



Research Article

Current status of sodium provision and reduction management in South Korean school meals: a descriptive study

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Objectives: This study investigated the current status of sodium provision and reduction management in South Korean school meals.

Methods: Using a proportional stratified random sampling by school level (kindergarten and elementary, middle, and high school), location (urban, rural, and island/remote area), and region (17 metropolitan and provincial Offices of Education), 1,068 schools (about 10% of all schools) were selected from 430 kindergartens and 5,883 elementary, 2,501 middle, and 2,268 high schools using the school meal system of the National Education Information System. An online survey was conducted with nutrition teachers and dietitians at the selected schools from September to November 2021 (n = 608; response rate: 57%).

Results: About 26.6% of schools had not established sodium provision standards. More than half of the respondents (59.9%) had never used low-sodium products; this percentage increased with school level. The reasons given included “insufficient information” (46.7%) and “high prices” (41.5%). The level of consideration for sodium management was highest at the cooking stage (3.89/5.00 points) and lowest at purchasing stage (3.20 points). Cooking-related consideration was significantly higher in kindergartens and elementary schools than in middle and high schools, while purchasing-related consideration was significantly higher in elementary than in middle schools. To reduce sodium, the most commonly reported requirement was “reduction of the excessive foodservice workload” (4.48/5.00 points), followed by “support for educational materials” (4.31 points).

Conclusion: Reducing sodium intake in school meals may require establishing clear sodium standards, increasing the availability of low-sodium products, easing the excessive workload, and enhancing educational support. To support these efforts, more comprehensive and consistently implemented policy approaches may be needed to reduce sodium in schools.

Keywords: schools; food services; sodium; surveys and questionnaires; nutritionists

INTRODUCTION

The average daily sodium intake among the South Korean population aged 1 year or older has steadily declined from 3,848 mg in 2013 to 3,030 mg in 2022 [1]. Despite the steady decline, sodium intake among children and adolescents in South

Korea still remains excessively high. The World Health Organization (WHO) recommends that sodium intake for children aged 2–15 years be lower than the adult maximum (2,000 mg/day), adjusted downward based on their energy requirements [2]. Although WHO does not specify absolute sodium intake values for each age within this range, several pediatric nutrition guidelines and public-health institutions suggest age-adjusted upper limits: for instance, less than 1,200 mg/day for ages 1–3 years; less than 1,500 mg/day for ages 4–8 years; less than 1,800 mg/day for ages 9–13 years [3]. Using these age-adjusted benchmarks as a reference, current school meal sodium provision levels appear far higher than recommended, underscoring the need for stronger sodium-reduction policies in school foodservice settings.

Excessive sodium consumption is closely associated with various health conditions, including hypertension, cardiovascular diseases, and gastric cancer [4, 5]. Given that dietary habits established during childhood often persist into adulthood [6, 7], it is essential to cultivate healthy eating behaviors early in life such as offering less salty foods and gradually adapting children to lower-sodium tastes—may contribute to healthier lifelong dietary behaviors [8, 9].

School meals play a significant role in shaping diet and dietary habits during childhood and adolescence, which in turn influence health behaviors in adulthood [10–12]. However, school meals are often high in sodium. In one study conducted in elementary and middle schools in Incheon and Gangwon-do, the average sodium intake from school meals was 802 mg and 1,056 mg, respectively—accounting for 40% and 52% of the WHO's recommended daily sodium intake of 2,000 mg. As these figures reflect intake, the actual sodium content of the meals was even higher. Notably, sodium levels per menu item were higher in elementary school meals than in those served at the middle school level [13]. Several other studies have reported similar findings regarding sodium intake or provision through school meals [14–16], further emphasizing the need to reduce sodium levels in school meals.

In 2013, the Ministry of Education conducted a survey on sodium intake from school meals at 30 schools located in Seoul, Gyeonggi-do, and Incheon. The results revealed high levels of sodium intake, averaging 1,155

mg per meal—911 mg in elementary schools, 1,099 mg in middle schools, and 1,454 mg in high schools [17]. In response, the Ministry of Education published the “*Guide to Reducing Sodium in School Meals*” [18], which outlined strategies for sodium reduction in school meal programs. As part of these guidelines, the Ministry of Education established target sodium levels per meal of 900 mg for elementary schools, 1,000 mg for middle schools, and 1,300 mg for high schools. The target sodium levels were established on a per-meal basis because students in South Korea typically eat one lunch meal at school. When determining these targets, the Ministry of Education considered the actual sodium intake levels at the time and aimed to achieve an approximately 2%–10% reduction in sodium content in school meals by 2017 through gradual implementation. In addition, recommended salinity levels for soups and stews were set at 0.6% for elementary and middle schools and 0.7% for high schools [17]. These sodium reduction guidelines were not mandatory, but rather provided as national recommendations to promote gradual sodium reduction in school meals. Compliance depended largely on the operational capacity and discretion of individual schools and local education offices. Similar voluntary approaches have been implemented in other countries, showing varying levels of success. For example, the United States (US) phased in sodium reduction targets in the National School Lunch Program, which resulted in a significant decrease in sodium content in school meals over time [19, 20].

However, since 2013, no nationwide survey has been conducted to assess the status of sodium management in school meals, and thus, it remains unclear whether the target sodium levels established at that time have been effectively implemented. Although a national survey of school meal nutrition teachers and dietitians was conducted in 2013 to examine their awareness, practices, and strategies related to sodium reduction [21], few subsequent studies have investigated sodium reduction management from a national perspective. Most existing studies have been limited to specific regions, such as Gyeonggi-do and Daegu [13, 22–25]. In order to revise the sodium provision guidelines for school meals and develop effective sodium reduction strategies, it is essential to obtain an accurate understanding of the cur-

rent status of sodium provision and management. Such data will serve as a foundational resource for policy development and implementation.

Previously, the School Meals Act applied only to elementary, middle, and high schools; however, in 2021, kindergartens were officially included within its scope [26]. While there has been active research on sodium provision and management in meals served at day-care centers [22, 27, 28], studies specifically addressing sodium management in kindergarten meals remain extremely limited. Therefore, to establish effective strategies for sodium reduction through school meals, a comprehensive nationwide assessment, including kindergartens, is urgently needed to better understand the current status of sodium management in school meal services.

Therefore, this study aimed to investigate the current status of sodium provision and reduction management in school meals by conducting a survey of nutrition teachers and dietitians, who are responsible for school meal operations and play a key role in influencing meal quality and students' dietary habits. Specifically, the objectives of this study were to (1) assess the current practices related to sodium reduction management in school meals across different school levels, and (2) provide foundational data to inform the development of specific and practical strategies for reducing sodium content in school meals.

METHODS

Ethics statement

Informed consent was obtained from all participants prior to their voluntary participation in the study. This study was approved by the Institutional Review Board of Kongju National University (IRB No. KNU_IRB_2021-103).

1. Study design

This was a descriptive study. It was described according to the STROBE statement (<https://www.strobe-statement.org/>).

2. Survey participants

This study was conducted as an exploratory nationwide survey to assess the current status of sodium-reduction

practices in school meal settings. Among the 11,082 schools registered in the National Education Information System (NEIS) database nationwide—430 kindergartens, 5,883 elementary schools, 2,501 middle schools, and 2,268 high schools—we selected a sample of 1,068 schools (41 kindergartens, 567 elementary schools, 241 middle schools, and 219 high schools), representing approximately 10%. This sample was selected using a proportional stratified random sampling method, considering the proportion of number of schools by school level (kindergarten vs. elementary school vs. middle school vs. high school), school location (urban vs. rural vs. island/remote area), and region (17 metropolitan and provincial Offices of Education).

From September 28, 2021, to November 12, 2021, an online questionnaire was distributed to nutrition teachers or dietitians from the sample of schools. School meal services in Korean kindergartens and elementary, middle, and high schools are operated by either nutrition teachers or dietitians. Since the implementation of the nutrition teacher system in 2008, some schools have newly appointed nutrition teachers in charge of school meals, while in other schools, dietitians who were previously employed continue to manage school meal operations. In other words, each school is staffed with either a nutrition teacher or a dietitian. A nutrition teacher is a certified educator who not only manages school meals but also provides nutrition education as part of the formal curriculum. In contrast, a dietitian mainly manages school meals, and although they may engage in some educational activities, teaching is not considered one of their core duties.

The study included 608 participants (25 kindergartens, 323 elementary schools, 136 middle schools, and 124 high schools). The response rates were 61.0% for kindergartens, 57.0% for elementary schools, 56.4% for middle schools, and 56.6% for high schools, with an overall response rate of 57.0%. A chi-square test revealed no statistically significant differences between the number of responding and non-responding schools by school level ($P = 0.303$).

3. Survey content

The questionnaire was developed based on previous studies on sodium reduction [17, 21, 29, 30]. The sur-

vey addressed several aspects of sodium provision and management in school meals. It covered the status of sodium provision (6 items), including the establishment of sodium provision standards, the availability and frequency of salinometer use, and the establishment of standard meal portion sizes per person. It also examined sodium reduction management (5 items), including the organization of sodium reduction events, the use of low-sodium products, methods for measuring salinity, and the level of sodium management at each stage of school meal preparation. The level of sodium management was measured using a 5-point Likert scale (1: not at all considered–5: highly considered).

The survey also covered the status of sodium reduction education (3 items), including participation in education, provision of education, and methods of education. Sodium-related awareness was also covered (3 items), such as awareness of the saltiness of food, awareness of the amount of sodium in each menu item, and perception related to sodium (interest, necessity, difficulty in implementation). The level of perception related to sodium was measured using a 5-point Likert scale (1: not at all interested/necessary/difficult–5: very interested/necessary/difficult). Reasons for difficulty in reducing sodium and sodium-related requirements were also covered (2 items). The level of support requirements related to sodium management was measured using a 5-point Likert scale (1: not at all necessary–5: very necessary). General characteristics of the participants and schools (12 items in total), including sex, age, school level, and meal type, were also recorded. Before the main survey, a pilot survey was conducted with practicing five nutrition teachers, and the questionnaire content was amended and augmented based on those results.

In this survey, “establishment of sodium provision standards” was defined as having a criterion for sodium content (mg) per meal in the school foodservice. “Awareness of the amount of sodium in each menu item” was defined as knowing the amount of sodium (salt) for each menu item. In addition, “use of low-sodium products” was defined as using sodium-reduced products, such as low-sodium soy sauce, low-sodium red pepper paste, low-sodium seasonings, and low-sodium processed foods.

4. Data analysis

All data were analyzed according to school level. Because school meal programs in South Korea differ markedly by school level in terms of policy guidelines, budget allocations, staffing arrangements, operational structures, menu standards, cooking facilities, nutrition education practices, and overall meal service environments, the data were analyzed by school level. Significant differences in the distributions were evaluated using the χ^2 test, and differences in the means were tested using one-way analysis of variance and the Duncan *post hoc* test. SPSS Package Program (version 26.0; IBM Corp.) was used to perform all statistical analyses, the threshold for statistical significance was $P < 0.05$.

RESULTS

1. General characteristics

Table 1 shows the general characteristics of the respondents and the subject schools. There were 608 schools in total with 25 kindergartens (4.1%), 323 elementary schools (53.1%), 136 middle schools (22.4%), and 124 high schools (20.4%). The vast majority of respondents identified as female, representing 98.8% of the total sample. The average age of the participants was 43.4 ± 9.4 years, and the participants from elementary (45.9 ± 7.8 years) and middle schools (43.0 ± 9.5 years) were older than those from kindergartens (37.0 ± 9.0 years) and high schools (38.4 ± 10.4 years; $P < 0.001$). The average total work experience of nutrition teachers and dietitians was 16.0 ± 9.1 years. Among the respondents, 351 were nutrition teachers and 257 were dietitians. Nutrition teachers were present in 57.7% of all the schools (dietitians: 42.3%), with the highest proportion in elementary schools (76.5%) and the lowest in kindergartens (4.0%; $P < 0.001$).

The school locations of respondents were 67.9%, 28.0%, and 4.1%, for urban, rural, and island or remote area, respectively, and there was no significant difference between school levels. Overall, public schools were the most common (84.4%). Most schools operated on-site cooking facilities (89.8%), whereas the proportion of schools utilizing central kitchen cooking was relatively higher among high schools (16.1%; $P = 0.007$). The most common form of eating place was cafeteria

Table 1. General characteristics of the respondents and the subject schools

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Respondents						
Sex						
Male	7 (1.2)	0 (0.0)	5 (1.5)	2 (1.5)	0 (0.0)	0.640
Female	601 (98.8)	25 (100.0)	318 (98.5)	134 (98.5)	124 (100.0)	
Age (year)	43.38 ± 9.35	37.00 ± 8.96 ^a	45.93 ± 7.79 ^b	43.01 ± 9.52 ^b	38.44 ± 10.35 ^a	< 0.001
Years of work experience	15.98 ± 9.05	8.28 ± 6.35 ^a	18.66 ± 8.82 ^d	14.83 ± 8.11 ^c	11.81 ± 8.41 ^b	< 0.001
Job status						
Nutrition teacher	351 (57.7)	1 (4.0)	247 (76.5)	53 (39.0)	50 (40.3)	< 0.001
Dietitian	257 (42.3)	24 (96.0)	76 (23.5)	83 (61.0)	74 (59.7)	
Subject schools						
School locations						
Urban	413 (67.9)	20 (80.0)	203 (62.8)	96 (70.6)	94 (75.8)	0.081
Rural	170 (28.0)	5 (20.0)	105 (32.5)	36 (26.5)	24 (19.4)	
Island or remote area	25 (4.1)	0 (0.0)	15 (4.6)	4 (2.9)	6 (4.8)	
School type						
National	24 (3.9)	0 (0.0)	10 (3.1)	6 (4.4)	8 (6.5)	< 0.001
Public	513 (84.4)	25 (100.0)	312 (96.6)	105 (77.2)	71 (57.3)	
Private	71 (11.7)	0 (0.0)	1 (0.3)	25 (18.4)	45 (36.3)	
Foodservice system						
On-site cooking	546 (89.8)	24 (96.0)	287 (88.9)	131 (96.3)	104 (83.9)	0.007
Central kitchen cooking	62 (10.2)	1 (4.0)	36 (11.1)	5 (3.7)	20 (16.1)	
Eating place						
Cafeteria	530 (87.2)	20 (80.0)	269 (83.3)	122 (89.7)	119 (96.0)	0.003
Classroom	56 (9.2)	4 (16.0)	40 (12.4)	10 (7.4)	2 (1.6)	
Cafeteria + classroom	22 (3.6)	1 (4.0)	14 (4.3)	4 (2.9)	3 (2.4)	
No. of meal participants (lunch)	513.04 ± 404.32	196.24 ± 87.01 ^a	500.79 ± 445.25 ^b	515.95 ± 337.78 ^b	605.64 ± 362.76 ^b	< 0.001
No. of meals/day	1.21 ± 0.57	1.08 ± 0.28 ^a	1.00 ± 0.00 ^a	1.07 ± 0.35 ^a	1.93 ± 0.89 ^b	< 0.001

n (%) or Mean ± SD.

¹⁾P-value by chi-squared test, Fisher's exact test, analysis of variance.^{a-d)}Values in the same row with different superscripted letters are significantly different at P < 0.05 using analysis of variance and Duncan's multiple range test.

service in 87.2% of schools, but there were significant differences depending on the school level ($P = 0.003$). At lower school level, there was a higher rate of classroom service. At lunch, the number of people receiving school meals was higher at elementary, middle, and high schools (all ≥ 500 persons) than at kindergartens (196 persons; $P < 0.05$).

2. Status of sodium provision in school meals

Table 2 shows the current status of sodium provision in school meals. An investigation into the establishment of sodium provision standards (mg) per meal for school meals revealed that approximately 26.6% of the sampled schools had not established such standards. Sodium provision standards per menu item had not been established in 30.8% of all schools, and there were no significant differences by school level.

The entire sample of schools (608) had salinometers available. At most schools, the participants reported using the salinometers daily (96.4%), whereas one middle and one high school reported using the salinometers “once per month”. The reasons for not using the salinometer at these schools were “the cooks do not want to do it” and “it is cumbersome to use it” (data not shown in the table).

An investigation into the management of portion sizes for school meals revealed that 66.3% of schools provided different portions depending on the school grade and sex of students. There were also significant differences by school level ($P < 0.001$). High proportions of kindergartens (72.0%) and elementary schools (94.4%) provided different portions by school grade and student sex, whereas high proportions of middle (68.4%) and high schools (70.2%) provided identical portions to all students.

3. Status of sodium reduction management and education for school meals

Table 3 shows the current status of sodium reduction management in school meals. When asked if they had held special events to encourage sodium reduction in the past year, 47.5% said they had, with no differences by school level. The events mostly consisted of “No Soup Days” and “Low-Sodium Days” (data not displayed in the table). At more than half of the schools (59.9%), par-

ticipants reported that they had never used low-sodium products in school meals, and there were significant differences by school level ($P = 0.001$). The proportion of participants who did not use low-sodium products was higher at higher school levels (kindergartens 48.0%, elementary schools 53.6%, middle schools 66.9%, high schools 71.0%).

At the 364 schools that had never used low-sodium products, the most common reasons for not using low-sodium products were “insufficient information” (46.7%) and “high prices” (41.5%). There were significant differences by school level; high prices were of a greater concern in middle and high schools than in other schools ($P < 0.001$), while insufficient information was a very common reason in kindergartens (91.7%; $P = 0.012$). The most common reason was “difficult to purchase” in elementary schools (22.0%; $P < 0.001$).

Most schools (90.5%) reported using a salinometer to measure the salinity of soups and stews. As a result of comparing how much sodium content or provision was considered at each stage of school meal preparation using scores (1–5 points), the response “sodium content is considered when cooking (e.g., adjusting the amount of seasoning using salt, fermented sauces, and soy sauce)” showed the highest average score (3.89 points), while the response “sodium content is considered when purchasing ingredients (e.g., low-sodium soy sauce)” showed the lowest average score (3.20 points). There were differences between school levels at all stages of food preparation. The level of consideration when planning the menu was significantly higher in elementary (3.78 points) than in middle (3.46 points) or high schools (3.45 points; $P < 0.05$). The level of consideration while purchasing ingredients was significantly higher in elementary (3.35 points) than in middle schools (2.96 points; $P < 0.05$). The level of consideration when cooking was significantly higher in kindergartens (4.16 points) and elementary schools (4.03 points) than in middle (3.74 points) and high schools (3.64 points; $P < 0.05$).

Table 4 shows the status of sodium reduction education by school level. Among the nutrition teachers and dietitians who responded to the survey, 38.5% had completed sodium reduction education, and there were no differences by school level. A total of 33.9% of the partic-

Table 2. Current status of sodium provision in school meals

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Establishment of sodium provision standards						
Yes	446 (73.4)	16 (64.0)	234 (72.4)	98 (72.1)	98 (79.0)	0.334
No	162 (26.6)	9 (36.0)	89 (27.6)	38 (27.9)	26 (21.0)	
Sodium provision standards per menu item						
Yes	421 (69.2)	15 (60.0)	226 (70.0)	85 (62.5)	95 (76.6)	0.067
No	187 (30.8)	10 (40.0)	97 (30.0)	51 (37.5)	29 (23.4)	
Possession of a salinometer	608 (100.0)	25 (100.0)	323 (100.0)	136 (100.0)	124 (100.0)	
Frequency of using a salinometer						
Once a month	2 (0.3)	0 (0.0)	0 (0.0)	1 (0.7)	1 (0.8)	0.139
1–2 times a week	12 (2.0)	1 (4.0)	4 (1.2)	4 (2.9)	3 (2.4)	
3–4 times a week	8 (1.3)	0 (0.0)	2 (0.6)	2 (1.5)	4 (3.2)	
Everyday	586 (96.4)	24 (96.0)	317 (98.1)	129 (94.9)	116 (93.5)	
Establishment of standard meal portion sizes per person						
Yes	458 (75.3)	18 (72.0)	233 (72.1)	109 (80.1)	98 (79.0)	0.209
No	150 (24.7)	7 (28.0)	90 (27.9)	27 (19.9)	26 (21.0)	
Meal portion sizes						
The same for all students	205 (33.7)	7 (28.0)	18 (5.6)	93 (68.4)	87 (70.2)	< 0.001
Different portions depending on the school grade and sex	403 (66.3)	18 (72.0)	305 (94.4)	43 (31.6)	37 (29.8)	

n (%).

¹⁾P-value by chi-squared test or Fisher's exact test.**Table 3.** Current status of sodium reduction management in school meals

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Sodium reduction events						
Yes	289 (47.5)	8 (32.0)	151 (46.7)	68 (50.0)	62 (50.0)	0.372
No	319 (52.5)	17 (68.0)	172 (53.3)	68 (50.0)	62 (50.0)	
Use of low-sodium products						
Yes	244 (40.1)	13 (52.0)	150 (46.4)	45 (33.1)	36 (29.0)	0.001
No	364 (59.9)	12 (48.0)	173 (53.6)	91 (66.9)	88 (71.0)	

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Table 3. Continued

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Reasons for not using low-sodium products ²⁾						
Insufficient information	170 (46.7)	11 (91.7)	81 (46.8)	42 (46.2)	36 (40.9)	0.012
High prices	151 (41.5)	5 (41.7)	51 (29.5)	47 (51.6)	48 (54.5)	< 0.001
Limited product variety	97 (26.6)	2 (16.7)	50 (28.9)	28 (30.8)	17 (19.3)	0.234
Poor taste	93 (25.5)	2 (16.7)	43 (24.9)	21 (23.1)	27 (30.7)	0.562
Difficult to purchase	52 (14.3)	1 (8.3)	38 (22.0)	10 (11.0)	3 (3.4)	< 0.001
Other	15 (4.1)	0 (0.0)	10 (5.8)	3 (3.3)	2 (2.3)	0.601
Methods for measuring salinity						
Using a salinometer	550 (90.5)	24 (96.0)	298 (92.3)	120 (88.2)	108 (87.1)	0.206
Sensory evaluation by food service staff	13 (2.1)	0 (0.0)	6 (1.9)	3 (2.2)	4 (3.2)	
Sensory evaluation by nutrition teacher/dietitian	27 (4.4)	0 (0.0)	8 (2.5)	9 (6.6)	10 (8.1)	
Other	18 (3.0)	1 (4.0)	11 (3.4)	4 (2.9)	2 (1.6)	
Level of sodium management at each stage of school meal preparation ³⁾						
Menu planning	3.64 ± 0.80	3.72 ± 0.74 ^{ab}	3.78 ± 0.76 ^b	3.46 ± 0.78 ^a	3.45 ± 0.87 ^a	< 0.001
Purchasing ingredients	3.20 ± 0.93	3.24 ± 0.97 ^{ab}	3.35 ± 0.93 ^b	2.96 ± 0.88 ^a	3.06 ± 0.93 ^{ab}	< 0.001
Cooking	3.89 ± 0.77	4.16 ± 0.69 ^b	4.03 ± 0.73 ^b	3.74 ± 0.71 ^a	3.64 ± 0.87 ^a	< 0.001
Serving	3.65 ± 0.87	3.60 ± 1.04	3.77 ± 0.84	3.50 ± 0.87	3.54 ± 0.89	0.007

n (%) or Mean ± SD.

¹⁾P-value by chi-squared test, Fisher's exact test, or analysis of variance.

²⁾Multiple responses.

³⁾5-point Likert scale (1: not at all considered–5: highly considered).

^{ab}Values in the same row with different superscripted letters are significantly different at $P < 0.05$ using analysis of variance and Duncan's multiple range test.

Table 4. Status of sodium reduction education by school level

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Participation of nutrition teachers/dietitians in sodium reduction education						
Yes	234 (38.5)	8 (32.0)	123 (38.1)	55 (40.4)	48 (38.7)	0.876
No	374 (61.5)	17 (68.0)	200 (61.9)	81 (59.6)	76 (61.3)	
Provision of sodium reduction education for students						
Yes	402 (66.1)	10 (40.0)	228 (70.6)	87 (64.0)	77 (62.1)	0.009
No	206 (33.9)	15 (60.0)	95 (29.4)	49 (36.0)	47 (37.9)	

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Table 4. Continued

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Methods of education ²⁾						
Newsletter for parents	297 (73.9)	7 (70.0)	180 (78.9)	59 (67.8)	51 (66.2)	0.066
School websites for parents	275 (68.4)	7 (70.0)	142 (62.3)	67 (77.0)	59 (76.6)	0.023
Education for cooks	232 (57.7)	7 (70.0)	128 (56.1)	49 (56.3)	48 (62.3)	0.668
Displaying posters in the cafeteria for students	111 (27.6)	2 (20.0)	63 (27.6)	27 (31.0)	19 (24.7)	0.776
Education during regular class time for students	94 (23.4)	0 (0.0)	91 (39.9)	1 (1.1)	2 (2.6)	< 0.001
Education for school teacher	51 (12.7)	2 (20.0)	30 (13.2)	9 (10.3)	10 (13.0)	0.811
Special extracurricular activities for students	17 (4.2)	0 (0.0)	9 (3.9)	1 (1.1)	7 (9.1)	0.078

n (%).

¹⁾P-value by chi-squared test or Fisher's exact test.²⁾Multiple responses.

ipants reported that they had not provided sodium reduction education to students in the last year, and there were differences by school level ($P = 0.009$). The proportion of participants not providing education was especially high in kindergartens (60.0%). Overall, the most commonly used type of education for sodium reduction was newsletter to parents (73.9%), and other methods included school websites (68.4%) and education for cooks (57.7%). The method of educating students using regular class time was observed almost exclusively in elementary schools (39.9%; $P < 0.001$).

4. Sodium-related awareness and support requirements

Regarding the perceived saltiness of school meals, the most common response from nutrition teachers and dietitians was "normal" (78.9%) (Table 5). The saltiness of school meals was perceived to be milder at lower school levels compared with higher school levels ($P < 0.001$). In only 8.9% of schools, participants reported knowing the sodium levels of all menu items provided for school meals, whereas in 18.6%, participants responded they were completely unaware.

The average overall score for interest in sodium reduction was 3.82/5 points, and there were significant differences by school level ($P = 0.001$). Interest was significantly higher in kindergartens (4.00 points) than in middle (3.75 points) or high schools (3.72 points; $P < 0.05$). As for the difficulties in practicing sodium reduction, the average score was 2.31 points. There were significant differences depending on school level ($P < 0.001$), with participants at the kindergarten (2.56 points) and elementary school levels (2.45 points) showing higher scores for difficulty in reducing sodium intake than those at the middle school (2.18 points) and high school levels (2.05 points; $P < 0.05$).

To reduce sodium in school meals, the most commonly reported requirement was "reduction of the excessive foodservice workload" (4.48 points), followed by "support for educational materials" (4.31 points) and "sodium reduction education for students" (4.22 points). There were no differences in any items by school level.

DISCUSSION

Because the level of sodium intake from school meals

Table 5. Awareness and support requirements related to sodium in school meals

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Perceived saltiness level of school meals by nutrition teachers/dietitians						
Not salty at all	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	< 0.001
Not salty	120 (19.7)	12 (48.0)	82 (25.4)	14 (10.3)	12 (9.7)	
Normal	480 (78.9)	13 (52.0)	237 (73.4)	120 (88.2)	110 (88.7)	
Salty	7 (1.2)	0 (0.0)	4 (1.2)	1 (0.7)	2 (1.6)	
Awareness of amount of sodium in each menu item						
All menus	54 (8.9)	0 (0.0)	28 (8.7)	16 (11.8)	10 (8.1)	0.538
Some menus	441 (72.5)	18 (72.0)	237 (73.4)	95 (69.9)	91 (73.4)	
Completely unaware	113 (18.6)	7 (28.0)	58 (18.0)	25 (18.4)	23 (18.5)	
Perception related to sodium reduction						
Interest in sodium reduction ²⁾	3.82 ± 0.63	4.00 ± 0.58 ^b	3.93 ± 0.60 ^{ab}	3.75 ± 0.63 ^a	3.72 ± 0.68 ^a	0.001
Necessity of reducing sodium ³⁾	3.51 ± 0.73	3.40 ± 0.65	3.48 ± 0.79	3.53 ± 0.69	3.62 ± 0.66	0.250
Difficulty in practicing sodium reduction ⁴⁾	2.31 ± 0.72	2.56 ± 0.82 ^b	2.45 ± 0.72 ^b	2.18 ± 0.61 ^a	2.05 ± 0.73 ^a	< 0.001
Reasons for difficulty in reducing sodium ⁵⁾						
Decrease in satisfaction of students	331 (86.6)	9 (90.0)	156 (87.6)	86 (84.3)	80 (87.0)	0.860
Due to poor taste	183 (47.9)	5 (50.0)	88 (49.4)	46 (45.1)	44 (47.8)	0.922
Lack of budget for purchasing low-sodium products	79 (20.7)	2 (20.0)	37 (20.8)	22 (21.6)	18 (19.6)	0.979
Lack of information on sodium reduction	52 (13.6)	1 (10.0)	28 (15.7)	14 (13.7)	9 (9.8)	0.611
Staff unwilling to implement	27 (7.1)	2 (20.0)	15 (8.4)	4 (3.9)	6 (6.5)	0.191
Support requirements related to sodium management						
Reduction of the excessive foodservice workload	4.48 ± 0.70	4.40 ± 0.82	4.51 ± 0.67	4.39 ± 0.73	4.51 ± 0.74	0.354
Support for educational materials	4.31 ± 0.72	4.16 ± 0.80	4.34 ± 0.69	4.26 ± 0.76	4.31 ± 0.71	0.504
Sodium reduction education for students	4.22 ± 0.69	4.16 ± 0.85	4.26 ± 0.66	4.13 ± 0.73	4.23 ± 0.70	0.263
Sodium reduction education for foodservice staff	4.17 ± 0.72	4.12 ± 0.78	4.23 ± 0.71	4.04 ± 0.73	4.15 ± 0.71	0.098
Sodium reduction education for parents	4.15 ± 0.72	4.16 ± 0.75	4.21 ± 0.69	4.07 ± 0.75	4.10 ± 0.74	0.232
Sodium reduction education for teachers	4.10 ± 0.75	4.04 ± 0.98	4.12 ± 0.74	4.07 ± 0.77	4.08 ± 0.73	0.867
Supply of low-sodium recipes	4.06 ± 0.81	4.08 ± 0.86	4.15 ± 0.77	3.93 ± 0.88	3.99 ± 0.79	0.050
Sodium reduction education for dietitians	4.01 ± 0.73	3.92 ± 0.86	4.05 ± 0.72	3.96 ± 0.71	3.96 ± 0.74	0.453

n (%) or Mean ± SD.

¹⁾P-value by chi-squared test, Fisher's exact test, or analysis of variance.²⁾5-point Likert scale (1: not at all interested - 5: very interested).³⁾5-point Likert scale (1: not at all necessary - 5: very necessary).⁴⁾5-point Likert scale (1: not at all difficult - 5: very difficult).⁵⁾Multiple responses.^{ab}Values in the same row with different superscripted letters are significantly different at $P < 0.05$ using analysis of variance and Duncan's multiple range test.

can affect the health of students in kindergartens and elementary, middle, and high schools, it is important to manage sodium provision in school meals. However, in this study, 26.6% of the sampled nutrition teachers and dietitians reported that they had not established sodium provision standards for school meals. Sodium standards are a tool to help appropriately manage sodium provision when planning and cooking school meals. In South Korea, the nutritional standards for school meals are managed by the government according to the Enforcement Decree of the School Meals Act, and sodium standards are not included in the nutritional standards for school meal [31]. The Ministry of Education proposed target sodium level per meal and recommended each school to independently set and manage sodium standards [17].

Several countries including the US, Japan, and the United Kingdom, have established sodium standards in their nutritional standards for school meals. In the US, until July, 2027, sodium provision levels for school lunches must be < 935, < 1,035, and < 1,080 mg for grades K-5, 6-8, and 9-12, respectively [32], and in Japan, the sodium provision levels for school lunches are < 600, < 800, < 800, and < 1,000 mg for students aged 6-7 years, 8-9 years, 10-11 years, and 12-14 years, respectively [33]. In the United Kingdom, to limit sodium provision, it is forbidden to provide salt to add to food after it has been cooked, or to use high-sodium flavor enhancers such as MSG or E621 [34]. Detailed criteria have also been established for checking labeled salt levels; using herbs, spices, garlic, vegetables and fruits to add flavor to dishes instead of salt; and choosing biscuits, cakes and pastries that are lower in fat, saturated fat, sugar and salt. There is a need to incorporate sodium standards into the nutritional standards for school meals in South Korea as well.

More than half of the participants who responded to the questionnaire in this study reported that they had not used low-sodium products in school meals, and the most common reasons for not using these products were “insufficient information” and “high prices”. Lee [23] reported that 90.5% of nutrition teachers and dietitians had not used low-sodium products. Although direct comparison is limited, the findings may cautiously suggest a potential increase in the use of low-sodium

products over the past decade. Additionally, the same study reported that the most common reasons for not using low-sodium products were “insufficient information,” “high prices,” and “lack of product diversity,” which were similar to the reasons reported in this study. In the US, the major strategies for sodium reduction include the development of low-sodium products [35]. Using low-sodium products can be considered a starting point for sodium provision management. Therefore, it is imperative to provide nutrition teachers and dietitians with the necessary information and education to ensure their awareness of the need to use low-sodium products. In particular, information provision and education should be prioritized for nutrition teachers and dietitians in middle or high schools that showed a higher incidence of not using low-sodium products in this study. Food companies also need to develop diverse low-sodium products with policy support from the government, and low-sodium products need to be popularized through proper price-setting and active publicity.

The level of consideration for sodium management at each stage of school meal preparation was highest at the “cooking,” followed by the “serving,” “menu planning,” and “ingredient purchasing.” In a study investigating the status of salt reduction in the Jeju region [36], 98.7% of nutrition teachers and dietitians reported making efforts to reduce sodium at the cooking stage among the school meal preparation stages, 86.4% at the menu planning stage, and 68.8% at the ingredient purchasing stage, which is similar to the findings of this study. In this study, the level of consideration for sodium provision was between “neutral” (3.0 points) and “considered” (4.0 points) at all stages. Management should be provided at a level of “considered” (4.0 points) or above for all stages. Thus, it will be necessary to develop sodium reduction management guidelines for each stage of school meal preparation, while also providing education to help nutrition teachers and dietitians implement these guidelines.

In this study, only 38.5% of all nutrition teachers and dietitians reported having completed an educational course on sodium reduction. Jeong [36] reported that 97.4% of nutrition teachers and dietitians perceived a need for sodium reduction education for nutrition teachers and dietitians, and 76.4% reported that sodium

reduction education and training would help reduce sodium in school meals. In Kim's study [37], 79.1% of nutrition teachers perceived sodium reduction education as necessary for nutrition teachers and dietitians. Taken together, these findings illustrate that there is an urgent need to develop a sodium reduction curriculum for nutrition teachers and dietitians at the government level to manage sodium provision in school meals. Additionally, 33.9% of the participants in this study reported that they had provided no sodium reduction education in school over the past year, and this proportion was highest in kindergartens. For nutrition teachers and dietitians to provide sodium reduction education, it will be necessary to develop and support specific educational materials depending on the recipients of the education (cooks, students, teachers, and parents) and the school level of the students (kindergarten and elementary, middle, and high school).

To reduce sodium levels in school meals, the most strongly reported requirement was "reduction of the excessive foodservice workload," followed by "support for educational materials." These findings suggest that the workload of nutrition teachers and dietitians may be associated with challenges in allocating sufficient time for sodium reduction management. Additionally, support for educational materials was identified as an important need that could facilitate more efficient sodium reduction practices. Overall, addressing these perceived barriers may help improve the implementation of sodium reduction strategies in school foodservice settings.

Overall, this study found significant differences in sodium-related management, education, and perceptions by the school level, suggesting that sodium reduction strategies in school meals should be tailored to the specific operational contexts of each school level. Taken together, these findings emphasize the importance of developing differentiated strategies for sodium reduction in school meals, including strengthening informational and educational support in kindergartens, enhancing practical feasibility in middle and high schools, and sustaining effective management practices in elementary schools. Another important consideration is that sodium-reduction practices may be weaker in kindergartens and middle and high schools, where the use of low-sodium products or educational activities was less

common.

The findings of this study suggest the need for national-level action to strengthen sodium-reduction management in South Korean school meals. More comprehensive and consistently implemented policy approaches may be needed to support sodium reduction in school meals. Policymakers may consider incorporating clear sodium standards into the nutritional standards for school meals to promote more consistent management across all schools. Expanding the availability of diverse and affordable low-sodium products through government-industry collaboration could also be beneficial. Reducing the excessive workload of nutrition teachers and dietitians may help facilitate the implementation of sodium-reduction practices. Moreover, developing standardized, stage-specific guidelines for sodium management—covering ingredient purchasing, menu planning, cooking, and serving—could contribute to more systematic sodium management in schools.

One strength of this study is that the survey was conducted in kindergartens and elementary, middle, and high schools nationwide. Therefore, the findings of this study can be used as a baseline to devise specific and practical methods for reducing sodium in school meals. Future studies should include qualitative investigations to more deeply explore the barriers and facilitators to implementing sodium-reduction policies in school meals. Furthermore, research that objectively measures the actual sodium content of school meals, along with studies evaluating low-sodium product adoption and targeted education programs, will be essential for identifying practical strategies that can support sustainable sodium reduction in school meal settings.

Limitations

This study has several limitations. Although analyses were conducted by school level, the observed differences may have been influenced by other school-related characteristics (e.g., job status, school type, foodservice system, and number of meal participants), which could act as potential confounders. Therefore, further research employing more comprehensive analytical approaches is needed.

Moreover, kindergartens have been included in the school meal service since 2021, and currently only pub-

lic kindergartens use the NEIS. Among the study participants, kindergartens were limited to public institutions that use NEIS and provide school meals, and therefore the findings should be interpreted with caution.

In addition, this study relied on self-reported data from nutrition teachers and dietitians, which may be subject to recall bias or social desirability bias. The survey was conducted within a limited period (September to November 2021), and sodium-reduction practices may have changed since then due to policy revisions or market developments related to low-sodium products.

Conclusion

There appears to be a need to strengthen sodium-reduction management in South Korean school meals. To support sodium reduction, it may be helpful to consider establishing clearer sodium standards within the nutritional standards for school meals, developing and promoting low-sodium products, reducing excessive workload, and enhancing educational support. These findings highlight potential areas for policy and practice improvement.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to conflict of interest.

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DATA AVAILABILITY

The data that support the findings of this study are available from Korea Educational Environments Protection Agency. Restrictions apply to the availability of these data, which were used under license for this study.

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