influence later-life HRQoL not through a direct persistent effect, but via intermediate factors such as oral health behaviors, health awareness, socioeconomic trajectories, and cumulative health status. For example, breastfeeding experience may be associated with greater engagement in preventive health behaviors and healthcare utilization during and after the childbearing period, which in turn can shape oral health status and HRQoL in later life. These pathways are likely interrelated with socioeconomic conditions and health behaviors accumulated over time.

Accordingly, the loss of statistical significance in Model 3 supports a mediation framework, whereby the effects of breastfeeding on HRQoL are partially or fully transmitted through socioeconomic position, lifestyle behaviors, and health-related conditions, rather than reflecting a direct biological or behavioral effect persisting into older adulthood. This interpretation is consistent with prior studies reporting that breastfeeding is associated with improved oral health awareness and self-care behaviors [16], reduced prevalence of periodontitis [17], and better postpartum HRQoL [18,19]. Collectively, these findings suggest that breastfeeding may exert long-term, cumulative influ-

ences on HRQoL through indirect life course pathways, including oral health behaviors, hormonal regulation, and systemic health, rather than functioning as an independent predictor in later life.

Menopause age showed no significant association with health-related quality of life (HRQoL) in any of the models, suggesting that the timing of menopause itself may not independently influence EQ-5D–based HRQoL outcomes. In this study, menopausal age was categorized into four groups (<45, 45–49, 50–54, and ≥55 years) to represent early menopause, the typical menopausal transition period, and late menopause. However, despite this classification, menopausal age alone may not adequately capture the complexity of menopausal experiences relevant to HRQoL.

Previous studies examining menopause and HRQoL have reported inconsistent findings regarding the role of menopausal age. Several population-based studies indicate that HRQoL is more strongly associated with menopausal status, symptom severity, or time since menopause rather than with chronological menopausal age itself [20,21]. In particular, studies using the EQ-5D have shown that HRQoL declines progressively with increasing duration since menopause, suggesting that cumulative postmenopausal changes may be more relevant to HRQoL than the timing of menopause alone [20]. Studies conducted among Korean women have similarly reported poorer HRQoL among women in later postmenopause, supporting the importance of postmenopausal duration and related health conditions [21].

These findings are also consistent with previous research linking menopause to periodontal and oral health outcomes [22,23], indicating that factors occurring after menopause—such as lifestyle behaviors, oral health practices, and accumulated health conditions—may play a more important role in shaping HRQoL than menopausal age per se. Moreover, as noted by Lee et al. [24], qualitative aspects of the menopausal transition, particularly the use of hormone replacement therapy (HRT), may be more relevant to periodontal and overall health than chronological age at menopause alone. Therefore, the lack of a significant association between menopausal age and HRQoL observed in the present study may reflect the limited ability of menopausal age alone to capture heterogeneity in menopausal experiences, including symptom burden, health behaviors, and HRT use.

In contrast, oral health–related variables consistently remained significant predictors of HRQoL, reaffirming that functional oral conditions are key determinants of well-being in middle-aged and older women. The strong positive association between better chewing function and higher EQ-5D index scores, reflecting better HRQoL, aligns with existing evidence that tooth loss, periodontal disease, and oral pain substantially contribute to reduced HRQoL [25-27]. Similarly, the association between a greater number of remaining teeth and higher HRQoL supports previous research emphasizing the importance of tooth retention in older adulthood [28]. Although unmet dental care needs were significant only in partially adjusted models, their attenuation in Model 3 suggests that access to dental care is closely linked to socioeconomic resources and health behaviors, consistent with prior findings [29,30].

Importantly, functional oral health indicators such as chewing ability and number of remaining teeth are closely connected to broader health domains beyond the oral cavity. Impaired mastication can restrict food choices and compromise nutritional intake, particularly of protein- and fiber-rich foods, which may adversely affect metabolic and systemic health. In addition, difficulties in chewing and speaking can limit social participation and interpersonal interactions, potentially leading to social withdrawal and psychological distress. Through these interrelated pathways involving nutrition, social engagement, and general health, functional oral impairment may exert a substantial and direct influence on health-related quality of life.

Overall, while breastfeeding experience showed an initial association with HRQoL, its influence appears to be indirect and mediated by cumulative socioeconomic and behavioral factors across the life course, rather than exerting a direct independent effect in later life. In contrast, functional oral health factors—particularly chewing ability and number of remaining teeth—emerged as robust and proximal determinants of HRQoL across all models. These results underscore that daily oral function and access to oral healthcare play a more immediate role in shaping HRQoL among middle-aged and older women than reproductive life-cycle characteristics such as breastfeeding history or menopause age. Moreover, the lack of a direct association between menopause age and HRQoL highlights the multifactorial nature of the relationship between menopause, oral health, and well-being, as also supported by cluster-based findings [31].

This study has several limitations. First, the cross-sectional design limits the ability to establish temporal order and causal relationships among breastfeeding experience, menopausal factors, oral health, and HRQoL, raising the possibility of reverse causation. In addition, detailed breastfeeding characteristics (e.g., duration, frequency, and intensity) could not be assessed. Importantly, menopause-related factors such as time since menopause and hormone replacement therapy (HRT) use were not incorporated,

which may have led to residual confounding in the analysis of menopausal effects on HRQoL. Nevertheless, by using nationally representative data and adopting a life course perspective that integrates reproductive history, oral health, and HRQoL, this study provides important insights into indirect pathways linking early-life reproductive behaviors to quality of life in later adulthood. Future longitudinal studies incorporating time since menopause and HRT exposure are warranted to explicitly test mediation mechanisms and to clarify how reproductive experiences, oral health trajectories, and socioeconomic factors jointly shape HRQoL over time.

## 5. Conclusions

Breastfeeding experience was associated with quality of life in unadjusted and partially adjusted models, but this association did not persist after accounting for socioeconomic characteristics. Menopause age also showed no significant association with quality of life. In contrast, functional oral health indicators—particularly chewing ability and number of remaining teeth—emerged as strong and consistent determinants of quality of life among middle-aged and older women. These findings suggest that preserving oral function and ensuring access to appropriate dental care may have a more direct and immediate impact on quality of life in this population than life course reproductive factors.

## Author Contribution

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## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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