

Trends in Prevalence and the Differentials of Unhealthy Dietary Habits by Maternal Education Level among Korean Adolescents

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Objectives: This study aimed to investigate the prevalence of unhealthy dietary habits by maternal educational level and how the effect of maternal education changed between 2009 and 2019.

Methods: Using data from the Korea Youth Risk Behavior Survey conducted between 2009 and 2019, we assessed the prevalence of each unhealthy dietary habit (insufficient consumption of milk and fruit/vegetable, breakfast-skipping, and frequent consumption of fast food, soft drinks, and instant noodles) and the prevalence difference between maternal middle/high school and college graduate groups in four periods. The models included maternal educational level, four periods and the interaction between them, sex, and grade. In addition, we estimated the ORs of unhealthy dietary habits between the two maternal educational groups at each period.

Results: Throughout the study period, unhealthy dietary habits were consistently more prevalent among mothers with lower education levels. Between 2009–2010 and 2017–2019, the prevalence of unhealthy dietary habits increased, with a particular increase in that of frequent consumption of fast food and soft drink. The prevalence differentials between the middle school and college graduate group decreased or did not differ, while those between the high school and college graduate groups increased over time. A similar trend was observed in the relative scale.

Conclusion: Considering the increase in the prevalence of unhealthy dietary habits and the prevalence differentials by maternal educational level, targeted efforts are needed not only for all adolescents and their parents but also for those with low socioeconomic status to improve the dietary habits of adolescents. (*Ewha Med J* 2021;44(4):133-143)

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Key Words

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Introduction

Adolescence is an important period of life since dietary habits in this period not only directly impact physical and mental growth but also affect life-long health. Increased dietary requirements for a large growth spurt and development make adolescence a period of potential nutritional vulnerability [1].

Unhealthy dietary habits including a preference for fast food, apathy for nutrition, and meal choices based on convenience, taste, and price also make adolescents more nutritionally vulnerable [2,3]. In Korea, adolescents aged 12 to 18 years had the highest proportion of calcium deficiency across all age groups. Insufficient calcium intake is associated with lower bone mineral density, and an increased risk of osteoporosis, which has

emerged as a major health burden in developed countries [1]. The obesity rate among Korean adolescents has continuously risen from 5.3% in 2009 to 10.8% in 2018 [4]. High body mass index (BMI) in adolescence increases the risk of obesity-related diseases in adulthood, such as coronary heart disease and diabetes [5,6]. In addition, nutritional status and health behaviors are important variables for mental health among adolescents. Intake of sodium, vitamin A, and vitamin C are associated with perceived stress level among Korean adolescents [7]. Thus, it is essential for the well-being of Korean adolescents to improve their unhealthy dietary habits.

Dietary habits of adolescents are known to be influenced by a number of factors, including socioeconomic factors such as family income and maternal education. Previous studies in South Korea revealed that adolescents having frequent family meals consumed significantly more rice, tofu, legumes, meats, fishes, eggs, green vegetables, seaweeds, fruit, milk, and milk products, thus having a higher probability for a balanced diet [8]. Maternal education is considered one of the most important factors influencing child health outcomes. A large body of literature associated maternal education to healthier diets and better nutritional status, such as a higher intake of milk and fresh fruit and vegetable and lower intake of sugar-sweetened beverages [9,10]. However, to our best knowledge, no study has investigated how the prevalence of unhealthy dietary habits have changed with differences in maternal education levels over time in South Korea.

Therefore, this study aimed to assess the trend of prevalence of unhealthy dietary habits among Korean adolescents and to determine whether the prevalence differentials by maternal educational levels differed from 2009 through to 2019. Understanding changes in the overall dietary patterns of adolescents may provide helpful insights into nutritional interventions and policies.

Methods

1. Data source and study population

The Korea Youth Risk Behavior Survey (KYRBS) is a health-related risk behavior surveillance of a representative sample of Korean adolescents, conducted annually by the Korean Center for Disease Control since 2005. KYRBS uses a stratified cluster-sampling design to select a nationwide sample

of students from the first grade of middle school to the third grade of high school in South Korea, where schools are selected from approximately 120 strata on the basis of regional group and school type, and a class for each grade is randomly selected. Approximately 70,000 students were sampled from 400 middle schools and 400 high schools every year, which accounts for approximately 15% of total number of schools and 2% of the target population. The response rate was above 95%. We used data obtained from the fifth to 15th KYRBS collected between 2009 and 2019. For 11 years, a total of 755,818 subjects participated in the survey. We excluded 19,092 subjects in 2019 who chose not to answer questions about family members, which was a new option provided that year. We then excluded 29,023 subjects who responded that they did not have a mother, 110,875 who responded that they did not know their maternal educational level, and another 1,501 subjects who responded with the educational level of their stepmother or lacked maternal education data. Finally, 595,327 subjects over 11 survey years were included in the analysis. Questions about milk, fruit, and vegetable consumption were not asked in 2018, as well as questions about instant noodle consumption in 2016, 2018, and 2019; hence, the analyses of these dietary habits had a different number of survey years and subjects.

2. Variables

For obtaining independent variables, we categorized maternal education level into three groups: middle school graduate or below (hereinafter referred to as “middle school graduate”), high school graduate, and college graduate or above (hereinafter referred to as “college graduate”). For dependent variables, we defined six unhealthy dietary habits. Each unhealthy dietary habit was assessed using questions that inquired about the frequency of intake of certain types of food in the last 7 days, and subjects were provided seven categorical responses, ranging from “never”, “1–2 times”, “3–4 times”, “5–6 times”, “once a day”, “twice a day”, and “more than three times a day”. The 7 categorical responses were common to all questions, except for a question on days of breakfast consumption in the last 7 days; students were assigned to four categorical responses (“1–2 times”, “3–5 times”, “6–7 times”, and “never”) in 2009 to 2010 and seven categorical responses (ranging from “0” to “7 days”) in 2011 to 2019. Insufficient consumption of fruit and vegetable was defined as fruit intake (excluding fruit juice)

≤ 4 times and vegetable (excluding kimchi) ≤ 4 times in the last 7 days. Insufficient consumption of milk was defined as intake of milk or processed/flavored milk ≤ 4 times in the last 7 days. Frequent consumption of fast food (where hamburger, pizza, and chicken were provided as examples in the survey question), frequent consumption of instant noodles or cup noodles, and frequent consumption of carbonated soft drinks were also defined as intake ≥ 3 times in the last 7 days. Breakfast skipping was defined as not eating breakfast for ≥ 5 days in the last 7 days.

We categorized the 11 years of the survey period into four time periods (2009–2010, 2011–2013, 2014–2016, and 2017–2019) to obtain stable estimates of the prevalence and the prevalence difference by maternal education over time because they were not linear and displayed fluctuation.

3. Statistical analyses

Based on the complex sampling design, all analyses were performed by incorporating the sampling weight, which accounts for unequal probabilities of selection, nonresponse, and the number of students by region, school type, sex, and grade in the target population. Variances of all estimates were calculated using the Taylor linearization method. The prevalence of each unhealthy dietary habit by maternal educational level and the time period and the prevalence difference between their levels were assessed using regression models incorporating considerations of the complex survey design (SAS surveyreg procedure). The models included maternal educational level, time period, the interaction term between each maternal educational level and time period, sex, and grade. The sex- and grade-adjusted prevalence and prevalence difference were estimated on the basis of the population with 12 groups of sex and 6 grades with same fraction (0.0833). In these models, we considered college graduates as the reference for maternal educational level and 2009 to 2010 for time period, and the interaction between maternal educational level and each time period indicated whether the prevalence difference between the middle/high school graduate group and college graduate group observed at a specific time period was different from that observed in 2009 to 2010, or whether the change in prevalence difference between 2009 to 2010 and a specific time period among middle/high school graduate group was different from that of the college graduate group.

To evaluate whether the odds ratios (ORs) of unhealthy dietary habits changed over time in accordance with maternal educational levels, we performed logistic regression analysis incorporating complex sampling design (using the SAS surveylogistic procedure). Similar to the models used to determine the difference in prevalence, the model included maternal educational level, time period, the interaction term between each maternal educational level and time period, sex, and grade. All P-values of <0.05 were considered statistically significant. All statistical analyses were performed using SAS ver. 9.4 (SAS Institute, Cary, NC, USA).

4. Ethics statement

This study was approved by the institutional review board of Ewha Womans University Seoul Hospital, Seoul, Korea (SEUMC2021–07–050). The institutional review board waived the requirement for informed consent because this study did not involve human participant interactions and all data were publicly available and fully anonymized.

Results

Table 1 shows the characteristics of study participants by sex, grade, school type, and maternal educational level. The distribution of maternal educational levels changed significantly between 2009 and 2019: the proportion of middle-school-graduate mothers decreased by 5.1%p (from 6.7% to 1.6%); high-school-graduate mothers, decreased by 23.5%p (from 56.8% to 33.3%); college-graduate mothers, increased by 28.5%p (from 36.5% to 65%).

1. Trends in prevalence of unhealthy dietary habits

The prevalence on all unhealthy dietary habits increased over time. In the earliest 2 years of study (2009–2010), insufficient consumption of milk showed the highest prevalence (55.8%), followed by insufficient consumption of fruit and vegetable (28.7%) (Table 2). Frequent consumption of fast food showed the lowest prevalence (11.4%). The largest increase in prevalence between 2009–2010 and 2017–2019 was in frequent consumption of carbonated soft drinks (11.7%p) and fast food (10.2%p). The prevalence of breakfast-skipping also increased significantly (8.9%p), accompanied by an increase in the prevalence in insufficient consumption of fruit and vegetable,

Table 1. Characteristics of study participants by maternal education level (%)

Characteristics	Total (595,327)	2009 (61,347)	2010 (59,611)	2011 (63,129)	2012 (61,357)	2013 (58,475)	2014 (57,904)	2015 (54,219)	2016 (52,357)	2017 (49,441)	2018 (47,445)	2019 (30,042)
Sex												
Boy	50.6	51.2	51.4	51.2	51.2	50.9	50.5	50.6	50.6	50.6	50.5	44.9
Girl	49.4	48.8	48.6	48.8	48.8	49.1	49.5	49.4	49.4	49.4	49.5	55.1
School												
Middle school	45.5	47.8	47.2	46.8	46.1	45.2	45.2	44.1	42.5	42.6	43.7	49.1
High school	54.5	52.2	52.8	53.2	53.9	54.8	54.8	55.9	57.5	57.4	56.3	50.9
Grade												
Middle 1st	13.7	14.8	14.5	14.2	13.8	14.0	13.0	12.1	12.9	13.3	12.8	16.4
Middle 2nd	15.2	16.1	15.7	15.8	15.3	14.9	15.8	14.6	13.5	14.5	14.9	15.4
Middle 3rd	16.5	16.9	16.9	16.8	17.0	16.3	16.4	17.4	16.1	14.8	16.0	17.3
High 1st	17.8	17.6	17.5	17.9	17.8	18.0	17.7	18.0	19.1	17.7	16.5	17.2
High 2nd	18.1	17.5	17.5	17.6	18.1	18.0	18.3	18.5	18.8	19.9	18.7	16.0
High 3rd	18.6	17.1	17.8	17.6	18.0	18.7	18.8	19.4	19.5	19.9	21.1	17.7
Maternal education												
≤Middle school	3.9	6.7	6.2	5.3	4.7	3.9	3.0	2.6	2.2	1.9	1.6	1.6
High school	47.6	56.8	54.9	53.4	52.5	50.4	46.8	43.5	41.8	38.9	35.5	33.3
≥College	48.5	36.5	38.9	41.3	42.8	45.7	50.2	54.0	56.0	59.2	62.9	65.0

insufficient consumption of milk, and frequent consumption of instant noodles (5.2%p, 5.6%p, and 2.7%p, respectively). Consequently, in the last 3 years of study (2017–2019), insufficient consumption of milk and insufficient consumption of fruit and vegetable still showed the highest prevalence (61.4% and 33.9%, respectively), and that of breakfast–skipping and frequent consumption of carbonated soft drinks also exceeded 30% (34.3% and 33.9%, respectively). The prevalence of frequent consumption of fast food was the lowest, but this also approached 21.6% in 2017 to 2019.

2. Absolute difference in prevalence of unhealthy dietary habits by maternal education level

Throughout the study, higher prevalence of unhealthy dietary habits was observed among lower maternal education groups. The prevalence difference between middle school and college graduate group observed in 2009 to 2010 was the largest for breakfast–skipping and insufficient consumption of fruits and vegetable (11.5%p and 9.5%p, respectively), and the difference in 2017 to 2019 (10.6%p and 7.7%p) was not significantly different from that in 2009 to 2010. The prevalence difference in frequent consumption of fast food and that of carbonated soft drinks (by maternal educational level) was small between the two groups and not different between 2009 to 2010 and 2017 to 2019 (3.6%p and 3.9%p for fast food and 0.9%p and 0.1%p for carbonated soft drinks, respectively). In contrast, the prevalence difference between the two maternal educational levels for insufficient consumption of milk and frequent consumption of instant noodles decreased significantly between 2009–2010 and 2017–2019 (milk: from 6.3%p to 2.1%p, $P_{\text{interaction}}=0.006$; instant noodles: from 7.0%p to 3.3%p, $P_{\text{interaction}}=0.009$). This resulted from a greater increase in prevalence in the college graduate group compared to that in the middle school graduate group between the two periods: the prevalence of insufficient consumption of milk and consumption of instant noodles increased by 6.7%p and 3.1%p in the college graduate group, while the changes in the middle school group included an increase of 2.5%p and a decrease of 0.7%p, respectively.

The prevalence difference of insufficient consumption of milk between the high school and college graduate groups decreased from 2009–2010 to 2017–2019 (from 4.5%p to 2.5%p, $P_{\text{interaction}} < 0.001$), which is also attributable to a greater increase in prevalence between the two periods between the college grad-

Table 2. Prevalence of unhealthy dietary habits by maternal education level and the difference in the prevalence of these habits (%)

Unhealthy dietary habits Maternal education level	2009–2010 % (SE)	2011–2013 % (SE)	2014–2016 % (SE)	2017–2019 % (SE)	Difference between 2009–2011 and 2017–2019 % (95% CI)
Insufficient consumption of fruit and vegetable					
Total	28.7 (0.2)	31.5 (0.1)	31.8 (0.1)	33.9 (0.2)	5.2 (4.7–5.8)
≥College	25.0 (0.3)	27.8 (0.2)	27.9 (0.2)	29.9 (0.2)	4.9 (4.2–5.6)
High school	31.9 (0.2)	34.7 (0.2)	35.3 (0.2)	37.6 (0.3)	5.7 (5.0–6.4)
≤Middle school	34.4 (0.6)	38.2 (0.5)	37.2 (0.8)	38.2 (1.3)	3.8 (0.9–6.6)
Difference, % (95% CI)					
High school to college	7.0 (6.3–7.6)	6.9 (6.4–7.3)	7.4 (6.9–7.9)	7.7 (7.1–8.4)	
Middle school to college	9.5 (8.1–10.8)	10.3 (9.2–11.4)	9.3 (7.7–10.8)	8.4 (5.8–11.0)	
Insufficient consumption of milk					
Total	55.8 (0.4)	55.3 (0.3)	58.1 (0.3)	61.4 (0.3)	5.6 (4.6–6.5)
≥College	53.4 (0.4)	52.8 (0.3)	56.0 (0.3)	60.0 (0.3)	6.7 (5.6–7.7)
High school	57.8 (0.4)	57.4 (0.3)	59.9 (0.3)	62.5 (0.4)	4.7 (3.6–5.9)
≤Middle school	59.7 (0.7)	58.9 (0.6)	60.4 (0.8)	62.2 (1.4)	2.5 (-0.5–5.5)
Difference, % (95% CI)					
High school to college	4.5 (3.7–5.2)	4.6 (4.0–5.1)	3.8 (3.3–4.4)	2.5 (1.7–3.3) [†]	
Middle school to college	6.3 (4.9–7.7)	6.0 (4.9–7.2)	4.4 (2.9–5.9)	2.1 (-0.5–4.8) [†]	
Breakfast skipping					
Total	23.6 (0.2)	23.3 (0.1)	27.0 (0.1)	32.5 (0.2)	8.9 (8.4–9.4)
≥College	20.5 (0.3)	20.3 (0.2)	23.6 (0.2)	28.7 (0.2)	8.2 (7.6–8.8)
High school	26.1 (0.3)	25.9 (0.2)	29.9 (0.2)	35.8 (0.3)	9.8 (9.0–10.5)
≤Middle school	32.0 (0.6)	29.0 (0.5)	32.4 (0.7)	39.3 (1.1)	7.3 (4.9–9.8)
Difference, % (95% CI)					
High school to college	5.6 (4.9–6.2)	5.6 (5.2–6.0)	6.3 (5.8–6.7)	7.2 (6.6–7.7) [†]	
Middle school to college	11.5 (10.2–12.8)	8.7 (7.6–9.7) [†]	8.8 (7.4–10.2) [†]	10.6 (8.6–12.7)	
Frequent consumption of fast food					
Total	11.4 (0.1)	11.5 (0.1)	15.1 (0.1)	21.6 (0.1)	10.2 (9.8–10.6)
≥College	11.7 (0.2)	11.4 (0.1)	15.2 (0.1)	21.3 (0.2)	9.6 (9.1–10.1)
High school	11.0 (0.2)	11.6 (0.1)	15.1 (0.1)	21.9 (0.2)	10.9 (10.4–11.4)
≤Middle school	12.6 (0.5)	12.4 (0.4)	15.1 (0.5)	21.4 (0.9)	8.8 (6.8–10.7)
Difference, % (95% CI)					
High school to college	-0.7 (-1.1--0.2)	0.1 (-0.2–0.4) [†]	-0.1 (-0.5–0.3)	0.6 (0.1–1.1) [†]	
Middle school to college	0.9 (0.0–1.9)	1.0 (0.2–1.7)	-0.1 (-1.2–1.0)	0.1 (-1.7–1.9)	
Frequent consumption of carbonated soft drinks					
Total	22.6 (0.2)	23.1 (0.1)	26.1 (0.1)	34.3 (0.2)	11.7 (11.2–12.2)
≥College	21.9 (0.3)	22.1 (0.2)	25.1 (0.2)	32.3 (0.2)	10.4 (9.7–11.0)
High school	23.0 (0.2)	23.9 (0.2)	27.1 (0.2)	36.1 (0.2)	13.1 (12.5–13.8)
≤Middle school	25.6 (0.6)	26.6 (0.5)	27.9 (0.7)	36.2 (1.0)	10.6 (8.4–12.9)

Table 2. Continued

Unhealthy dietary habits Maternal education level	2009–2010 % (SE)	2011–2013 % (SE)	2014–2016 % (SE)	2017–2019 % (SE)	Difference between 2009–2011 and 2017–2019 % (95% CI)
Difference, % (95% CI)					
High school to college	1.1 (0.5–1.6)	1.8 (1.4–2.2)	2.0 (1.6–2.5)*	3.8 (3.3–4.4)†	
Middle school to college	3.6 (2.5–4.8)	4.5 (3.5–5.5)	2.8 (1.5–4.2)	3.9 (1.9–5.9)	
Frequent consumption of instant noodle/cup noodle					
Total	22.9 (0.2)	21.1 (0.1)	21.8 (0.2)	25.5 (0.2)	2.7 (2.1–3.3)
≥College	21.0 (0.2)	19.0 (0.2)	20.2 (0.2)	24.1 (0.3)	3.1 (2.4–3.8)
High school	24.4 (0.2)	23.0 (0.2)	23.2 (0.2)	26.9 (0.4)	2.5 (1.7–3.4)
≤Middle school	28.0 (0.6)	26.0 (0.5)	25.8 (0.8)	27.3 (1.3)	-0.7 (-3.4–2.0)
Difference, % (95% CI)					
High school to college	3.4 (2.8–4.0)	3.6 (3.2–4.0)	3.0 (2.5–3.5)	2.8 (2.0–3.6)	
Middle school to college	7.0 (5.8–8.3)	6.7 (5.8–7.7)	5.6 (4.1–7.1)	3.3 (0.7–5.8)†	

Prevalence in all students is adjusted for sex, grade, and maternal education level; Prevalence by maternal education group is adjusted for sex and grade.

CI, confidence interval; SE, standard error.

* <0.05 , † <0.01 , ‡ <0.001 : P for interaction of maternal education level and each time period.

uate and high school graduate groups (by 6.7%p and 4.7%p, respectively). In contrast, the prevalence difference between the two groups increased for breakfast-skipping by 1.6%p over the same period (from 5.6%p to 7.2%p), for frequent consumption of fast food by 1.3%p (from -0.7%p to 0.6%p), and for frequent consumption of soft drinks by 2.8%p (from 1.1% to 3.8%) (for all, $P_{\text{interaction}} < 0.001$).

3. Relative difference in prevalence of unhealthy dietary habits by maternal education level

In 2009 to 2010, the prevalence odds were significantly higher for the unhealthiest dietary habits in middle/high school graduate group than in the college graduate group (Table 3). In 2017 to 2019, the ORs of the middle school graduate group relative to those of the college graduate group decreased substantially compared to those in 2009 to 2010, for both insufficient consumption of milk (from OR, 1.31; 95% CI, 1.23–1.39 to OR, 1.11; 95% CI, 0.98–1.25; $P_{\text{interaction}} = 0.014$) and frequent consumption of instant noodles (from OR, 1.49; 95% CI, 1.39–1.59 to OR, 1.21; 95% CI, 1.05–1.39; $P_{\text{interaction}} = 0.008$). The OR of the middle school group, compared to that of the college graduate group, for breakfast skipping also decreased, although still substantial in 2017–2019 (from OR,

1.83; 95% CI, 1.72–1.94 to OR, 1.61; 95% CI, 1.47–1.75; $P_{\text{interaction}} = 0.02$). In contrast, the relative odds for frequent consumption of fast food and carbonated soft drinks did not differ in 2017–2019 (fast food: from OR, 1.00; 95% CI, 0.90–1.11 to OR, 1.10; 95% CI, 1.01–1.20; carbonated soft drinks: from OR, 1.20; 95% CI, 1.10–1.31 to OR, 1.22; 95% CI, 1.15–1.30) from 2009–2010.

The OR of the high school graduate group compared to that of the college graduate group for insufficient consumption of milk decreased between 2009–2010 and 2017–2019, from 1.21 (95% CI, 1.17–1.35) to 1.12 (95% CI, 1.08–1.16) ($P_{\text{interaction}} = 0.014$). In contrast, the ORs for frequent consumption of fast food and carbonated soft drinks increased significantly during the same period, from 0.94 (95% CI, 0.90–0.98) to 1.03 (95% CI, 1.00–1.06) and from 1.06 (95% CI, 1.02–1.11) to 1.19 (95% CI, 1.16–1.23), respectively (for both, $P_{\text{interaction}} < 0.001$).

Discussion

This study shows that unhealthy dietary habits were more prevalent among adolescents from families with lower maternal educational attainment, using a representative sample of Ko-

Table 3. Prevalence odds ratio by maternal education level during 2009 to 2019

Unhealthy dietary habits Maternal education (reference: ≥college)	2009–2010 OR (95% CI)	2011–2013 OR (95% CI)	2014–2016 OR (95% CI)	2017–2019 OR (95% CI)	OR for time trend (2017–2019 relative to 2009–2010)
Insufficient consumption of fruit and vegetable					
High school	1.41 (1.37–1.46)	1.38 (1.35–1.41)	1.41 (1.38–1.44)	1.41 (1.37–1.46)	1.28 (1.24–1.32)
≤Middle school	1.58 (1.49–1.68)	1.60 (1.52–1.67)	1.52 (1.43–1.63)	1.45 (1.30–1.62)	1.18 (1.04–1.33)
Insufficient consumption of milk					
High school	1.21 (1.17–1.25)	1.21 (1.19–1.24)	1.18 (1.15–1.21)	1.12 [†] (1.08–1.16)	1.24 (1.17–1.30)
≤Middle school	1.31 (1.23–1.39)	1.29 (1.23–1.36)	1.21 (1.13–1.30)	1.11* (0.98–1.25)	1.12 (0.98–1.29)
Skipping breakfast					
High school	1.37 (1.32–1.42)	1.37 (1.34–1.41)	1.38 (1.35–1.41)	1.39 (1.35–1.42)	1.58 (1.53–1.64)
≤Middle school	1.83 (1.72–1.94)	1.60 [†] (1.52–1.69)	1.55 [†] (1.46–1.65)	1.61* (1.47–1.75)	1.38 (1.24–1.53)
Frequent consumption of fast food					
High school	0.94 (0.90–0.98)	1.02 [†] (0.99–1.05)	0.99* (0.96–1.02)	1.03 [†] (1.00–1.06)	2.25 (2.16–2.33)
≤Middle school	1.10 (1.01–1.20)	1.10 (1.03–1.18)	0.99 (0.91–1.08)	1.00 (0.90–1.11)	1.86 (1.64–2.12)
Frequent consumption of soft drinks					
High school	1.06 (1.02–1.10)	1.11 (1.08–1.13)	1.11* (1.09–1.14)	1.19 [†] (1.16–1.23)	1.93 (1.87–2.00)
≤Middle school	1.22 (1.15–1.30)	1.28 (1.22–1.35)	1.16 (1.08–1.24)	1.20 (1.10–1.31)	1.68 (1.51–1.87)
Frequent consumption of instant noodles					
High school	1.22 (1.18–1.26)	1.24 (1.21–1.27)	1.20 (1.16–1.24)	1.18 (1.13–1.23)	1.15 (1.10–1.21)
≤Middle school	1.49 (1.39–1.59)	1.49 (1.41–1.57)	1.39 (1.28–1.51)	1.21 [†] (1.05–1.39)	0.97 (0.84–1.13)

All models include maternal education level, four periods, interaction term of maternal education level and four periods, sex, and grade.

CI, confidence interval; OR, odds ratio.

*P<0.05, [†]P<0.01, [‡]P<0.001 are for interaction between maternal educational level and each time period.

rean adolescents. Maternal education affects dietary behaviors and nutritional status of the offspring [11], as it may be associated with better understanding of nutritional information, maximized utilization of available resources, and higher interest for nutrition messages; furthermore, mothers with low educational attainment might have limited time available for shopping and cooking meals, lower contribution to the family income, or apathy for nutrition messages in addition to nutritional knowledge [12]. Previous studies have reported that nutrition knowledge serves as mediator of the sociodemographic variation in dietary habits [13].

From 2009 to 2019, the prevalence of the unhealthy dietary habits increased among all maternal educational levels. The prevalence differences between the middle school and the col-

lege graduate group either decreased or did not differ significantly. The decreased prevalence differences were often attributable to a rapid increase in prevalence in the college graduate group. The prevalence differences between the high school and college graduate groups either increased or showed no significant difference over time. In Korea, middle school education was made compulsory in island regions initially in 1985 and was made totally compulsory in 2004. Therefore, differences in dietary habits between students with high-school-graduate mothers and college-graduate mothers may be of greater importance.

Insufficient consumption of milk (≤4 days per week) showed high prevalence of over 50% and consistently increased over 11 years. Although the prevalence difference and ratio between

the maternal middle/high school graduate group and the college graduate group decreased significantly over time, this was attributable to a rapid increase in prevalence in the higher maternal education group rather than improvement in the lower maternal education group. According to the 2020 Dietary Reference Intakes for Koreans [14], the recommended amount of milk intake is 200 mL/day. Milk is among major sources of calcium in the Korean diet. Inadequate intake of calcium can lead to lower bone mineral density and an increased risk of osteoporosis [15]. Low milk consumption during adolescence may also contribute to insufficient intake of important nutrients essential for growth, such as magnesium and iodine [16].

Increasing prevalence of not consuming the recommended amount of milk among adolescents is possibly related to changes in the school milk program and reduced participation of students owing to low satisfaction among parents, children, and schools and difficulties in management of milk in schools [17]. Drinking milk is increasingly considered a personal preference and choice rather than a nutritional obligation. The finding that the prevalence of insufficient milk consumption increased more rapidly in the group with higher maternal educational levels may reflect that mothers' preference and a sense of duty toward their children's milk intake do not differ in accordance with the mother's educational level. However, studies have revealed a significant difference in calcium intake between students attending schools that have a milk program and those that do not [18]. Therefore, another approach to increase calcium intake, including milk consumption, is imperative among adolescents, in that the proportion of people with insufficient calcium intake compared to the recommended intake was the highest in all age groups [19].

Insufficient consumption of fruit and vegetable also showed high prevalence during the study period (>20%). The prevalence difference and ratio between middle/high-school-graduate mothers and college-graduate mothers were substantially large (9.5%p between middle and college graduate groups and 7.0%p between high and college graduate groups in 2009–2010) and did not change significantly over the study period. It is of note that we set a considerably lower standard in defining insufficient consumption of fruit and vegetable than existing health guidelines; recommendations for dietary intake vary globally, from at least 400 g/day by the WHO and the World Cancer Research Fund, to 500 g/day in Sweden, to 600 g/day

in Denmark, and 640–800 g/day in the USA, and 1 serving of fruit and 3 servings of vegetable daily in Korea [20,21]. Our standard for insufficient consumption (intake frequency of ≤ 4 times for both fruit and vegetable per week) represents approximately an intake of 640 g per week (and approximately once a day in terms of frequency), assuming 80 g of vegetable and 100 g of fruit as the average portion size [22]. This signifies that our study participants categorized as having insufficient consumption were well below dietary guidelines.

The result of the prevalence differences by maternal education level was consistent with many previous studies showing the close relationship between consumption of fruit and vegetable and socioeconomic factors such as family income and parental education [23]. However, considering that the prevalence differences between maternal educational levels did not decrease between 2009 and 2019, the similar increasing rates of prevalence of insufficient fruit and vegetable consumption observed for all maternal educational levels can be explained as a general trend in Korean society. For example, increased women's economic activities, increasing double-income households and single-person households, and delivery services have led to changes in lifestyle, which underline simplicity and practicality in diet [24]. The frequency of eating out and purchasing home meal replacements (HMRs) rapidly increased among Korean households (i.e., an average 15.3% annual increase between 2017 and 2019). HMR is a food type that requires no additional cooking process (e.g., sandwich, hamburger, or kimbap) or only simple processing such as heating (e.g., instant soup). On the contrary, Korean households' frequency of purchasing vegetables once a day decreased from 4.6% in 2013 to 1.0% in 2019 and that of purchasing vegetables $\geq 2-3$ times per week decreased from 40.3% in 2013 to 30.5% in 2019 [25]; the frequency of purchasing fruit once a day decreased from 2.2% to 0.5% and that of purchasing fruit $\geq 2-3$ times per week decreased from 24.4% to 18.6% during the same period. In this trend, improvements in school meals and reinforced nutritional education are recommended as primary measures to provide fruit and vegetable for adolescents [26,27]. Introduction of fresh and healthy foods in the HMR market, such as healthier meal-kits, may also contribute to overall increased fruit and vegetable consumption [28].

Breakfast-skipping was more prevalent among lower maternal educational levels, and the prevalence of an unhealthy

diet among all groups and the prevalence differences between groups with maternal high school and college graduate education increased over time. Although the differential in the relative scale between the middle-school-graduate group and the college-graduate group decreased, the differences and ORs of breakfast-skipping between these maternal educational groups were still higher than those for other dietary habits in the last 3 years of study. Breakfast provides many health benefits related to appetite control, satiety, dietary composition, and chronic disease risk factors [29]. In Korean adolescents, breakfast-skipping was positively associated with other unhealthy habits, including drinking alcohol and smoking, more snack intake [30], increased eating out at fast food restaurants and convenience stores [31], and consumption of sugar-sweetened drinks and carbonated drinks [32]. In addition, previous studies also showed the association between a higher frequency of breakfast-skipping and negative health outcomes, such as an increased risk of obesity, higher fasting blood glucose concentrations, and mortality from cardiovascular diseases [30,33,34].

Since breakfast is still prepared mainly by mothers until now, children's breakfast intake depends largely on their mothers [35]. The unwillingness of the adolescents might have played a role, but the lack of mothers' perception and encouragement of their children for regular breakfast consumption and inadequate resources including time might increase the frequency of breakfast-skipping in families with a lower maternal education. Hence, it is necessary that additional measures be taken to mediate the effect of maternal education on breakfast consumption [36].

The prevalence of both frequent consumption of fast food and carbonated soft drink increased approximately by 10% between 2009–2010 and 2017–2019 among all maternal education groups. Fast foods including pizza, hamburgers, and chicken are popular in modern society because they are relatively inexpensive and convenient to eat [2]. The number of fast food restaurants increased greatly over the past decade, and adolescents account for a large proportion of fast food customers. Adolescents tended to eat fast food more frequently than other age groups because they preferred it for its convenience and low price, preferences for westernized diets, and high availability of fast food near schools and academies [2,25]. Carbonated soft drinks are generally provided with fast food menu items in Korean fast food restaurants. However,

consumption of fast food and sugar-sweetened carbonated soft drinks is reportedly associated with obesity in adolescents, osteoporosis, tooth cavities, cardiovascular disease, diabetes, lower calcium intake, and lower intake of healthy foods such as fruit and vegetable [2,5,6,37,38]. Overall, these result in an increased risk of unbalanced nutrient intakes for Korean adolescents.

Interestingly, prevalence difference and ratio of fast food and carbonated soft drink based on maternal educational levels were small throughout the study period. This can be explained by the recent trend in the fast food industry in Korea. Fast food restaurants have become a popular choice of dining among Korean families. A variety of marketing strategies and promotions are used to attract customers, such as introduction of healthy menu items [39]. While it is unknown whether fast food offered at a higher price has higher nutritional value, it is possible that this trend has made fast food an attractive choice for groups with higher maternal educational levels. Fast food is also being offered at a substantially lower price in convenience stores [25]. Thus, it is possible that the price and quality of fast food in Korea vary greatly. However, the diversity of fast food with possibly varying nutritional values were not reflected in the survey. Hence, it would be necessary to investigate whether there exists types and nutritional differences across fast food consumed by groups with high and low maternal educational levels.

The prevalence of frequent consumption of instant noodles showed a relatively small increase between 2009 and 2019 compared to other dietary habits, and the increase was the largest in the college graduate group. The prevalence differential and odds of the middle school graduate group compared to the college graduate group decreased over time. The high sodium and saturated fat content of instant noodles have long been considered a nutritional problem in Korea. In Korea, instant noodles have long been consumed as a substitute for meals, more frequently by low-income families rather than by high-income families owing to their relatively low price and simple cooking process [40]. Given the diversification of processed and instant foods over the past decade, the small change in the prevalence of frequent instant noodle consumption may be due to increased consumption of other processed/instant food items [25]. Among processed food items, according to the average monthly expenditure per household, instant noodles ranked 4th

in 2010 but 9th in 2019, while instant/frozen food ranked 21st in 2010 but 4th in 2019 [28]. The pattern of the consumption of other processed/instant foods by maternal educational levels was not investigated; hence, the significance of the largest increase in the prevalence of frequent instant noodle consumption in the group with high school-graduate mothers is less clear. Furthermore, the processed/instant foods available at convenience stores may be similarly energy-dense, nutrient-poor, and less costly. Therefore, future studies should include overall processed/instant food items available for adolescents to further investigate their unhealthy dietary habit.

This study has some limitations. First, only the mother's education level was used as an indicator of socioeconomic position. Other objective indices of the socioeconomic status of the adolescent's household such as family income or house owning are not included in the data source of the study (the KYRBS) and were not adjusted for the analysis. Therefore, the prevalence difference in unhealthy dietary habits by mother's education level in the study could be confounded by other socioeconomic conditions. Second, only the intake frequency of milk was included in our study. Insufficient consumption of milk may not be a health problem for subjects who consume enough quantities of other dairy products such as cheese and yogurt. Nevertheless, milk accounts for a much larger proportion than other dairy products in the Korean diet, accounting for 13.6% of calcium intake, while cheese and yogurt account for 3.5% and 1.6%, respectively. Hence, we believe that our findings can provide enough information regarding dietary habits with respect to dairy products. In addition, all data were based on self-reported questionnaires using rough food classifications in everyday language, not typical dietary questionnaires that can be translated directly to nutrient intake. However, it can make information more straightforward and easier to understand for adolescents and parents. Therefore, this could be more applicable to monitor adolescents' dietary habits, easily identify problems, and make improvements.

In conclusion, the prevalence of unhealthy dietary habits increased in Korean adolescents of all maternal educational levels from 2009 to 2019, especially with regard to frequent consumption of fast food and carbonated soft drinks, and insufficient consumption of fruit and vegetable, and milk. For most unhealthy dietary habits, the difference in prevalence between groups of high-school-graduate and college-graduate mothers

increased with time. Even the decrease in the difference between the groups was attributed to the increase in the prevalence of unhealthy behavior in the group with higher maternal education. To improve the dietary habits of adolescents, a concerted effort of the society for all students and parents including targeted efforts for those with low socioeconomic status is needed. Therefore, further studies are required to investigate dietary habits in greater detail and the needs and the barriers against healthy dietary habits of adolescents and their parents.

References

1. Mesias M, Seiquer I, Navarro MP. Calcium nutrition in adolescence. *Crit Rev Food Sci Nutr* 2011;51:195-209.
2. Kim BR. Fast food consumption pattern and food habit by fast food intake frequency of middle school students in Wonju area. *JKorean Home Econ Educ Assoc* 2009;21:19-33.
3. Kim K, Park E. Nutrient density of fast-food consumed by the middle school students in Cheongju city. *Korean J Community Nutr* 2005;10:271-280.
4. Korea Centers for Disease Control and Prevention. The statistics of the 4th Korea Youth Behavior Survey 2018. Cheongju: Korea Centers for Disease Control and Prevention; 2018.
5. Tirosh A, Shai I, Afek A, Dubnov-Raz G, Ayalon N, Gordon B, et al. Adolescent BMI trajectory and risk of diabetes versus coronary disease. *N Engl J Med* 2011;364:1315-1325.
6. Zhang T, Xu J, Li S, Bazzano LA, He J, Whelton PK, et al. Trajectories of childhood BMI and adult diabetes: the Bogalusa Heart Study. *Diabetologia* 2019;62:70-77.
7. Oh S. The association of dietary life, nutrition and mental health in Korean adolescents. *JKorea Entertain Ind Assoc* 2016;10:235-250.
8. Kwon JE, Park HJ, Lim HS, Chyun JH. The relationships of dietary behavior, food intake, and life satisfaction with family meal frequency in middle school students. *Korean J Food Cult* 2013;28:272-281.
9. Lee MY, Choi EM, Chung WG, Son JH, Chang SJ. The effects of perceived stress on dietary habits and oral health behaviors in Korean adolescents. *JDent Hyg Sci* 2013;13:440-448.
10. Cullen KW, Ash DM, Warneke C, de Moor C. Intake of soft drinks, fruit-flavored beverages, and fruits and vegetables by children in grades 4 through 6. *Am J Public Health* 2002;92:1475-1478.
11. Corsi DJ, Mejia-Guevara I, Subramanian SV. Risk factors for chronic undernutrition among children in India: estimating relative importance, population attributable risk and fractions. *Soc Sci Med* 2016;157:165-185.
12. Dubowitz T, Acevedo-Garcia D, Salkeld J, Lindsay AC, Subramanian SV, Peterson KE. Lifecourse, immigrant status and acculturation in food purchasing and preparation among low-income mothers. *Public Health Nutr* 2007;10:396-404.

13. Wardle J, Parmenter K, Waller J. Nutrition knowledge and food intake. *Appetite* 2000;34:269-275.
14. Korean Nutrition Society. Dietary reference intakes for Koreans 2020. Sejong: Ministry of Health and Welfare; 2020.
15. Munoz-Garach A, Garcia-Fontana B, Munoz-Torres M. Nutrients and dietary patterns related to osteoporosis. *Nutrients* 2020;12:1986.
16. Givens DI. MILK Symposium review: the importance of milk and dairy foods in the diets of infants, adolescents, pregnant women, adults, and the elderly. *J Dairy Sci* 2020;103:9681-9699.
17. Lee HW. A negative perception of milk-meal program and the measure to activate milk-meal program [Thesis]. Seoul: Konkuk University; 2020.
18. Kim W, Ha AW, Lee JH, Kim SH. Yearly trend of milk intake in Korean children and adolescents and their nutritional status by the milk intake level using 2007-2015 Korea National Health and Nutrition Examination Survey. *J Nutr Health* 2020;53:503-517.
19. Korea Institute for Health and Affairs. A study for development of the national dietary guidelines for Koreans. Sejong: Ministry of Health and Welfare; Korea Institute for Health and Affairs; 2015.
20. Aune D, Giovannucci E, Boffetta P, Fadnes LT, Keum N, Norat T, et al. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality: a systematic review and dose-response meta-analysis of prospective studies. *Int J Epidemiol* 2017;46:1029-1056.
21. Korean Nutrition Society. Dietary reference intakes for Koreans 2015. Sejong: Ministry of Health and Welfare; Korean Nutrition Society; 2015.
22. Riboli E, Norat T. Epidemiologic evidence of the protective effect of fruit and vegetables on cancer risk. *Am J Clin Nutr* 2003;78(3 Suppl):559S-569S.
23. Darmon N, Drewnowski A. Does social class predict diet quality? *Am J Clin Nutr* 2008;87:1107-1117.
24. Seo S, Im S. Comparison of influencing factors on Korean household's dining out frequency and HMR purchase frequency using the consumer behavior survey for food 2019. *J Tour Sci* 2020;44:55-78.
25. Korea Rural Economic Institute. Statistical report of 2019 food consumption behavior survey. Naju: Korea Rural Economic Institute; 2019.
26. Park DH. A study on school lunch service policy [Thesis]. Geum-san: Joongbu University; 2010.
27. Yeon K. The effects of school dietary education on adolescent fruit and vegetable consumption [Thesis]. Seoul: Korea University; 2019.
28. Korea Rural Economic Institute; Seoul National University. Report of 2020 food industry information analysis agency. Sejong: Ministry of Agriculture, Food and Rural Affairs; 2020.
29. Timlin MT, Pereira MA. Breakfast frequency and quality in the etiology of adult obesity and chronic diseases. *Nutr Rev* 2007;65(6 Pt 1):268-281.
30. Bae YJ. Evaluation of nutrient intake and meal variety with breakfast eating in Korean adolescents: analysis of data from the 2008-2009 National Health and Nutrition Survey. *Korean J Community Nutr* 2013;18:257-268.
31. Choi EJ, Choi MK. Eating out status according to skipping and type of breakfast among male high school students in Incheon. *Korean J Community Nutr* 2020;25:102-111.
32. Kye S. Breakfast skipping, body mass index, health related factors in Korean adolescents: analysis of the data from the 2018 Youth Health Behavior Online Survey. *J Learn Cent Curric Instr* 2019;19:1263-1281.
33. Ma X, Chen Q, Pu Y, Guo M, Jiang Z, Huang W, et al. Skipping breakfast is associated with overweight and obesity: a systematic review and meta-analysis. *Obes Res Clin Pract* 2020;14:1-8.
34. Rong S, Snetselaar LG, Xu G, Sun Y, Liu B, Wallace RB, et al. Association of skipping breakfast with cardiovascular and all-cause mortality. *J Am Coll Cardiol* 2019;73:2025-2032.
35. Ali RA, Abdel Razeq NM, Alnuaimi KM, Alzoubi FA. Maternal sociodemographic characteristics and behaviors as correlates of preadolescent's breakfast habits. *J Pediatr Nurs* 2018;39:61-67.
36. Affenito SG, Thompson D, Dorazio A, Albertson AM, Loew A, Holschuh NM. Ready-to-eat cereal consumption and the School Breakfast Program: relationship to nutrient intake and weight. *J Sch Health* 2013;83:28-35.
37. Gonzalez-Morales R, Canto-Osorio F, Stern D, Sanchez-Romero LM, Torres-Ibarra L, Hernandez-Lopez R, et al. Soft drink intake is associated with weight gain, regardless of physical activity levels: the health workers cohort study. *Int J Behav Nutr Phys Act* 2020;17:60.
38. Striegel-Moore RH, Thompson D, Affenito SG, Franko DL, Obarzanek E, Barton BA, et al. Correlates of beverage intake in adolescent girls: the National Heart, Lung, and Blood Institute Growth and Health Study. *J Pediatr* 2006;148:183-187.
39. Park SH, Cho WJ. The structural relationship between consumer values, attitude and purchase intention towards healthy menu items at fast food restaurants. *Korean J Tour Res* 2012;27:179-194.
40. Korea Rural Economic Institute. Statistical report of 2020 food consumption behavior survey. Naju: Korea Rural Economic Institute; 2020.