# Predictors of osteoporosis prevention behaviors in women in their 20s and 30s

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## Abstract

There is a need to provide insight into the management and health care fields for the prevention of osteoporosis in young women by analyzing the factors affecting the prevention of osteoporosis. This descriptive survey aimed to identify the predictors of osteoporosis prevention behaviors in women in their 20s and 30s by examining their body mass index (BMI), weight control experience, osteoporosis knowledge, osteoporosis self-efficacy, and osteoporosis prevention behaviors.

One hundred fifty participants were conveniently sampled, and data were collected from August to September 2020. Participants in their 20s and 30s completed a questionnaire concerning the general characteristics, osteoporosis-related characteristics, osteoporosis knowledge, osteoporosis self-efficacy, and osteoporosis prevention behaviors.

Approximately 82.6% of the participants had at least 1 type of weight control experience. The mean participants' age and BMI were 28.94 (±5.32) years and 21.62 (±3.21) kg/m$^2$, respectively. No significant differences in weight control experience according to the participants' characteristics were observed. However, significant differences were noted in BMI and age, osteoporosis knowledge and educational background, osteoporosis prevention behavior and educational background, and household type. Osteoporosis prevention behaviors were significantly positively correlated with weight control experience, osteoporosis knowledge, and osteoporosis self-efficacy. Osteoporosis prevention behaviors increased with increasing osteoporosis self-efficacy (β = 0.53, $P < .001$), among multiperson households (β = 0.20, $P = .003$), and among those with a weight control experience (β = 0.18, $P = .007$), and these factors explained 47.2% of the variance ($F = 23.11$, $P < .001$).

Based on the study results, further studies are needed to identify and analyze the predictors of osteoporosis prevention behaviors in women to increase the awareness of osteoporosis and osteoporosis prevention and management in this group and expand similar efforts.

**Abbreviations:** BMD = bone mineral density, BMI = body mass index, IRB = institutional review board, NRF = National Research Foundation of Korea.

**Keywords:** body mass index, knowledge, osteoporosis, prevention, self-efficacy

## 1. Introduction

In South Korea, women in their 20s and 30s more commonly perceive themselves to be overweight despite having normal weight per body mass index (BMI) than their male counterparts. Furthermore, excessive weight control behaviors using fasting, food limitations, and drugs are on the rise.[1–3] In particular, the incidence of osteopenia is markedly high among underweight women in their 20s and 30s,[4] and the 10-year risk for hip fracture may differ according to the degree of weight loss in women in their 20s.[5] In addition, being underweight can induce osteopenia and osteoporosis, 2 chronic conditions for which women seek medical care more frequently than men.[4,6]

Osteopenia may lead to osteoporosis, which increases the risk of fracture.[7] In addition to genetic factors, there are also modifiable causes of osteopenia and osteoporosis, including lifestyle, nutrition, underweight, smoking, and drinking.[8,9] Peak bone

mass is reached between the age of 20 and early 30s and is maintained until 35 to 40 years of age, after which bone mass begins to decline.[10] Furthermore, an increase in peak bone mass in early adulthood reduces the risk of fracture in older adults,[11] further highlighting the importance of a modifiable lifestyle that promotes bone health, such as diet, nutrition, and physical activity.[10] In particular, as women are influenced by estrogen, maintaining peak bone mass in early adulthood is especially important.[12]

Women in their 20s and 30s who control their weight through exercise and diet are less likely to develop abnormal bone mineral density (BMD) than those who do not use both means to control weight.[4] In fact, women in their 20s and 30s show a lower level of interest in factors associated with osteoporosis and lower practice of health behaviors that prevent osteoporosis than women in their 40s and 50s.[13] Furthermore, the majority of women in their 20s fail to meet the recommended nutrient intake and do not exercise at all.[14] A comparative study of

health-promoting behavioral scales, including exercise and nutrition, also reported that female college students engaged in significantly lower levels of health-promoting behaviors than their male counterparts.[15] These data shed light on the low compliance with osteoporosis prevention behaviors by women in their 20s and 30s, an optimal time for osteoporosis prevention. In particular, lifestyle factors such as physical activity and calcium intake in young female adults explained 58% to 69.8% of the variance in BMD,[8] highlighting the importance of identifying the predictors of osteoporosis prevention behaviors in women in their 20s and 30s to help them modify their lifestyle through education and ultimately achieve peak BMD. Further, to the best of our knowledge, no study has examined the factors affecting the health promotion behavior of osteoporosis prevention in light of the BMI and weight control experience of young women.

The aim of this study was to analyze the predictors of osteoporosis prevention behaviors by examining the BMI, weight control experience, osteoporosis knowledge, and osteoporosis self-efficacy of Korean women in their 20s and 30s. The findings of this study will be useful as foundational data for developing health management programs that promote osteoporosis prevention behaviors in this population.

## 2. Methods

### 2.1. Study design

This descriptive survey aimed to examine the BMI, weight control experience, osteoporosis knowledge, osteoporosis self-efficacy, and osteoporosis prevention behaviors and identify the predictors of osteoporosis prevention behaviors in women in their 20s and 30s.

### 2.2. Study participants and data collection

Korean women in their 20s and 30s from the community who voluntarily signed an informed consent form were enrolled in this study. The participants were conveniently sampled, and data were collected from August 1, 2020, to September 15, 2020. The sample size was determined using the G*Power 3.1.9.2 software (https://www.gpower.hhu.de). For a regression analysis with an effect size of 0.15, $\alpha$ of 0.05, $1-\beta$ of 0.85, and ten predictor variables, the minimum sample size was calculated to be 131. Considering 10% withdrawal, a total of 154 questionnaires were distributed, and after excluding 4 questionnaires with missing responses, a total of 150 questionnaires were included in the analysis.

### 2.3. Instruments

**2.3.1. General characteristics and osteoporosis-related characteristics.** BMI (calculated with height and weight), age, education level, and living with family were surveyed as general characteristics. Osteoporosis-related characteristics included prior education about osteoporosis or osteopenia, diagnosis of osteoporosis or osteopenia, and weight control experience. BMI was classified into underweight (BMI <18.5 kg/m$^2$), normal weight (18.5 kg/m$^2$ ≤ BMI ≤22.9 kg/m$^2$), overweight (23.0 kg/m$^2$ ≤ BMI ≤24.9 kg/m$^2$), and obesity (BMI ≥25.0 kg/m$^2$). Weight control experience referred to whether the participant had tried

**Table 1**

General characteristics of the participants and level of variables (N = 150).

| Variables | Categories | | n (%) | Mean ± SD |
|---|---|---|---|---|
| Age (yr) | | | | 28.94 ± 5.32 |
| | 20–29 | | 84 (56.0) | |
| | 30–9 | | 66 (44.0) | |
| Education background | High school | | 25 (16.6) | |
| | ≥College | | 125 (83.3) | |
| Household type | Single | | 32 (21.3) | |
| | Multi | | 118 (78.6) | |
| Previous osteoporosis- or osteopenia-related training experience | Yes | | 16 (10.6) | |
| | No | | 134 (89.3) | |
| Diagnosed with osteoporosis or osteopenia | Herself | | 2 (1.3) | |
| | Family member | | 32 (21.3) | |
| | None | | 116 (77.3) | |
| BMI, kg/m$^2$ | | | | 21.62 ± 3.21 |
| | <18.5 | | 17 (11.3) | |
| | 18.5–22.9 | | 89 (59.3) | |
| | 23–24.9 | | 22 (14.6) | |
| | ≥25 | | 22 (14.6) | |
| Weight control experience* | No | | 26 (17.3) | |
| | Yes | Diet | 124 (82.6) | |
| | | Exercise | 12 (8.0) | |
| | | Drug | 2 (1.3) | |
| | | Diet + exercise | 63 (42.0) | |
| | | Diet + drug | 0 (0.0) | |
| | | Exercise + drug | 3 (2.0) | |
| | | Diet + exercise + drug | 21 (14.0) | |
| Osteoporosis knowledge | | | | 13.00 ± 2.42 |
| Osteoporosis self-efficacy | | | | 72.90 ± 21.82 |
| Exercise | | | | 36.64 ± 13.46 |
| Calcium intake | | | | 36.26 ± 11.18 |
| Health-promoting behavior | | | | 41.64 ± 5.91 |
| Diet | | | | 18.64 ± 3.75 |
| Exercise | | | | 11.32 ± 3.16 |
| Preferred food | | | | 11.66 ± 2.32 |

*Multiple responses.

to lose weight in the past using weight loss means such as diet, exercise, and drugs, as applicable.

### 2.3.2. Osteoporosis knowledge.
The Facts on Osteoporosis Quiz revised by Ailinger et al[16] and modified and adapted in Korean by Won[17] was used. This 20-item quiz is answered with "yes," "no," or "I do not know." "Yes" was scored 1 point, while "no" and "I do not know" were scored 0 points each. The total score ranges from 0 to 20, with a high score indicating a high level of osteoporosis knowledge. The Cronbach α was 0.76 in the study by Ailinger et al,[16] and the Kuder–Richardson Formula 20 in this study was 0.58.

### 2.3.3. Osteoporosis self-efficacy.
The Osteoporosis Self-Efficacy Scale developed by Horan et al[18] and adapted by Won[17] was used. This 12-item tool comprises 6 items for exercise behaviors and 6 items for calcium intake. Each item is rated on a 10-point scale from 0 (I am not confident at all) to 10 (I am very confident). The total score ranges from 0 to 120, with a high score indicating high self-efficacy. The Cronbach α was 0.94 in the study by Won[17] and 0.94 in this study.

### 2.3.4. Osteoporosis prevention behaviors.
The Osteoporosis Health Promoting Behavior developed by Yoon[19] and modified and adapted by Won[17] was used. This 17-item tool comprises 8 items for diet, 5 items for exercise, and 4 items for personal indulgences. Each item is rated on a 4-point scale; item 7 for diet and items 1 to 4 for personal indulgences were reverse-coded. The total score ranges from 17 to 68, with a higher score indicating greater compliance with health-promoting behaviors. The Cronbach α was 0.72 in the study by Won[17] and 0.70 in this study.

## 2.4. Data analysis
The collected data were analyzed using STATA Version 14.0 (StataCorp LLC). The participants' general characteristics, BMI, weight control experience, osteoporosis knowledge, osteoporosis self-efficacy, and osteoporosis prevention behaviors were analyzed using descriptive statistics. Differences in participants' BMI, osteoporosis knowledge, osteoporosis self-efficacy, and osteoporosis prevention behaviors according to their general characteristics were analyzed using chi-square tests, $t$ tests, or analyses of variance followed by a post hoc test where necessary. The correlations among latent variables were analyzed using Pearson correlation coefficients, and the predictors of osteoporosis prevention behaviors were analyzed using multiple regression analysis.

## 2.5. Ethical considerations
This study was approved by the Institutional Review Board of the authors' affiliation (approval number: JJNU-IRB-2020-030).

Before the survey, the participants signed a consent form specifying voluntary participation, anonymity of data, freedom to withdraw from the study at any time, and no disadvantages for not participating in the study.

## 3. Results

### 3.1. General and osteoporosis-related characteristics
The mean age was 28.94 (±5.32) years, and the education level was predominantly college or higher (83.3%). The most common household structure was a multiperson household (78.6%). While 89.3% had no prior education about osteoporosis or osteopenia, 1.3% were diagnosed with osteoporosis or osteopenia. The mean BMI was 21.62 (±3.21) kg/m², with 59.3% of the participants in the normal weight group (18.5–22.9 kg/m²). A total of 82.6% of the participants had previously attempted to control their weight, and the most common means were diet + exercise (42.0%). The mean osteoporosis knowledge score was 13.00 (±2.42) out of 20, and the mean osteoporosis self-efficacy score was 72.90 (±21.82) out of 120. The self-efficacy subscale scores were 36.64 (±13.46) out of 60 for exercise and 36.26 (±11.18) out of 60 for calcium intake. The mean osteoporosis prevention behavior score was 41.64 (±5.91) out of 68, and the subscale scores were 18.64 (±3.75) out of 32 for diet, 11.32 (±3.16) out of 20 for exercise, and 11.66 (±2.32) out of 16 for personal indulgences (Table 1).

### 3.2. Differences in weight control experience, BMI, osteoporosis knowledge, osteoporosis self-efficacy, and osteoporosis prevention behaviors according to general characteristics
There were no significant differences in weight control experience according to participant characteristics (Table 2). BMI significantly differed according to age ($t = -2.62$, $P = .009$), while osteoporosis knowledge significantly differed according to education level ($t = -2.56$, $P = .011$). Osteoporosis prevention behaviors significantly differed according to education level ($t = -1.52$, $P = .012$) and household structure ($t = -0.42$, $P = .020$; Table 3).

### 3.3. Correlations among measurement variables
Osteoporosis prevention behaviors had a statistically significant positive correlation with weight control experience ($r = 0.17$, $P = .032$), osteoporosis knowledge ($r = 0.19$, $P = .018$), and osteoporosis self-efficacy ($r = 0.56$, $P < .001$) but was not significantly correlated with BMI (Table 4).

**Table 2**

**Weight control experience according to general characteristics (N = 150).**

| Characteristics | Categories | Total n | Weight control experience Yes n (%) | No n (%) | $x^2$ | p |
|---|---|---|---|---|---|---|
| Age (yr) | 20-29 | 84 | 67 (79.7) | 17 (20.2) | 1.12 | .289 |
| | 30-39 | 66 | 57 (86.3) | 9 (13.6) | | |
| Education background | High school | 25 | 19 (76.0) | 6 (24.0) | 0.93 | .335 |
| | ≥College | 125 | 105 (84.0) | 20 (16.0) | | |
| Household type | Single | 32 | 30 (93.7) | 2 (6.2) | 3.48 | .062 |
| | Multi | 118 | 94 (79.6) | 24 (20.3) | | |
| Previous osteoporosis- or osteopenia-related training experience | Yes | 16 | 15 (93.7) | 1 (6.2) | 1.53 | .215 |
| | No | 134 | 109 (81.3) | 25 (18.6) | | |
| Diagnosed with osteoporosis or osteopenia | Herself | 2 | 2 (100.0) | 0 (0.0) | 0.95 | .621 |
| | Family member | 32 | 25 (78.1) | 7 (21.8) | | |
| | None | 116 | 124 (83.6) | 26 (16.3) | | |

**Table 3**

BMI, osteoporosis knowledge, osteoporosis self-efficacy, and osteoporosis prevention health-promoting behaviors according to general characteristics (N = 150)

| Variables | Categories | BMI M ± SD | BMI t or F | BMI P value | Osteoporosis knowledge M ± SD | Osteoporosis knowledge t or F | Osteoporosis knowledge P value | Osteoporosis self-efficacy M ± SD | Osteoporosis self-efficacy t or F | Osteoporosis self-efficacy P value | Osteoporosis health promoting M ± SD | Osteoporosis health promoting t or F | p |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age, yr | 20–29 | 21.06 ± 3.11 | −2.62 | .009 | 13.14 ± 2.29 | 0.62 | .534 | 73.36 ± 21.63 | 0.29 | .770 | 41.36 ± 5.72 | −0.63 | .528 |
| | 30–39 | 22.43 ± 3.25 | | | 12.89 ± 2.58 | | | 72.31 ± 22.21 | | | 41.98 ± 6.18 | | |
| Education background | High school | 20.51 ± 3.42 | −1.96 | .051 | 11.92 ± 2.64 | −2.56 | .011 | 66.48 ± 27.13 | −1.62 | .107 | 40.00 ± 5.70 | −1.52 | .012 |
| | ≥College | 21.90 ± 3.16 | | | 13.25 ± 2.32 | | | 74.19 ± 20.48 | | | 41.96 ± 5.92 | | |
| Household type | Single | 21.83 ± 3.93 | 0.31 | .752 | 13.21 ± 2.48 | 0.48 | .627 | 71.34 ± 21.11 | −0.45 | .649 | 39.50 ± 6.07 | −0.42 | .020 |
| | Multi | 21.62 ± 3.04 | | | 12.98 ± 2.41 | | | 73.33 ± 22.07 | | | 42.22 ± 5.76 | | |
| Previous osteoporosis- or osteopenia-related training experience | Yes | 21.72 ± 3.24 | 0.58 | .558 | 14.00 ± 2.55 | −1.69 | .091 | 78.50 ± 18.91 | −1.08 | .279 | 43.81 ± 6.82 | −1.56 | .120 |
| | No | 21.22 ± 3.29 | | | 12.91 ± 2.39 | | | 72.23 ± 22.11 | | | 41.38 ± 5.77 | | |
| Diagnosed with osteoporosis or osteopenia | Herself | 20.91 ± 1.01 | 1.75 | .177 | 13.00 ± 4.24 | −1.35 | .261 | 81.50 ± 34.64 | 0.22 | .804 | 42.21 ± 5.30 | 2.90 | .058 |
| | Family member | 20.75 ± 2.77 | | | 13.65 ± 2.22 | | | 74.00 ± 23.16 | | | 42.21 ± 5.30 | | |
| | None | 21.93 ± 3.34 | | | 12.86 ± 2.44 | | | 72.45 ± 21.45 | | | 41.31 ± 5.88 | | |

BMI = body mass index, M = mean, SD = standard deviation.

### 3.4. Predictors of osteoporosis prevention behaviors

To identify the predictors of osteoporosis prevention behaviors, multiple regression analysis was performed with household structure (multiperson), which significantly differed according to osteoporosis prevention behaviors, weight control experience, osteoporosis knowledge, and osteoporosis self-efficacy, which were significantly correlated with osteoporosis prevention behaviors, as the independent variables. Categorical parameters, weight control experience, and household structure were dummy coded for analysis. In the multicollinearity test, tolerance was above 0.1, that is, at 0.95 to 0.97, and variance inflation factor was below 10, that is, at 1.01 to 1.04, confirming the absence of multicollinearity.

The regression model was significant ($P < .001$), with the model explaining 37.2% of the variance. The model showed that osteoporosis self-efficacy ($\beta = 0.53$, $P < .001$) was the most potent predictor of osteoporosis prevention behaviors, followed by household structure ($\beta = 0.20$, $P = .003$) and weight control experience ($\beta = 0.18$, $P = .007$; Table 5).

## 4. Discussion and Conclusion

This study identified predictors of osteoporosis prevention behaviors in women in their 20s and 30s. Approximately 1.3% of our participants stated that they had been diagnosed with osteoporosis or osteopenia, which differs from previous results about the prevalence of osteoporosis and osteopenia in women in their 20s and 30s (2% and 32.8%, respectively[4]) and female college students (4.3% and 52.2%, respectively[20]; 11.9%–21.5% diagnosed with osteopenia[21,22]). The low rate seems to be attributable to the fact that we used a self-report questionnaire to determine whether the respondent had been diagnosed with osteoporosis or osteopenia. Because osteoporosis is a preventable progressive metabolic disease,[23] reducing the future prevalence of osteoporosis requires reducing reduction in the risk of future osteoporosis in young adults.[24] Therefore, management and early screening of osteoporosis or osteopenia in women in their 20s and 30s are important, as this is the golden period for osteoporosis prevention.

The osteoporosis prevention behavior score was significantly higher among the educated women and women in multiperson households. Previous studies have reported that adult female single-person households have higher smoking and drinking rates than their multiperson household counterparts.[25,26] There was a positive and direct relationship between knowledge and attitudes on osteoporosis prevention, the intention and osteoporosis prevention behavior, and subjective norms and osteoporosis prevention behavior.[23] Further, the rate of regular exercise was 1.28 times higher among single-person households than multiperson households,[25] calling for further research on the health behaviors of single-person households of women in their 20s and 30s.

Osteoporosis self-efficacy was identified as the most potent predictor of osteoporosis prevention behaviors. It was also identified as a predictor of osteoporosis health behaviors among female college students.[20] Further studies are needed to analyze the barriers to calcium intake and weight-bearing exercise as a measure to enhance osteoporosis self-efficacy. Multimember households were the second predictor of osteoporosis prevention behaviors. The rates of smoking and drinking were 6.19 times higher and 2.67 times higher, respectively, among women who live alone than among women from multimember households.[26] This may be attributable to the fact that women who live alone have relatively less social support, including family support, and spend more time with friends or at work. Furthermore, the percentage of women in their 20s and 30s who live alone is rising primarily in urban areas,[26] necessitating tailored policies to support lifestyle modification in this population. The third predictor of osteoporosis prevention behaviors was weight control history, where women who have engaged in

**Table 4**

Correlation between BMI, weight control experience, osteoporosis knowledge, osteoporosis self-efficacy, and health-promoting behaviors that prevent osteoporosis (N = 150).

| Variable | BMI<br>r (*P*) | Weight control<br>experience<br>r (*P*) | Osteoporosis<br>knowledge<br>r (*P*) | Osteoporosis<br>self-efficacy<br>r (*P*) |
|---|---|---|---|---|
| Health-promoting behaviors | 0.05 (.506) | 0.17 (.032) | 0.19 (.018) | 0.56 (<.001) |

BMI = body mass index.

**Table 5**

Factors influencing health-promoting behaviors that prevent osteoporosis (N = 150).

| Variable | Health-promoting behaviors in preventing osteoporosis | | | | | | |
|---|---|---|---|---|---|---|---|
| | B | SE | β | *t* | *P* value | *F* (*P*) | Adj. *R²* |
| Weight control experience* | 2.84 | 1.03 | 0.18 | 2.76 | .007 | 23.11 | 0.372 |
| Household type* | 2.89 | 0.94 | 0.20 | 3.05 | .003 | (<.001) | |
| Osteoporosis knowledge | 0.24 | 0.16 | 0.09 | 1.49 | .140 | | |
| Osteoporosis self-efficacy | 0.14 | 0.01 | 0.53 | 8.17 | <.001 | | |

SE = standard error.

*Dummy variable = weight control experience (no = 0, yes = 1), household type (single = 0, multi = 1)

weight control efforts in the past practiced health behaviors that prevent osteoporosis. Although 70.6% of our participants had a normal or lower than normal BMI, 82.6% of our participants had attempted to lose weight in the past. Hence, women in their 20s and 30s, who often engage in weight loss efforts, need to be educated about the impact of BMI on BMD such that they do not attempt to lose weight when they have a normal BMI and consequently lose BMD. Moreover, it is necessary to instill the importance of concordance between objective BMI and self-perceived body image. Approximately 8.0% to 31.4% of adult women[3] and 53.3% of female college students[27] displayed body image distortion, where they perceived themselves as obese despite having normal weight, and women with a distorted body image were 1.68 times more likely to attempt to control their weight compared to those without a distorted body image.[28] In other words, it is important to address body image distortions in young women such that they have an accurate sense of their BMI and do not attempt to lose weight despite having a normal body weight. As young adults are not concerned about future disease risk, it is necessary to raise awareness of osteoporosis to increase participation in preventive action.[24]

Moreover, several findings were derived from the qualitative study on health information-seeking behaviors and self-care behaviors in women with osteoporosis: identification of knowledge gaps, established networking for seeking information, information from trust-to-distrust, information-seeking inhibiting factors, information-seeking facilitating factors, and self-care behaviors based on required knowledge.[29] Furthermore, young adults were mistakenly perceived to be consuming sufficient nutrients for bone health, which was associated with lower participation in osteoporosis prevention activities.[30]

Taken together, strategies that promote osteoporosis self-efficacy, lifestyle modification for women who live alone, and weight-bearing exercise to promote bone health, as opposed to losing weight to achieve a thin figure, would help facilitate health-promoting behaviors that prevent osteoporosis in women in their 20s and 30s. We hope that our study findings provide an opportunity to encourage women in their 20s and 30s, who have been relatively neglected compared to middle-aged women and older women who are more commonly affected by osteoporosis, to actively prevent and manage osteoporosis and ultimately reduce the incidence of osteoporosis or osteopenia in women. This study is significant in that it presents evidence for

osteoporosis prevention interventions and management, as well as provides foundational data for developing relevant educational programs for women in their 20s and 30s.

The limitations of this study include the possibility of participant selection bias, limitation of the research design of only 1 descriptive research study, and the inability to examine participants' perceived body image. Moreover, the objective indicators of osteoporosis that could have improved the study results were not studied all together. Because our results cannot explain all the osteoporosis prevention behaviors among women in their 20s and 30s, further studies are needed to analyze other associated factors.

In conclusion, the most potent and significant predictor of osteoporosis prevention behaviors among women in their 20s and 30s in our study was osteoporosis self-efficacy, followed by multiperson household and weight control experience. Thus, future studies should develop and evaluate the effects of educational programs that consider weight control history, household structure, and osteoporosis efficacy.

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## Author contributions

Conceptualization: Suni Kang, Young A Kim.
Data curation: Suni Kang.
Methodology: Suni Kang, Young A Kim.
Writing – original draft: Suni Kang.
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