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## **Association between nutrition education, dietary habits, and body image misperception in adolescents**

doi: 10.6133/apjcn.202108/PP.0001

Published online: August 2021

**Running title:** Nutrition education and dietary behaviors

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Individual contribution: JHL and HK developed the study concept and design. All authors contributed to the acquisition and interpretation of the data. HSL performed the statistical analysis. JHL and YJK prepared the first version of the manuscript. JS and JWL revised the manuscript critically for essential intellectual content. All authors read and approved the final version to be published.

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## ABSTRACT

**Background and Objectives:** In adolescents, adequate nutrition education is essential for making decisions regarding healthy eating habits. We aimed to investigate differences in dietary habits and body image misperception according to nutrition education status. **Methods and Study Design:** We analyzed 60,389 adolescents aged 12–18 years old, using the 2017 Korea Youth Risk Behavior Web-based Survey data. Participants were divided into nutrition-educated (EDU) and uneducated (non-EDU) groups, according to nutrition education status within the past year. Skipping breakfast was defined as skipping breakfast  $\geq 5$  times/week. Desirable dietary behaviors were divided into the frequency of consumption of 3 items: vegetables  $\geq 1$  time/day, milk  $\geq 1$  time/day, and fruits  $\geq 1$  time/day. Participants with normal weight who reported being slightly fat or very fat were defined as having body image misperception. **Results:** Compared to the non-EDU group, the odds ratio (OR) and 95% confidence interval (CI) for desirable dietary behaviors in the EDU group were 1.08 (1.04–1.13), 1.14 (1.09–1.19), and 1.16 (1.12–1.20) for the intake of fruits, milk, and vegetables, respectively. The EDU group was less associated with skipping breakfast than the non-EDU group (OR=0.91, 95% CI: 0.87–0.95,  $p < 0.001$ ). The OR and 95% CI of body image misperception in the EDU group were lower than in the non-EDU group (OR=0.92, 95% CI: 0.87–0.97,  $p < 0.001$ ). **Conclusions:** Nutrition education have positive effects on healthy dietary behaviors. It also shows a negative association with body image misperception, confirming the importance of nutrition education at school.

**Key Words:** schools, public health, adolescent behavior, breakfast, body image

## INTRODUCTION

Adolescence is related to higher nutritional demands, due to rapid growth and development. Therefore, inappropriate nutrition could negatively affect physical and mental development in adolescents. Because eating habits during adolescence are the foundation of lifelong health,<sup>1,2</sup> adequate nutrition education at that time is essential for the development of healthy eating habits. However, adolescents are prone to having undesirable food, such as refined carbohydrates (snacks and sugar-sweetened beverages), caffeine, and junk food, instead of fruits, milk, and vegetables.<sup>3</sup>

Teenagers are exposed to the risk of nutritional imbalance. Milk has an excellent balance of nutrients for growth and development, including whey protein, casein, and calcium.<sup>4</sup> Previous studies have reported that milk consumption is associated with decrease in body fat

percentage and increase in body weight, lean mass, and bone mineral contents.<sup>4,5</sup> Although the Korean Nutrition Society recommends that Korean adolescents consume two cups of milk daily (400 mL/day),<sup>6</sup> the average amount of milk consumed by Korean adolescents was only 114.2 mL/day.<sup>7</sup> The World Health Organization (WHO) recommends people to maintain their free sugar consumption as low as possible, as there is no evidence of harmful effects related to the intake of free sugars to less than 5% of the total calorie intake.<sup>8</sup> However, the daily average sugar intake for Korean adolescents aged 12 to 18 years is 69.5 g, which is 13.9% of the total energy intake;<sup>9</sup> and this exceeds the WHO's recommended amount of free sugar intake.<sup>8</sup> In addition, 14.3g (20.5%) of sugar intake is consumed as a beverage and 53.9% of which consists of added sugar drink.<sup>9</sup> The average daily caffeine intake of high school students is 78.98 mg in boys and 61.23 mg in girls, both of which are lower than the recommended daily caffeine intake of less than 2.5 mg/kg.<sup>10</sup> However, 12.5% of high school students consume up to 1,346.22 mg of caffeine per day, which is more than their recommended daily caffeine intake.<sup>10</sup> The prevalence of obesity in adolescents has increased from 12.2% in 2011 to 17.3% in 2016.<sup>11</sup> Obese adolescents are known to inappropriately assess diet quality compared to normal-weighted adolescents.<sup>3</sup> The skipping breakfast rate, which is defined as skipping breakfast for more than 5 days a week, has been reported to be 31.5% in adolescents.<sup>12</sup> In addition, adolescents are easily affected by the media and social prejudice and are susceptible to having distorted body image. A previous study showed that 24.2% of middle and high school students have body image misperception, in which they consider themselves obese regardless of normal BMI.<sup>13</sup> For these reasons, nutrition education is important for building proper dietary habits and correcting wrong dietary awareness.<sup>3</sup>

In the past, adolescents have received nutritional information from home education.<sup>14</sup> However, as the numbers of nuclear families and working women have increased, schools have started offering nutrition education. Thus, schools are considered as important places to provide nutrition information for school-aged children in many countries.<sup>15</sup> After the enforcement decree of the school meals act was established in 2003, Korean school nutrition programs included not only providing school meal service, but also providing adequate nutritional information in elementary, middle, and high schools.<sup>16,17</sup> In Korean schools, however, the role of nutrition teachers is mainly focused on providing meal service to students. In addition, there are currently an insufficient number of nutrition teachers. In 2017, only 619 out of 3,238 middle schools (18.9%) and 622 out of 2,386 high schools (26.3%) employed nutrition teachers.<sup>18</sup> Moreover, several healthy diet programs for children and adolescents have shown limited success,<sup>19,20</sup> although some studies have confirmed a

relationship between nutrition education and dietary change.<sup>21,22</sup> This suggests that the effectiveness of school-based nutrition education needs to be verified.

In the current study, we aimed to investigate differences in dietary habits and body image misperception according to nutrition education, using nationally representative data.

## **MATERIALS AND METHODS**

### ***Sample***

We used data from the 2017 Korea Youth Risk Behavior Web-based Survey (KYRBS). KYRBS was a national, school-based survey that was conducted by the Korea Centers for Disease Control and Prevention (KCDC). The KYRBS had a cross-sectional design that employed a stratified, multistage, probability sampling design based on geographical area. Sample weights were assigned to participants to represent the general Korean population.<sup>23</sup> Validity and reliability of KYRBS has been validated in the previous studies.<sup>24,25</sup> Because this web-based survey was performed at the school with huge participants, the written informed consent from their parents was exempted. This consent procedure was approved by the Institutional Review Board (IRB) of KCDC (approval number 117058).

Students completed the survey in the classroom, and all responses were anonymous. The questionnaires included anthropometric variables (height, and weight), demographic variables (age, school grade, gender, physical activity, residential area, and subjective household economic status), variables related to diet (dietary behaviors, frequency of having breakfast), and variables associated with subjective status (subjective body image perception).

The 2017 KYRBS consisted of data on 62,276 students from 400 middle schools and 400 high schools. Students were in the first grade of middle school up to the third grade of high school. Of these participants, we excluded those without height or weight data (n=1,884) and dietary behavior data (n=3). A total of 60,389 adolescents (30,659 boys and 29,730 girls) were included in the analysis.

### ***Demographic variables***

The variables included in the model were sex, level of school (middle school, high school), subjective household economic status (high, medium-to-high, medium, low-to-medium, low), residential area (metropolitan cities, small and medium-sized cities [cities except for metropolitan cities], counties) based on the size of cities in the administrative divisions of Korea, BMI Z-score, and regular physical activity (physical activity that lasted more than 60 minutes for 5 days or more per week).

### ***Nutrition education assessment***

The Korean Ministry of Food and Drug Safety has published electronic books (e-books) on nutrition education as a guide for standardized nutrition education. The e-books emphasized nutritional practice and discussion during class to recognize factors hindering healthy diets in teenagers and to encourage them to change their diet. Although it is not compulsive to use e-books, teachers at each school referred to e-books to provide nutrition information for the implementation of healthy eating habits for students and promoting a positive attitude for healthy dietary behaviors (Figure S1). The nutrition education curriculum for middle and high school students in Korea were classified as food safety (caffeine intake and food additives) and nutrition information (diet, obesity, and nutrition labeling).<sup>26</sup> The food safety education curriculum included caffeine (caffeine content in foods, the health hazards of excess caffeine intake, and ways to reduce caffeine intake) and food additives (types, uses, and safety of processed foods). After nutrition education, students were able to determine proper diets and calculate the recommended daily caloric intake according to their BMI. In the nutritional information class, students received information on obesity and eating disorders and discussed ways to prevent obesity and eating disorders with proper body image training. Also, students learned how to read nutritional labels and to select proper food when eating out. More detailed information about nutrition education is available through the Ministry of Food and Drug Safety website.<sup>27</sup>

Participants responded “yes” or “no” to the following question about their experience of nutrition education at school: “During the last 12 months, have you participated in a nutrition and dietary habits class at school?” Participants were then divided into 2 groups: group who experienced nutrition education at school within a year (EDU) or group who did not (non-EDU).

### ***Dietary behaviors and breakfast frequency assessment***

The dietary behaviors of adolescents were assessed through online questionnaires as follows: “In the last 7 days, how many days did you have breakfast or eat fruit/vegetable/milk/fast food/instant noodles/snack/soda/sweet drinks/caffeine?” The responses consisted of the following: 1) never, 2) 1-2 times/week, 3) 3-4 times/week, 4) 5-6 times/week, 5) once daily, 6) twice a day, and 7) at least 3 times a day. Desirable dietary behaviors included fruit, vegetable, and milk consumption, whereas undesirable dietary behaviors included instant food (fast food, instant noodles, and snack), added-sugar drink (soda and sweet drinks), and caffeinated drink consumption. These were based on food-based dietary guidelines for Korean adolescents.<sup>28</sup>

The consumption of the desirable and undesirable items was assessed in the survey. Each item was classified as a dichotomized variable based on whether the intake was once or more per day. The frequency of breakfast was determined by the number of days participants had breakfast in the last week. Drinking milk or juice in the morning was not considered breakfast. Those who skipped breakfast for five or more times in the last week were placed in the skipping breakfast group; the remaining participants were assigned to the non-skipping breakfast group.<sup>28</sup>

### ***Assessment of body image misperception***

Heights and weights were self-reported to the nearest 0.01 m and 0.1 kg, respectively. BMI was calculated as body weight divided by height squared ( $\text{kg}/\text{m}^2$ ). The BMI Z-score was calculated using the 2017 Korea national growth chart for children and adolescents.<sup>29</sup> Subjective perceptions of body image were surveyed with a question (“What body shape do you think you have?”) using a 5-point Likert-type scale: very thin, slightly thin, normal, slightly fat, and very fat. Non-overweight adolescents who had a BMI Z-score less than the 85th percentile<sup>30</sup> and responded that they were slight fat or very fat were defined as having body image misperception. In contrast, non-overweight adolescents who reported a slim or normal body shape were defined as having proper body image recognition. We did not include those who are overweight but think of themselves as normal weight in the analysis for body image misperception, since their sample size was too small ( $n=670$ ).

### ***Statistical analysis***

We applied sampling weights to participants in KYRBS by accounting for the complex survey design to represent Korean adolescents. The weights were allocated after stratification in this study, after considering the nonresponse rate. All data are presented by means or percentages (%)  $\pm$  standard error (SE). We used the weighted independent t test to compare differences in continuous variables, such as height Z-score, weight Z-score, and BMI Z-score. For categorical variables (i.e., sex, level of school, subjective household economic status, residential area, regular physical activity, skipping breakfast status, and dietary behaviors), weighted chi-square tests were used to compare differences between groups. In addition, milk consumption frequency (MCF) was divided into 3 categories ( $\text{MCF} < 1$  time/day,  $1 \leq \text{MCF} < 2$  times/day, and  $\text{MCF} \geq 2$  times/day), and the proportion of both EDU and non-EDU subjects to each MCF category was calculated. Odds ratio (OR) with 95% confidence interval (CI) was calculated by using a weighted multi-variate logistic regression analysis to evaluate the

relationship between nutrition education and dietary behaviors, skipping breakfast, or body image misperception. We also performed subgroup analyses for sex and school grade. All statistical analyses were conducted using the SPSS statistical software (version 25.0; SPSS Inc., Chicago, IL, USA).  $p < 0.05$  was considered statistically significant.

## RESULTS

### *General characteristics of the study population*

Table 1 represents the general characteristics of the study population. Overall, 47.7% participants experienced nutrition education within the past year. When classified by sex, 43.4% of girls experienced nutrition education, whereas 49.4% of boys experienced nutrition education. Similarly, when classified according to school level, 58.7% of middle school students experienced nutrition education, and 35.9% of high school students experienced nutrition education (data not shown). In the EDU group, the proportion of boys was higher than that of girls ( $55.1 \pm 1.3\%$  vs  $44.9 \pm 1.3\%$ ,  $p < 0.001$ ). Middle school students comprised  $57.5 \pm 0.9\%$  of the group, and the remaining  $42.5 \pm 0.9\%$  were high school students. In contrast, the proportion of middle school students in the non-EDU group was  $34.7 \pm 0.9\%$ , and the proportion of high school students was  $65.3 \pm 0.9\%$ . Most participants in both groups resided in small and medium-sized cities, followed by metropolitan cities and counties. The proportion of participants who regard their subjective their household economic status as high or medium-to-high were significantly higher in the EDU group. The skipping breakfast rate was significantly lower in the EDU group than in the non-EDU group ( $30.0 \pm 0.4\%$  vs  $32.8 \pm 0.4\%$ ,  $p < 0.001$ ). Among the dietary behaviors, fruit, milk, and vegetable intake was significantly higher in the EDU group. The consumption of undesirable foods, such as instant foods, added sugar drinks, and caffeinated drinks, for more than once a day was similar in both groups.

### *Association between nutrition education and dietary behaviors*

Table 2 represents weighted multivariate logistic regression analysis of the association between nutrition education and dietary behaviors in the total population and in sex and school grade- specific subgroups. Compared to the non-EDU group, the ORs and 95% CIs for desirable dietary behaviors in the EDU group were 1.08 (1.04–1.13) for fruits, 1.14 (1.09–1.19) for milk, and 1.16 (1.12–1.20) for vegetables, after adjusting for sex, school level, residence area, subjective household economic status, BMI Z-score, and regular physical activity. Unlike desirable dietary behaviors, undesirable dietary behaviors were not

significantly associated with the nutrition education groups. The same trend was shown in subgroup analyses by sex and school level, except for added-sugar drinks for middle school students (OR = 0.91, 95% CI: 0.84–0.99) in the EDU group.

Figure 1 shows the proportion of adolescents with different MCF in the two nutrition education groups. Although the highest proportion of both EDU and non-EDU subjects had a MCF <1 time/day, a higher proportion of EDU subjects, with both  $1 \leq \text{MCF} < 2$  times/day and MCF  $\geq 2$  times/day, compared to non-EDU subjects ( $17.1 \pm 0.3\%$  vs  $14.9 \pm 0.3\%$  for  $1 \leq \text{MCF} < 2$  times/day,  $10.4 \pm 0.2\%$  vs  $7.9 \pm 0.2\%$  for MCF  $\geq 2$  times/day,  $p < 0.001$ ).

### ***Association of nutrition education with skipping breakfast***

The relationship between nutrition education and skipping breakfast is presented in Table 3. Compared with the non-EDU group, the EDU group was less associated with skipping breakfast after adjusting for all potential confounders (OR=0.91, 95% CI: 0.87–0.95,  $p < 0.001$ ). The same significant trends were also observed in the sex- and school level-specific subgroup analyses.

### ***Relationship between nutrition education and body image misperception***

Table 4 shows the association between nutrition education and body image misperception. After adjusting for all potential confounders, the OR (95% CI) of body image misperception in the EDU group was 0.92 (0.87–0.97,  $p = 0.002$ ) compared with the non-EDU group. In the subgroup analyses, the ORs and 95% CIs of body image misperception in the EDU group were significantly low only in girls and middle school students.

## **DISCUSSION**

Healthy nutrition during adolescence prevents chronic diseases in adulthood and contributes to optimal growth and long-term physical balance.<sup>31</sup> Dietary habits are established during adolescence and young adulthood.<sup>31</sup> In this context, nutrition education is essential for adolescents, as it could change current nutrition-related behaviors or facilitate the adoption of new behaviors.<sup>32</sup> Using data collected from a nationwide school-based survey in Korea, we showed that nutrition education had positive effects on dietary behaviors and body image misperception in adolescents. A recent study suggested that the most effective method of delivering nutrition education is through classroom lectures.<sup>33</sup> In addition, school-based nutrition education programs have shown some success at increasing the consumption of healthy food.<sup>33</sup> After the enforcement decree of the school meals act in 2003 in Korea, the



Special Act on Children's Dietary Life Safety Management (enacted in 2008) and the Dietary Life Education Support Act (enacted in 2009) intended to promote health by regulating nutritious food and proper eating habits of children and adolescents.<sup>16</sup> However, there is currently an insufficient number of nutrition teachers, and slightly less than half of the students who participated in the KYRBS experienced nutrition education at school.

In this study, the EDU group had a higher frequency of desirable dietary behaviors, such as fruit, milk, and vegetable intake, compared to the non-EDU group. These findings corroborated several previous studies.<sup>34,35</sup> In a community-based controlled trial performed in North Indians over a 6-month period, participants in the nutrition and lifestyle education group showed significantly higher proportions of desirable dietary behavior (30.7%;  $p < 0.001$ ) and lower proportions of undesirable dietary behavior, such as consuming aerated drinks (15.1%;  $p < 0.001$ ) and energy-dense unhealthy foods (8.9%;  $p = 0.03$ ).<sup>34</sup> A systematic review demonstrated that the nutrition knowledge can bring about a change in adolescents dietary behavior toward healthy eating.<sup>35</sup> One thing worth noting in our study is that the EDU group was more likely to demonstrate desirable dietary behaviors than the non-EDU group, whereas no differences in choosing undesirable food were observed between groups. This suggests that nutrition education needs to focus on reducing undesirable dietary behaviors.

Many countries, including Korea, are facing persistent childhood underweight and stunting. There is also an increase in demand for early interventions of obesity, due to increases in obesity rates and its related comorbidities.<sup>29</sup> Interestingly, the EDU group were less likely to skip breakfast compared to the non-EDU group. Breakfast eating has a positive effect on cognitive function and is associated with the facilitation of tasks requiring attention, executive function, and memory in adolescents.<sup>36,37</sup> A breakfast that is rich in fruits, dairy products, whole grains, and vegetables can help to reduce the risk of obesity by providing a balanced diet.<sup>38,39</sup> It may also prevent malnutrition by reducing the risk of inadequate calorie intake.<sup>40</sup> Furthermore, eating breakfast is related to better metabolic profiles, including lipid profile, insulin resistance, blood pressure levels, and metabolic syndrome,<sup>41</sup> thus reducing the risk of becoming overweight or obese although breakfast eaters consume more total calories compared with breakfast skippers.<sup>42</sup>

With rapid physical growth, it is important for adolescents to adapt to body changes and to form an ideal body image.<sup>43</sup> However, body image misperception has increased among adolescents. Along with increased obesity, distorted body images can cause body dissatisfaction,<sup>44</sup> unhealthy weight control behavior,<sup>45</sup> and depressive symptoms.<sup>46</sup> In particular, approximately two-thirds of adolescent girls are dissatisfied with their body weight

and body shape. The number of adolescents expressing body dissatisfaction increases as their body weight increases.<sup>47</sup> Therefore, having an appropriate awareness of body image can be an important factor for having proper dietary habits. In this study, nutrition education was negatively associated with body image misperception, which suggests that nutrition education may influence correct weight perception. Further well-designed studies are needed to confirm the positive effects of nutrition education on body image and healthy dietary behavior.

### ***Limitations***

Some limitations should be considered in this study. First, caution should be used in causal and temporal interpretations of our findings, because of the cross-sectional nature of the study. Therefore, long-term clinical interventional studies based on nutrition education are needed. Second, self-reported weights tended to be lower than actual weights.<sup>25,48</sup> Third, the quality of education could not be evaluated in KYRBS, and there has been no published validation data on whether nutrition education was equally performed by all teachers. In addition, there was a lack of data regarding the quantity of food consumed or the number of servings in KYRBS. To further verify the effectiveness of nutrition education, large-scale studies considering the amount of macronutrients and micronutrients for each food consumed by adolescents will be required. Finally, although a significant positive effect of nutrition education was observed, it was not much higher in EDU than in non-EDU subjects. Nevertheless, we analyzed the association between nutrition education and dietary behavior using nationally representative, school-based data. In addition, this was the first study to verify the relationship between nutrition education and body image misperception.

### ***Conclusion***

Nutrition education have positive effects on healthy dietary behaviors. Nutrition education also shows a negative association with body image misperception, confirming its importance at school. It is necessary to establish a social infrastructure for more appropriate application and activation of nutrition education. Also, personalized nutrition education programs should be developed in the future.

Further prospective research is warranted to identify the causal relationship between nutrition education and dietary habits or perceived body image in students. Longitudinal studies will also be needed to verify whether nutrition education during adolescence can be helpful for good eating habits and health in adulthood. The development and validation of educational material are also needed.

## CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare they have no competing interests.

This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through High Value-added Food Technology Development Program funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (321030-5). This study is based on data from an observational study where clinical trials registration was not required. The findings reported in this article have not been previously published or presented at any conference proceedings.

## REFERENCES

1. Comprehensive framework for addressing the school nutrition environment and services. Atlanta: Centers for Disease Control and Prevention; 2019.
2. Cunha CM, Costa PRF, de Oliveira LPM, Queiroz VAO, Pitangueira JCD, Oliveira AM. Dietary patterns and cardiometabolic risk factors among adolescents: systematic review and meta-analysis. *Br J Nutr.* 2018;8:859-79. doi: 10.1017/s0007114518000533.
3. Vanhelst J, Beghin L, Duhamel A, De Henauw S, Ruiz JR, Kafatos A et al. Do adolescents accurately evaluate their diet quality? The HELENA study. *Clin Nutr.* 2017;6:1669-73. doi: 10.1016/j.clnu.2016.10.019.
4. Kang K, Sotunde OF, Weiler HA. Effects of milk and milk-product consumption on growth among children and adolescents aged 6-18 years: a meta-analysis of randomized controlled trials. *Adv Nutr.* 2019;2:250-61. doi: 10.1093/advances/nmy081.
5. de Lamas C, de Castro MJ, Gil-Campos M, Gil A, Couce ML, Leis R. Effects of dairy product consumption on height and bone mineral content in children: a systematic review of controlled trials. *Adv Nutr.* 2019;10(Suppl 2):S88-S96. doi: 10.1093/advances/nmy096.
6. Limpawattana P, Kotruchin P, Pongchaiyakul C. Sarcopenia in Asia. *Osteoporosis and sarcopenia.* 2015;2:92-97. doi: 10.1016/j.afos.2015.10.001.
7. Lee Y-E, Hwang D-H, Jeon M-S. Milk consumption and perception of school milk program among elementary, middle, and high school students in Korea. *Journal of the Korean Dietetic Association.* 2016;3:163-78. doi: 10.14373/jkda.2016.22.3.163.
8. Guideline: Sugars intake for adults and children. Geneva: World Health Organization 2015.
9. Lee H-S, Kwon S-o, Yon M, Kim D, Lee J-Y, Nam J et al. Dietary total sugar intake of Koreans: Based on the Korea National Health and Nutrition Examination Survey (KNHANES), 2008-2011. *Journal of Nutrition and Health.* 2014;4. doi: 10.4163/jnh.2014.47.4.268.
10. Park JH, Hahm M-I, Kim SJ, Min IS. Association between high-caffeine energy drink intake and suicidal ideation in Korean adolescents. *Journal of the Korean Society of School Health.* 2016;2:71-80. doi: 10.15434/kssh.2016.29.2.71.

11. Kim HY, Jung HW, Hong H, Kim JH, Shin CH, Yang SW, Lee YA. The role of overweight and obesity on bone health in Korean adolescents with a focus on lean and fat mass. *J Korean Med Sci.* 2017;10:1633-41. doi: 10.3346/jkms.2017.32.10.1633.
12. Ministry of Health & Welfare, Korea Centers for Disease Control & Prevention. Status of under- & over-nutrition in Korea National Health and Nutrition Examination Survey (KNHANES). *Public health weekly report.* 2014;48:1077
13. So ES. Perceptual body image and the relationship with weight control across the adult lifespan by sex in Koreans. *J Public Health (Oxf).* 2017;4:777-86. doi: 10.1093/pubmed/fox021.
14. Moser A, Chen SE, Jilcott SB, Nayga RM. Associations between maternal employment and time spent in nutrition-related behaviours among German children and mothers. *Public Health Nutr.* 2012;7:1256-61. doi: 10.1017/S1368980011003375.
15. Wang D, Stewart D. The implementation and effectiveness of school-based nutrition promotion programmes using a health-promoting schools approach: a systematic review. *Public Health Nutr.* 2013;6:1082-100. doi: 10.1017/S1368980012003497.
16. Yoon J, Kwon S, Shim JE. Present status and issues of school nutrition programs in Korea. *Asia Pac J Clin Nutr.* 2012;1:128-33
17. Kwak TK, Chang HJ. Advancing institutional dietetics and school nutrition program in Korea. *Asia Pac J Clin Nutr.* 2008:352-6
18. School information disclosore (<https://www.schoolinfo.go.kr/>): Korea education and research information service; 2017: <https://www.schoolinfo.go.kr/>.
19. Hingle MD, O'Connor TM, Dave JM, Baranowski T. Parental involvement in interventions to improve child dietary intake: a systematic review. *Prev Med.* 2010;2:103-11. doi:10.1016/j.ypmed.2010.04.014.
20. Luckner H, Moss JR, Gericke CA. Effectiveness of interventions to promote healthy weight in general populations of children and adults: a meta-analysis. *Eur J Public Health.* 2012;4:491-7. doi: 10.1093/eurpub/ckr141.
21. Dehdari T, Rahimi T, Aryaeian N, Gohari MR. Effect of nutrition education intervention based on Pender's Health Promotion Model in improving the frequency and nutrient intake of breakfast consumption among female Iranian students. *Public Health Nutr.* 2014;3:657-66. doi: 10.1017/S1368980013000049.
22. Tamiru D, Argaw A, Gerbaba M, Nigussie A, Ayana G, Belachew T. Improving dietary diversity of school adolescents through school based nutrition education and home gardening in Jimma Zone: Quasi-experimental design. *Eat Behav.* 2016:180-6. doi: 10.1016/j.eatbeh.2016.10.009.
23. Kim Y, Choi S, Chun C, Park S, Khang YH, Oh K. Data Resource Profile: The Korea Youth Risk Behavior Web-based Survey (KYRBS). *Int J Epidemiol.* 2016;4:1076-76e. doi:10.1093/ije/dyw070.
24. Bae J, Joung H, Kim JY, Kwon KN, Kim YT, Park SW. Test-retest reliability of a questionnaire for the Korea Youth Risk Behavior Web-Based Survey. *J Prev Med Public Health.* 2010;5:403-10. doi: 10.3961/jpmph.2010.43.5.403.

25. Bae J, Joung H, Kim JY, Kwon KN, Kim Y, Park SW. Validity of self-reported height, weight, and body mass index of the Korea Youth Risk Behavior Web-based Survey questionnaire. *J Prev Med Public Health*. 2010;5:396-402. doi: 10.3961/jpmph.2010.43.5.396.
26. Woo T. The school meal system and school-based nutrition education in Korea. *J Nutr Sci Vitaminol (Tokyo)*. 2015:S23-4. doi: 10.3177/jnsv.61.S23.
27. Nutrition education disclosure (<https://www.foodsafetykorea.go.kr/main.do>): Ministry of Food and Drug Safety 2019.
28. Park S, Rim SJ, Lee JH. Associations between dietary behaviours and perceived physical and mental health status among Korean adolescents. *Nutr Diet*. 2018;5:488-93. doi: 10.1111/1747-0080.12444.
29. Kim JH, Yun S, Hwang SS, Shim JO, Chae HW, Lee YJ et al. The 2017 Korean National Growth Charts for children and adolescents: development, improvement, and prospects. *Korean J Pediatr*. 2018;5:135-49. doi: 10.3345/kjp.2018.61.5.135.
30. Barlow SE, Expert C. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007:S164-92. doi: 10.1542/peds.2007-2329C.
31. Phagava H, Mikaberidze A, Tavadze O, Pagava K. Peculiarities of Nutrition among Medical University Students. *Georgian Med News*. 2019;295:118-23
32. Dattilo AM, Saavedra JM. Nutrition education: application of theory and strategies during the first 1,000 days for healthy growth. *Nestle Nutr Inst Workshop Ser*. 2019:1-18. doi: 10.1159/000499544.
33. Partida S, Marshall A, Henry R, Townsend J, Toy A. Attitudes toward nutrition and dietary habits and effectiveness of nutrition education in active adolescents in a private school setting: a pilot study. *Nutrients*. 2018;9. doi: 10.3390/nu10091260.
34. Singhal N, Misra A, Shah P, Gulati S. Effects of controlled school-based multi-component model of nutrition and lifestyle interventions on behavior modification, anthropometry and metabolic risk profile of urban Asian Indian adolescents in North India. *Eur J Clin Nutr*. 2010;4:364-73. doi: 10.1038/ejcn.2009.150.
35. Thakur S, Mathur P. Nutrition knowledge and its relation with dietary behaviour in children and adolescents: a systematic review. *Int J Adolesc Med Health*. 2021. doi: 10.1515/ijamh-2020-0192.
36. Adolphus K, Lawton CL, Champ CL, Dye L. The Effects of Breakfast and Breakfast Composition on Cognition in Children and Adolescents: A Systematic Review. *Adv Nutr*. 2016;3:590S-612S. doi: 10.3945/an.115.010256.
37. Lundqvist M, Vogel NE, Levin L. Effects of eating breakfast on children and adolescents: A systematic review of potentially relevant outcomes in economic evaluations. *Food Nutr Res*. 2019. doi: 10.29219/fnr.v63.1618.
38. Smith KJ, Breslin MC, McNaughton SA, Gall SL, Blizzard L, Venn AJ. Skipping breakfast among Australian children and adolescents; findings from the 2011-12 National Nutrition and Physical Activity Survey. *Aust N Z J Public Health*. 2017;6:572-78. doi: 10.1111/1753-6405.12715.

39. Williams PG. The benefits of breakfast cereal consumption: a systematic review of the evidence base. *Adv Nutr.* 2014;5:636S-73S. doi: 10.3945/an.114.006247.
40. Barr SI, DiFrancesco L, Fulgoni VL, 3rd. Breakfast consumption is positively associated with nutrient adequacy in Canadian children and adolescents. *Br J Nutr.* 2014;8:1373-83. doi: 10.1017/s0007114514002190.
41. Monzani A, Ricotti R, Caputo M, Solito A, Archero F, Bellone S, Prodam F. A Systematic Review of the Association of Skipping Breakfast with Weight and Cardiometabolic Risk Factors in Children and Adolescents. What Should We Better Investigate in the Future? *Nutrients.* 2019;2. doi: 10.3390/nu11020387.
42. de la Hunty A, Gibson S, Ashwell M. Does regular breakfast cereal consumption help children and adolescents stay slimmer? A systematic review and meta-analysis. *Obes Facts.* 2013;1:70-85. doi: 10.1159/000348878.
43. Kim S, So WY. Prevalence and sociodemographic trends of weight misperception in Korean adolescents. *BMC Public Health.* 2014;452. doi: 10.1186/1471-2458-14-452.
44. Angoorani P, Heshmat R, Ejtahed HS, Qorbani M, Motlagh ME, Ziaodini H et al. Body weight misperception and health-related factors among Iranian children and adolescents: the CASPIAN-V study. *J Pediatr Endocrinol Metab.* 2017;10:1033-40. doi: 10.1515/jpem-2017-0149.
45. Hazzard VM, Hahn SL, Sonnevile KR. Weight misperception and disordered weight control behaviors among U.S. high school students with overweight and obesity: Associations and trends, 1999-2013. *Eat Behav.* 2017;189-95. doi: 10.1016/j.eatbeh.2017.07.001.
46. Armstrong B, Westen SC, Janicke DM. The role of overweight perception and depressive symptoms in child and adolescent unhealthy weight control behaviors: a mediation model. *J Pediatr Psychol.* 2014;3:340-8. doi: 10.1093/jpepsy/jst091.
47. Ribeiro-Silva RC, Fiaccone RL, Conceição-Machado M, Ruiz AS, Barreto ML, Santana MLP. Body image dissatisfaction and dietary patterns according to nutritional status in adolescents. *J Pediatr (Rio J).* 2018;2:155-61. doi: 10.1016/j.jpmed.2017.05.005.
48. He J, Cai Z, Fan X. How accurate is the prevalence of overweight and obesity in children and adolescents derived from self-reported data? A meta-analysis. *Public Health Nutr.* 2018;10:1865-73. doi: 10.1017/S1368980018000368.

**Table 1.** Demographics and health characteristics of the study population

	EDU	non-EDU	<i>p</i>
Unweighted number, n (%)	28,863 (47.8)	31,526 (52.2)	
Sex, % (SE)			<0.001 <sup>†</sup>
Girls	44.9 (1.3)	50.5 (1.6)	
Boys	55.1 (1.3)	49.5 (1.6)	
School level, % (SE)			<0.001 <sup>†</sup>
Middle school	57.5 (0.9)	34.7 (0.9)	
High school	42.5 (0.9)	65.3 (0.9)	
Residential area, % (SE)			0.003 <sup>†</sup>
Metropolitan cities	41.5 (0.9)	45.0 (0.9)	
Small and medium-sized cities	52.0 (1.0)	49.3 (1.0)	
Counties	6.5 (0.7)	5.7 (0.5)	
Subjective household economic status, % (SE)			<0.001 <sup>†</sup>
High	12.3 (0.3)	9.8 (0.3)	
Medium-to-high	31.4 (0.4)	27.7 (0.4)	
Medium	44.3 (0.4)	46.7 (0.4)	
Low-to-medium	10.2 (0.2)	12.6 (0.3)	
Low	1.9 (0.1)	3.2 (0.1)	
Regular physical activity, % (SE)	15.8 (0.3)	12.0 (0.3)	<0.001 <sup>†</sup>
Height Z-score	0.304±0.008	0.232±0.008	<0.001 <sup>‡</sup>
Weight Z-score	0.133±0.009	0.117±0.009	0.178 <sup>‡</sup>
BMI Z-score	-0.031±0.010	-0.005±0.010	0.029 <sup>‡</sup>
Skipping breakfast, % (SE)	30.0 (0.4)	32.8 (0.4)	<0.001 <sup>†</sup>
Desirable dietary behavior, % (SE)			
Fruit ≥1 time/day	24.2 (0.4)	20.5 (0.3)	<0.001 <sup>†</sup>
Milk ≥1 time/day	27.5 (0.4)	22.8 (0.4)	<0.001 <sup>†</sup>
Vegetable ≥1 time/day	44.7 (0.4)	39.7 (0.3)	<0.001 <sup>†</sup>
Undesirable dietary behavior, % (SE)			
Instant foods ≥1 time/day	6.6 (0.2)	6.9 (0.2)	0.233 <sup>†</sup>
Added sugar drinks ≥1 time/day	10.9 (0.2)	11.1 (0.2)	0.419 <sup>†</sup>
Caffeine ≥1 time/day	1.8 (0.1)	1.8 (0.1)	0.608 <sup>†</sup>

EDU: group who experienced nutrition education at school within a year; non-EDU: group who did not experience nutrition education at school within a year; BMI: body mass index; SE: standard error.

All data are represented as means or percentages (%) ± SE

<sup>†</sup>*p* values derived from weighted chi-square test

<sup>‡</sup>*p* values derived from weighted generalized linear regression analysis

**Table 2.** Weighted multivariate logistic regression analysis of the association between nutrition education and dietary behaviors in the total population and in sex and school grade- specific subgroups

	OR (95% CI)					
	Desirable Dietary Behaviors			Undesirable Dietary Behaviors		
	Fruits $\geq 1$ time/day	Milk $\geq 1$ time/day	Vegetables $\geq 1$ time/day	Instant foods $\geq 1$ time/day	Added sugar drinks $\geq 1$ time/day	Drinking caffeine $\geq 1$ time/day
Total <sup>†</sup>						
non-EDU	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
EDU	1.08 (1.04–1.13)**	1.14 (1.09–1.19)**	1.16 (1.12–1.20)**	0.95 (0.89–1.03)	0.98 (0.93–1.04)	1.00 (0.87–1.14)
Girls <sup>‡</sup>						
non-EDU	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
EDU	1.10 (1.03–1.17)*	1.17 (1.10–1.25)**	1.18 (1.11–1.24)**	0.94 (0.85–1.03)	1.00 (0.91–1.09)	1.00 (0.80–1.25)
Boys <sup>‡</sup>						
non-EDU	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
EDU	1.07 (1.01–1.14)*	1.11 (1.05–1.18)**	1.14 (1.09–1.20)**	0.98 (0.88–1.09)	0.97 (0.90–1.05)	0.99 (0.84–1.17)
Middle school <sup>§</sup>						
non-EDU	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
EDU	1.07 (1.01–1.13)*	1.11 (1.05–1.17)**	1.15 (1.09–1.21)**	0.92 (0.83–1.02)	0.91 (0.84–0.99)*	1.04 (0.85–1.28)
High school <sup>§</sup>						
non-EDU	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
EDU	1.10 (1.02–1.18)*	1.17 (1.09–1.25)**	1.16 (1.10–1.23)**	0.99 (0.90–1.10)	1.05 (0.96–1.14)	0.97 (0.81–1.16)

non-EDU: group who did not experienced nutrition education at school within a year; EDU: group who experienced nutrition education at school within a year nutrition-educated group; OR: odds ratio; CI: confidence interval; BMI: body mass index.

Data are presented as OR and 95% CI.

<sup>†</sup>Adjusted for all confounders (sex, school grade, residential area, subjective household economic status, BMI Z-score, and regular physical activity).

<sup>‡</sup>Adjusted for all confounding variables except sex.

<sup>§</sup>Adjusted for all confounding variables except school grade.

\* $p < 0.05$ ; \*\* $p < 0.001$ ;  $p$  values derived from weighted multivariate logistic regression analysis.



**Table 3.** Weighted multivariate logistic regression analysis of the relationship between nutrition education and skipping breakfast in the total population and in sex and school grade- specific subgroups

	Skipping Breakfast		
	OR	95% CI	<i>p</i>
Total <sup>†</sup>			
non-EDU	1 (reference)		
EDU	0.91	0.87–0.95	<0.001
Girls <sup>‡</sup>			
non-EDU	1 (reference)		
EDU	0.90	0.85–0.96	0.001
Boys <sup>‡</sup>			
non-EDU	1 (reference)		
EDU	0.91	0.86–0.97	0.003
Middle school <sup>§</sup>			
non-EDU	1 (reference)		
EDU	0.88	0.83–0.93	<0.001
High school <sup>§</sup>			
non-EDU	1 (reference)		
EDU	0.93	0.87–0.99	0.030

non-EDU: group who did not experienced nutrition education at school within a year; EDU: group who experienced nutrition education at school within a year nutrition-educated group; OR: odds ratio; CI: confidence interval; BMI: body mass index  
Data are presented as OR and 95% CI.

<sup>†</sup>Adjusted for all confounders (sex, school grade, residential area, subjective household economic status, BMI Z-score, and regular physical activity).

<sup>‡</sup>Adjusted for all confounding variables except sex.

<sup>§</sup>Adjusted for all confounding variables except school grade

*p* values derived from weighted multivariate logistic regression analysis

**Table 4.** Weighted multivariate logistic regression analysis of the relationship between nutrition education and body image misperception in the total population and in sex and school grade- specific subgroups

	Body image misperception		<i>p</i>
	OR	95% CI	
Total <sup>†</sup>			
non-EDU	1 (reference)		
EDU	0.92	0.87–0.97	0.002
Girls <sup>‡</sup>			
non-EDU	1 (reference)		
EDU	0.87	0.81–0.94	<0.001
Boys			
non-EDU	1 (reference)		
EDU	0.99	0.91–1.08	0.896
Middle school <sup>§</sup>			
non-EDU	1 (reference)		
EDU	0.90	0.83–0.97	0.004
High school <sup>§</sup>			
non-EDU	1 (reference)		
EDU	0.95	0.88–1.02	0.117

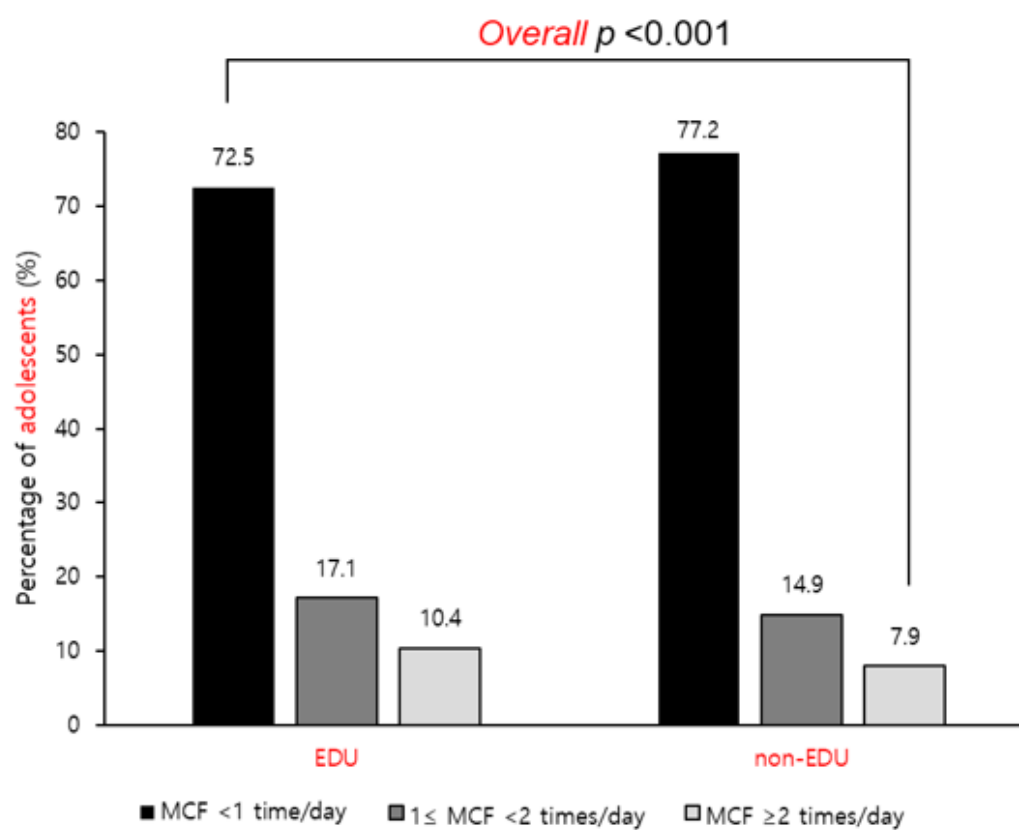
non-EDU: group who did not experienced nutrition education at school within a year; EDU: group who experienced nutrition education at school within a year nutrition-educated group; OR: odds ratio; CI: confidence interval; BMI: body mass index  
Data are presented as OR and 95% CI.

<sup>†</sup>Adjusted for all confounders (sex, school grade, residential area, subjective household economic status, BMI Z-score, and regular physical activity).

<sup>‡</sup>Adjusted for all confounding variables except sex.

<sup>§</sup>Adjusted for all confounding variables except school grade

*p* values derived from weighted multivariate logistic regression analysis.



**Figure 1.** Percentage of adolescents with different MCF in the two nutrition education groups. MCF, milk consumption frequency; EDU, group who experienced nutrition education at school within a year nutrition-educated group; non-EDU, group who did not experienced nutrition education at school within a year.

5. 청소년의 카페인 최대일일섭취권고량은?

식품의약품안전처는 19세 이하 어린이 및 청소년의 하루 카페인 섭취 제한량을 체중 1kg당 2.5mg 이하로 섭취할 것을 권고하고 있습니다. 예를 들면, 몸무게가 50kg인 청소년의 경우, 카페인 최대일일섭취권고량은 125mg입니다.

※ 카페인 최대일일섭취권고량(mg) = 내 몸무게(kg) × 2.5mg

6. 생활 속 고카페인 음료 섭취 줄이기 요령

- ① 줄음이 오거나 목이 마를 때는 고카페인 음료 대신 '물'을 마셔 보세요.
- ② 부득이하게 고카페인 음료를 마실 때는 제품에 표시된 '카페인 함량'과 '주의사항'을 꼭 확인하고, 최대일일섭취권고량 이하로 마시도록 노력합니다.

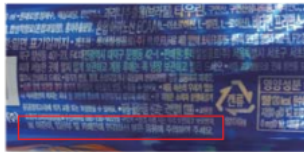
궁금해요

1. 고카페인 음료란 무엇일까요?

고카페인 함유 식품이란 카페인을 인위적으로 첨가하였거나 카페인을 함유한 원재료를 사용하여 제조·가공한 식품으로 카페인이 mL당 0.15mg 이상 함유한 액체식품을 말합니다. 우리 주변에서 쉽게 접할 수 있는 대부분의 에너지 음료는 카페인이 많이 함유되어 있어 고카페인 음료에 해당됩니다.

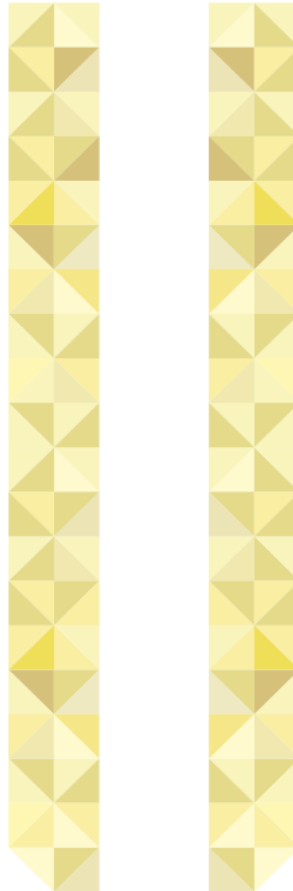
2. '고카페인 함유' 문구는 어떻게 확인하나요?

'식품위생법 제10조'와 '식품 등의 표시기준'에 따라 고카페인 함유 식품에는 '고카페인 함유' 문구와 '어린이, 임산부, 카페인 민감자는 섭취에 주의하여 주시기 바랍니다.'라는 주의 문구 및 해당 제품의 '총 카페인 함량(mg)'이 표시되어 있습니다. 따라서 카페인이 많이 함유된 음료의 포장용기에 기재된 '고카페인 함유' 문구를 찾아서 확인하시기 바랍니다.



3. 고카페인 음료 관리 규제는 이루어지고 있나요?

학교 자판기 등에서 손쉽게 구입했던 고카페인 음료가 카페인의 무분별한 섭취를 조장하는 경우가 많았습니다. 이와 같은 문제점을 해결하기 위해 학교 매점 및 우수 판매업소에서 고카페인 음료를 판매할 수 없도록 '어린이 식생활 안전관리 특별법'이 개정되었습니다. 따라서, 2014년 1월 31일부터는 학교 매점 및 우수판매업소에서 고카페인 음료를 판매할 수 없습니다.



3) 1일 식사 패턴

다음으로 하루 2,000kcal가 필요한 여고생의 실제 식사 패턴의 예를 살펴봅시다. 각 식품군의 '1일 권장 섭취 횟수'를 끼니별로 배분합니다.



그림 4-4 1일 식사 패턴의 예

- 유지·당류의 섭취 횟수(4회)는 조리할 때 사용되는 양으로 총분할.
- 국에서 채소류의 섭취 횟수 1회가 추가됨.
- 우유·유제품류와 과일류는 간식으로 섭취하도록 함.
- 1일 식사 패턴은 개인의 식습관과 음식에 따라 다양하게 응용할 수 있음.

보충학습

칼로리 코드II

맞춤형 영양 관리 모바일 프로그램인 칼로리코드II는 하루 섭취한 음식의 열량, 영양 정보와 신체활동을 입력하여 효과적으로 영양관리를 할 수 있도록 개발된 프로그램으로 비만 예방을 위하여 카뮈, 식생활 지침, 식습관 및 신체 활동 평가는 등도 제공됩니다. 하루 섭취한 음식의 열량 정보와 신체 활동을 입력하여 효과적으로 영양 관리를 할 수 있도록 개발된 프로그램으로 칼로리와 주요 영양소 섭취량, 체중 등의 정보를 그래프 형식으로 볼 수 있습니다. 식사와 활동이 종합적으로 제시되어 균형 잡힌 개인의 건강 관리에 실질적인 도움을 줄 수 있는 애플리케이션입니다.

Figure S1. An example of e-book for middle school students.