

Creating a school nutrition environment index and pilot testing it in elementary and middle schools in urban South Korea

Sohyun Park^{1,5*}, Kwang-il Kwon², Soon Ju Kweon³, Youfa Wang^{4,5} and Joel Gittelsohn⁵

¹Department of Food Science and Nutrition, Hallym University, Life Science Building Room 8519, 1 Hallymdaehak-gil, Chuncheon, Gangwon 24251, Korea

²Dietary and Nutritional Safety Policy Division, Food and Consumer Safety Bureau, Ministry of Food and Drug Safety, Osong Health Technology Administration Complex, Chungbuk 28159, Korea

³Physical Education and Health Division, Lifelong and Vocational Education Bureau, Seoul Metropolitan Office of Education, Seoul 03178, Korea

⁴Global Health Institute, School of Public Health, Xi'an Jiaotong University Health Science Center, Shaanxi 710061, PR China

⁵Center for Human Nutrition, Global Center on Childhood Obesity, Bloomberg School of Public Health, Johns Hopkins University, 615 North Wolfe Street Baltimore, MD 21205, USA

BACKGROUND/OBJECTIVES: The role of a school's nutrition environment in explaining students' eating behaviors and weight status has not been examined in an Asian setting. The purpose of this study was to create a school nutrition environment index and to pilot test the index in elementary and middle schools in urban South Korea.

SUBJECTS/METHODS: This study used a mixed-methods approach. Environment assessment tools were developed based on formative research, which comprised literature reviews, in-depth interviews, and focus group discussions. Key elements from the formative research were included in the assessment tool, which consisted of a structured survey questionnaire for school dietitians. Fifteen school dietitians from 7 elementary and 8 middle schools in Seoul completed the questionnaire.

RESULTS: The formative research revealed four main sections that guided a summary index to assess a school's nutrition environment: resource availability, education and programs, dietitians' perceptions and characteristics, and school lunch menu. Based on the literature reviews and interviews, an index scoring system was developed. The total possible score from the combined four index sections was 40 points. From the 15 schools participating in the pilot survey, the mean school nutrition-environment index was 22.5 (standard deviation \pm 3.2; range 17-28). The majority of the schools did not offer classroom-based nutrition education or nutrition counseling for students and parents. The popular modes of nutrition education were school websites, posters, and newsletters.

CONCLUSIONS: This paper illustrates the process used to develop an instrument to assess a school's nutrition environment. Moreover, it presents the steps used to develop a scoring system for creation of a school nutrition environment index. As pilot testing indicated the total index score has some variation across schools, we suggest applying this instrument in future studies involving a larger number of schools. Future studies with larger samples will allow investigation of the validity and reliability of this newly developed tool.

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INTRODUCTION

A school's nutrition environment has the potential to greatly affect children's and adolescents' eating patterns because they spend most of their day at school and have at least one meal within school boundaries. Previous studies conducted in the U.S.A. and other Western countries have examined the impact of the school's nutrition environment on students' eating patterns, revealing that a higher availability and accessibility of certain food items in schools increases the consumption of these foods by students [1-3]. Studies have also shown

associations between the food environment and body weight status among children and adolescents [4,5]. Beyond the results of observational studies, randomized intervention trials have shown that changing nutrition policies of and the nutrition environment in schools can be effective in preventing the development of obesity [6] and in reducing fat consumption among children in elementary and middle schools in the U.S.A. [7].

While evidence for an environmental effect on children's and adolescents' eating patterns and weight status has been reported for some Western countries, this is not the case for

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* Corresponding Author: Sohyun Park, Tel. 82-33-248-2134, Fax. 82-33-256-3420, Email. sopark@hallym.ac.kr

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Asian countries. Only two studies have examined the effect of the food retail environment on overweight and obesity issues in Asia: one among Chinese children [8] and one among Taiwanese children [9].

Several instruments exist for assessing school nutrition environments in some countries [10-16]; however, each is specific to its own research objective and is only relevant to the individual study setting. During the formative research for this study, we determined that these previously developed tools were unsuitable for use in South Korea because of the great degree of heterogeneity in food cultures and policy factors in Korea.

In order to develop a set of environmental assessment tools suitable for use in South Korea, this paper examined various attributes of school nutrition environments that may shape students' eating behaviors. Herein, we also describe the process of creating an index for school nutrition environments based on assessment of those attributes. Lastly, as a case study, this paper describes the school nutrition environments of 7 elementary and 8 middle schools in South Korea.

SUBJECTS AND METHODS

Formative research for instrument development: participants' recruitment, interview procedure, and data analysis

This study was conducted in two phases. First, during the formative phase of the study, we conducted qualitative interviews with teachers and parents in order to determine their perception of a school nutrition environment. Through these interviews, we attempted to identify the environmental factors that should be included in an assessment tool. Study protocols for this phase of the study have been presented in elsewhere [17]. Briefly, a total of 9 parents and 17 teachers participated in 20 in-depth interviews and two focus group discussions. Teachers with more than three years of work experience were recruited through local collaborators, such as government officers and researchers with previous experiences with school teachers. School dietitians, physical education teachers, and school nurses from Seoul and Gyeonggi-do participated in the interviews. Parents with adolescents between 10 and 16 years old were recruited with the help of participating teachers and local collaborators.

Individual interviews and focus group discussions took approximately 30 to 60 minutes to complete, and the interviews were digitally recorded, with participants' approval, for transcription. Parents were asked to describe their children's usual diet and their home nutrition environment, including home food rules and food availability at home. They were also asked to describe their perception of school and community nutrition environments, including what they think about school lunch and school nutrition programs and where their children go to get food in the neighborhood. Teachers were asked to describe how health programs or interventions are planned and implemented at the school and to describe their school's health and nutrition environments.

All recorded interviews were transcribed verbatim for analysis. The text-based data analysis package, Atlas.ti (version 6.0), was used for data management and the associated coding procedure.

Content analysis [18,19] was employed to extract key school nutrition environmental factors described by interviewees.

Instrument development

Using information gathered through interviews, tools for measuring a school's nutrition environment were developed. As school dietitians in South Korea are fully responsible for planning and preparing the school lunch, we considered school dietitians the most important persons shaping a school's nutrition environment; thus, the dietitian's questionnaire focused on existing school policies and programs that could potentially affect an individual's eating behavior. The dietitian questionnaire also included questions on their perceptions of available resources in their schools and on their individual characteristics (e.g., employment type and work-related training experience). Once the tools were developed, content and face validity were verified with two nutrition professors and three school dietitians in elementary and middle schools.

Pilot instrument testing: participants, procedure, and data analysis

Once the environmental assessment tools were developed, eight districts in Seoul were selected as target testing areas based on mean housing prices, education levels, and geographical characteristics, thus capturing a variety of social and physical environments. The Seoul Metropolitan Office of Education (the local collaborator) sent introductory study materials to four regional offices of education. Those regional offices randomly selected two schools within their region for pilot testing. Study invitation letters were sent to 16 schools, and 15 schools agreed to participate in the school survey [20]. All selected schools were public, coeducational schools.

Informed consent forms and survey questionnaires for teachers were sent to the health teachers or dietitians at each selected school by mail. Telephone calls and site visits were made to further introduce the study and to explain the instructions for survey completion. School dietitians were asked to submit the school's lunch menu for the prior two months. The participants in this phase were not the same individuals as the participants for the formative phase interviews and focus groups. Completed survey questionnaires and related documents were retrieved through the Seoul Metropolitan Office of Education. The survey was conducted during June and July 2011. All developed tools have been described previously [20]. Written informed consent was obtained from all respondents. All procedures involving human subjects were approved by the institutional review boards of the Johns Hopkins Bloomberg School of Public Health (00003203) and the Seoul-Paik Hospital of Inje University (No. IIT-2010-180).

Crude variables within the dietitians' questionnaire (e.g., presence of nutrition education and programs, nutritionist employment type, and perception of available resources) were used for model building during initial data analysis. A composite variable was created to reflect the teachers' perceptions of available resources (e.g., support from principals and other teachers, budget) and another composite variable was created to reflect the availability of health and nutrition programs in the schools. This paper discusses the detailed process used to create the school nutrition-environment index. Descriptive

statistics, such as means, standard deviations, and ranges, were calculated for the descriptive values of the obtained data. Student's t-tests were used to compare scale scores between elementary and middle schools in order to assess the differences in school nutrition environments (stata 10.1 college station, TX).

RESULTS

Formative research results

Importance of school social environments

Fig. 1 depicts the school social and physical environments that emerged from interviews and group discussions and that were regarded as key factors influencing students' health behaviors and health outcomes.

Most participants stressed the importance of the school's social environment, including the psychosocial and behavioral characteristics of teachers. A proactive mindset toward school-based programs and appropriate cooperation among teachers were considered particularly important to successful obesity prevention programs, as obesity prevention programs should be multicomponent, focusing on both nutrition and physical activities. One interviewee stressed the importance of the mindset of teachers in shaping healthy school environments.

I mentioned earlier that budget and the physical facilities or infrastructures are important for creating healthier school environment. But if asked the single most important thing... I would say it's the mindset of the teachers. If someone thinks making healthy environment and promoting students' health are important, they would do their best no matter what budget they get in any circumstances. (A school physical education teacher in elementary school in Gyeonggi-do)

In schools where teachers believe obesity prevention programs are very important and urgently needed, and where the teachers are willing to work together toward a common goal,

these mindsets can lead to beneficial programs, classroom-based curricula, and various health promotion services. Programs, classes, and services can be reinforced if they are supported by other factors, such as support from school principals, the use of different types of incentives, and budgetary support from regional and central governmental agencies. Effective programs and services can improve the schools' physical environment, through which students make various health choices, or they can directly affect students' knowledge and perceptions, which can affect students' health behaviors.

The quote below is from a nutritionist who plans to teach a classroom-based nutrition education course in the next semester. As part of a pilot project, the Ministry of Food and Drug Safety supported that plan with course materials and education tools. The interviewed nutritionist discussed the plan with the vice principal of the school and other teachers, and they decided to assign three hours per class during the next semester. When asked the reason for doing this extra teaching in addition to all the responsibilities for managing school lunch, the nutritionist answered as follows.

I think students' diet is so important. They will make dietary choices for the rest of their lives. When I saw what kids want from school lunch from the recent school lunch satisfaction survey and what they leave on the plate after lunch every day, I learned that there are so many picky eaters, who skip vegetables. So I want to teach them the importance of balanced diet...to increase the awareness of healthy choices when they are young. (A school nutritionist in elementary school in Seoul)

Interviewees acknowledged that the school's physical environment is important for students' health; however, most of the public schools in Seoul and throughout South Korea do not differ drastically in terms of its physical school environment. Therefore, interviewees suggested that measuring the school's

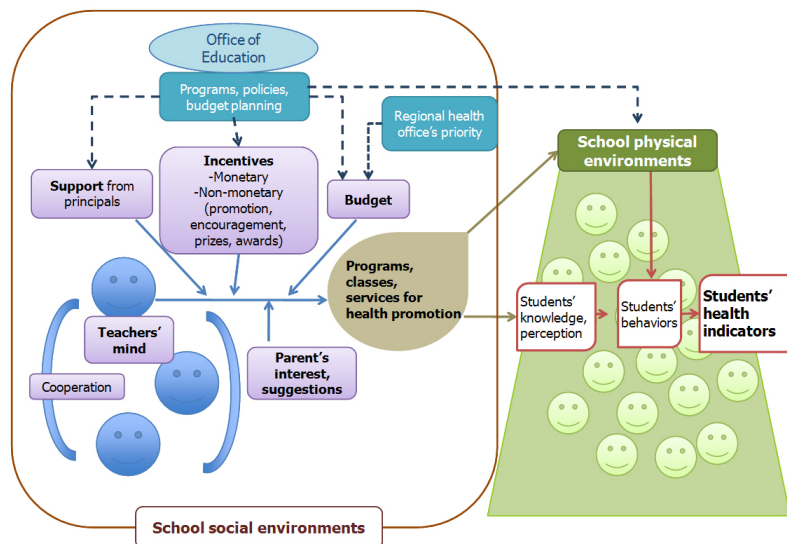


Fig. 1. Conceptual framework for the school nutrition environment and students' eating patterns

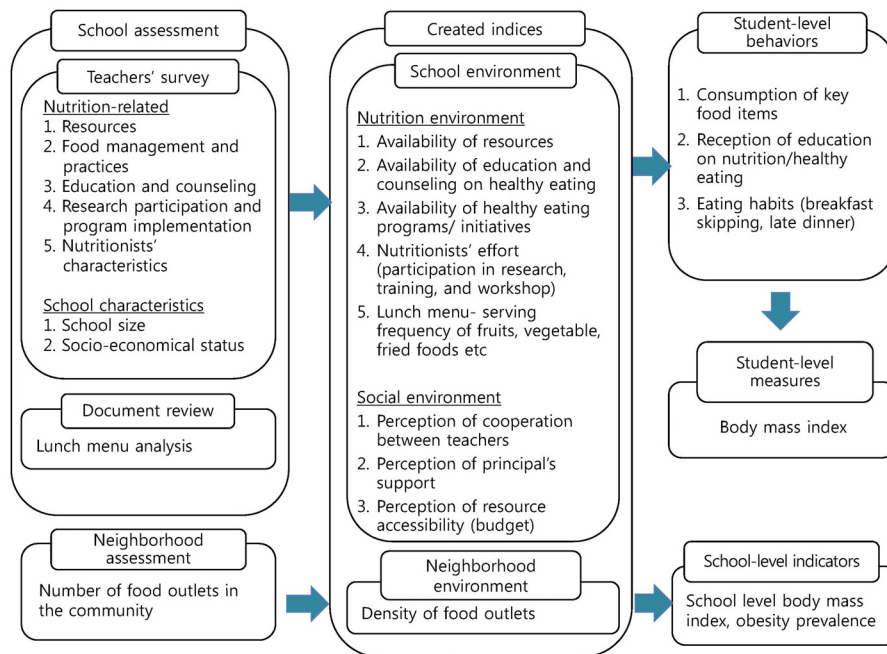


Fig. 2. Conceptual framework for measuring the school nutrition environment with links to students' eating patterns and body weight status in South Korea

physical environment might be insufficient for finding key characteristics of the school environment that influence students' health. Rather, they suggested that the school's social environment (e.g., teachers' mindsets, teachers' perceptions of available resources, the level of support from principals, and the level of cooperation among key stakeholders in schools) is much more important in shaping the school health environment, and that this environment is variable from school to school. Measuring these factors may be much more meaningful in studying environmental variability, which influences students' health behaviors and health indicators. Fig. 1 and Fig. 2 illustrate the physical and social environment of schools.

Resource availability and lunch menu

In addition to the social environment, the availability of various resources was frequently mentioned by interview participants. Budget, kitchen equipment, and personnel were regarded as key resources that can affect the quality of school lunches.

It's hard to give fruits to students frequently...It would be good for students to have the whole piece of a fruit, but it's not easy because of the limited budget. And if we give smaller portion, it's difficult too, because we don't really have many hands to peel and cut them (fruits). (A school nutritionist in elementary school in Gyeonggi-do)

The price that students pay for school lunch is set at certain level, but when the number of students are so small, the total amount that we get from students are limited. In that case, the percentage of expenses on personnel goes up and the percentage of expenses on purchasing ingredient should go down. In that case, we can't compromise the quality of main

menu...we sacrifice healthy desserts...such as fruits. (A school nutritionist in elementary school in Gyeonggi-do)

The above two quotes illustrate that, due to the limited budget and personnel, the frequency of providing fruits in a school lunch is low. Another interviewee mentioned that with the presence of an oven in the kitchen at school, she reduced the frequency of providing deep-fried foods to students.

Since we installed the oven here in the kitchen, we don't serve deep-fried food that much. When we didn't have the oven and had limited personnel, the easiest and the quickest cooking methods was deep-frying. And it's safe too, cause it's deep fried. (A school nutritionist in elementary school in Seoul)

Presence of nutrition education and programs

Different forms of nutrition education, counseling, and related programs were mentioned during the interviews. The most frequently mentioned mode of education was the use of monthly newsletters or weekly posters, which indicate the lunch menu of the upcoming month or week and present key nutrition information for both students and parents.

I sent out a newsletter with school lunch menu and some healthy eating tips every month. And for the classrooms, I posted weekly nutrition information for students. At this moment, I don't teach a regular nutrition course. (A school nutritionist in elementary school in Seoul)

Having a regular nutrition course as an official school curriculum was uncommon among the interviewed participants. However, some interviewees mentioned that they are having individual nutrition counseling sessions with students with

selective eating behaviors and/or with under- or overweight students. In addition, some interviewees said that they are not currently participating in any education program but are planning on teaching classes or opening individual counseling sessions in an upcoming semester.

One of my colleagues, who works in the neighbor school, told me that she tried to teach a class where students can have some hands-on experiences. She brought cucumbers and carrots, something that kids don't like to eat, to the classroom, and they tried to make some salad with dressing. The students really enjoyed it, she said. So I am thinking about doing similar next year. (A school nutritionist in elementary school in Seoul)

Measurement tool components

The results of the interviews guided the development of the measurement tools. Fig. 2 shows the conceptual framework that was created based on the formative research and illustrates the key measurement tool components. The far-left column lists the key areas assessed through the teachers' survey: Resource availability, food management and practices, nutrition education and counseling, teachers' experiences in research participation and program implementation, and teachers' other characteristics. School characteristics, such as class size and the school's socioeconomic status as determined by the percentage of students eligible for governmental social safety net programs, were also considered as factors affecting a school's nutrition environment. For the lunch menu analysis, we calculated the schools' frequency of serving fruits, vegetables, deep-fried foods, and sugary desserts.

The middle column of Fig. 2 presents the environment indices that were created based on our survey and a literature review. The school nutrition environment indices include physical factors such as the availability of ovens, lunch prices, the availability of nutrition education and other health programs, and social factors such as nutritionists' perceptions of available resources. These factors were all stressed by the interviewees as important factors shaping school nutrition environments.

School characteristics for pilot testing of the instruments

Resource availability, education, and counseling

The developed tools were implemented in 15 schools in Seoul, South Korea. The participating schools' general characteristics are

Table 1. Participating schools' characteristics in measuring school nutrition environments in South Korea

District	Participating schools	Percentage of students eligible for free lunch
A	2	4.0
B	1	Not available
C	2	10.1
D	2	17.0
E	2	4.8
F	2	1.7
G	2	7.1
H	2	3.3
	15	mean = 6.4
	Mean	Range
School size	918 students	181-1,870 students

presented in Table 1. The relative socioeconomic status of the schools was related to the percentage of students eligible for free school lunches, which ranged from 1.7% to 17.0% in the 7 school districts (mean 6.4%). With regard to school-level factors, resource availability included: 1) the presence of ovens, 2) the absolute price per meal, and 3) the percentage of the meal price spent on purchasing ingredients (Table 2).

The mean price per meal was 2,767 Korean won (approximately 2.44 USD), but the mean price was higher in middle schools than in elementary schools. The percentage of the meal price spent on purchasing ingredients was roughly 76%, with elementary schools having a higher ingredient percentage than middle schools. All schools had their own food preparation rooms with registered dietitians governing the planning and preparation of the school lunches. By South Korean law, it is mandatory that school nutritionists also be registered dietitians. The majority of the schools did not offer classroom-based nutrition education or nutrition counseling for students and parents. The popular modes of providing nutrition education were through school websites (93.3% of participating schools), posters (80.0%), and newsletters (100.0%). Notably, all schools provided nutrition information to parents and students through newsletters. In 11 of the schools (73.3% of the participating schools) the school dietitian provided nutrition education during lunchtime. However, the incidence of programs or initiatives related to students' healthy eating was very low.

Table 2. Measured aspects of school nutrition environments in South Korea

	All (n = 15) n (%), mean (standard deviation, range)	Elementary schools (n = 7)	Middle schools (n = 8)
School-level indices			
Resource availability			
Have oven in lunch preparation room	10 (66.7)	5 (71.4)	5 (62.5)
Absolute lunch price for students (Korean won)	2767 (456, 2,120-3,500)	2344 (164, 2,120-2,500)	3137 (240, 2,850-3,500)
% of lunch price used for purchasing ingredients	76.1 (7.2, 66.8-91.3)	82.0 (5.8, 77.0-91.3)	71.0 (3.0, 66.8-74.8)
Education, counseling, and other health programs ¹⁾			
Offer classroom-based nutrition education	2 (13.3)	0 (0.0)	2 (25.0)
Offer nutrition counseling for students	4 (26.7)	2 (28.6)	2 (25.0)
Offer nutrition counseling for parents	3 (20.0)	1 (14.3)	2 (25.0)
Offer nutrition education via different media - web	14 (93.3)	6 (85.7)	8 (100.0)

Table 2. continued

	All (n = 15)	Elementary schools (n = 7)	Middle schools (n = 8)
Offer nutrition education via different media - posters	12 (80.0)	5 (71.4)	7 (87.5)
Offer nutrition education via different media - newsletter	15 (100.0)	7 (100.0)	8 (100.0)
Offer nutrition education during lunchtime	11 (73.3)	4 (57.1)	7 (87.5)
Offer healthy eating programs (research-related or any other initiative)	1 (6.67)	0 (0.0)	1 (12.5)
Dietitians' perceptions and characteristics			
Composite index for perception of resources (0-12) ²⁾	7.5 (1.8, 3-10)	6.9 (1.9, 3-8)	8.1 (1.6, 6-10)
Participated in work-related training in past two years	10 (66.6)	4 (57.1)	6 (75.0)
Type of employment (contract-based vs. tenured nutritionist)	6 (40.0)	0 (0.0)	6 (75.0)
Dietitians' age	32.6 (2.3, 23-52)	36.9 (4.2, 23-52)	28.9 (1.7, 24-39)
School lunch menu (% of total meal number) ³⁾			
Offer fruit	14.7 (11.8, 0-48.7)	19.2 (14.4, 7.7-48.7)	10.9 (7.9, 0-23.5)
Offer fresh salad	6.9 (4.6, 0-15.4)	7.7 (4.6, 2.6-15.4)	6.2 (4.7, 0-15.2)
Offer deep-fried food	18.9 (5.7, 10.3-30.3)	18.7 (5.6, 10.3-28.2)	19.1 (6.2, 11.1-30.3)
Offer pan-fried food	39.9 (9.7, 24.3-55.9)	40.0 (9.6, 24.3-51.3)	39.8 (9.7, 27.8-55.9)
Offer sugary desserts	10.2 (10.4, 0-32.4)	5.9 (5.9, 0-17.9)	13.9 (12.3, 0-32.4)

¹⁾ In the bivariate and multivariate analyses, a composite variable was created based on these 7 items by giving 1 to "offer" responses and 0 to "do not offer" responses. A binary variable was created: 'good' vs. 'bad' based on the mean of the composite scores from the sample.

²⁾ Consists of four items: perceived importance of school-based health promotion (0: not so important, 1: somewhat important, but not urgent, 2: very important, but hard to implement, 3: very important, now implementing); perception of cooperation between teachers (0: very hard to work with other teachers for health programs, 1: somewhat hard to work with, 2: easy to work with, 3: very easy to work with); perception of principal's support (0: not supportive at all, 1: not supportive, 2: somewhat supportive, 3: very supportive); perception of budget accessibility (0: very hard to get necessary budget for health programs, 1: hard to get, 2: somewhat easy to get, 3: very easy to get).

³⁾ Since all schools had a different total number of meals offered during the same period of two months, the percentage of meals that offered certain food items or used certain cooking methods in the total number of meals was calculated. During analyses, categorical variables for each item were utilized due to the discontinuous nature of the data (low, mid, and high percentage of offering).

Table 3. Creating a school nutrition-environment index in South Korea

	Questions in questionnaire	Scoring methods	Score range
1. Resource availability			
Oven availability	Q: school has oven?	0: no, 1: yes	0-1
% of lunch price used for purchasing ingredients	Q: how much money spent on ingredients? How much money student pays for lunch?	Categorize based on data distribution	1-3
2. Education, counseling, and other health programs			
Offer classroom-based nutrition education	Q: classroom-based nutrition education this year?	0: no, 1: yes	0-1
	Q: if yes, how many hours?	0: if total class hrs ≤ 10, 1: if class hrs > 10 ¹⁾	0-1
Offer nutrition counseling for students	Q: nutrition counseling sessions available for students?	0: no, 1: yes	0-1
Offer nutrition counseling for parents	Q: nutrition counseling sessions available for parents?	0: no, 1: yes	0-1
Offer nutrition education via web	Q: nutrition education through web? How many times per semester?	0: 0, 1: ≤ 4 times, 2: 5-6 times, 3: ≥ 7 times/semester ¹⁾	0-3
Offer nutrition education via posters	Q: nutrition education in hallway? How many times per semester?	0: 0, 1: < 5 times, 2: 5-9 times, 3: 10 times/semester ¹⁾	0-3
Offer nutrition education during lunch time	Q: perform nutrition education during lunchtime?	0: no, 1: half of time, 2: all the time	0-2
Offer healthy eating programs (Research-related or any initiatives)	Q: has this school participated in nutrition-related research?	0: no, 1: yes, previously 2: yes, currently	0-2
3. Dietitians' perception and characteristics			
Composite index for perception	Q: how supportive other teachers would be if you were planning health promotion programs?	0: not supportive at all, 1: not supportive, 2: supportive, 3: very supportive	
	Q: how supportive principal would be for health promotion programs?	0: not supportive at all, 1: not supportive, 2: supportive, 3: very supportive	

Table 3. continued

	Questions in questionnaire	Scoring methods	Score range
	Q: how easy do you think to get necessary budget?	0: very hard, 1: hard, 2: doable, 3: easy	
	Q: how important do you think health promotion programs are in this school?	0: not important, 1: important, but not the most urgent issue, 2: very important, but hard to do, 3: very important and currently doing my best	
	Sum the above (12 total) and categorize based on data distribution		1-3
Participated in work-related training/ other programs past two years	Q: participated in nutrition-related community program?	0: no, 1: previously yes, 2: yes	
	Q: attended in training?	0: no, 1: previously yes, 2: yes while working for the current school	
	Q: hours of training attended last year	0: no, 1: < 10 hrs, 2: 10-20 hrs, 3: > 20 hrs ¹⁾	
	Sum the above (7 total) and categorize based on data distribution		1-3
Employment type	Q: are you a regular teacher or a contract-based employee?	0: contract-based, 1: regular teacher	0-1
4. School lunch menu ²⁾			
Offer fruit	#of fruit servings/total meals	Categorize based on data distribution	1-3
Offer fresh salad	#of salad servings/total meals		1-3
Offer deep-fried food	#of deep-fried food servings/total meals		1-3
Offer pan-fried food	#of oil-based cooking methods/total meals		1-3
Offer sugary desserts	#of sugary dessert serving/total meals		1-3
Total possible score ³⁾			40

¹⁾ Cutoffs are based on data distribution in the current survey

²⁾ Calculated based on school lunch documents (lunch menus for a 2-month period) collected from participating schools

³⁾ In the multivariate analyses, a categorical variable was used (3 categories based on the total score): score range, 17-28

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Creating an index for dietitians' perceptions and characteristics

In addition to school-level resources and education availability, another factor that was stressed by the interviewed teachers was the school's social environment. School social environmental factors included dietitians' perceptions and their characteristics. The composite index for dietitians' perceptions was created based on four items in the questionnaire: 1) the perceived importance of school-based health promotion, 2) the perception of cooperation among other teachers (physical education teachers and health teachers), 3) the perception of the principal's support, and 4) the perception of budget accessibility (each item was based on a four-point scale). The mean value for this composite perception index was 7.5 out of a maximum of 12. Compared to elementary school dietitians, middle school dietitians had a more favorable perception of school-based health promotion programs and the availability of other resources (8.1 vs. 6.9, respectively).

Ten of the 15 dietitians surveyed had participated in work-related training in the past two years. With regard to type of employment, roughly 60% of the dietitians were tenured school and government employees, whereas 6 dietitians (40%) were contract-based, short-term employees. All of the contract-based dietitians worked in middle schools, which could indicate a different working situation for dietitians in elementary and

middle schools.

Analysis of school lunch menus

The last component of the school nutrition environment that was assessed was the school lunch menu. Roughly 15% of the meals offered fruit, while 7% of the meals had fresh salad. Deep-fried foods were served in approximately 19% of the meals, and 50% of the meals had dishes that used oil-based cooking methods. Lastly, 10% of the meals offered sugary desserts. It was observed that fruits were served more frequently in elementary schools than in middle schools, and sugary desserts were provided more often to the middle school students.

Scale construction: creating a school nutrition environment index

Table 3 shows the scoring system for each item of the school nutrition-environment index. The index was composed of four main sections: 1) resource availability, 2) education and programs, 3) dietitians' characteristics, and 4) lunch menu. The scoring ranges for each of those sections are: resource availability, 0 to 4; education and programs, 0 to 14; dietitians' perceptions and characteristics, 2 to 7; and school lunch menu, 5 to 15. Consequently, the total possible score for the school nutrition-environment index from all four sections is 40.

Table 4. School nutrition-environment index scores: results from 15 schools in Seoul, South Korea

Subcomponent	Score range	Score mean (range)		
		All (n = 15)	Elementary schools (n = 7)	Middle schools (n = 8)
Resource availability ¹⁾	0-4	2.7 (1-4)	3.4 (2-4)	2.0 (1-3)
Education and programs	0-14	5.1 (0-9)	4.3 (0-9)	5.9 (4-9)
Dietitians' perceptions and characteristics	2-7	4.5 (2-6)	4.6 (3-6)	4.5 (2-6)
School lunch menu	5-15	10.1 (6-13)	10.6 (9-12)	9.8 (6-13)
Total	7-40	22.3 (13-28)	22.8 (13-27)	21.9 (16-28)

¹⁾ Statistically significant difference between elementary and middle schools ($P=0.003$)

We used our formative findings to identify and weigh components of the school nutrition environment. If the nature of the item was not binary and if there were no distinct cutoffs, then the scores were relative terms based on the data's distribution. For most of the categorical variables created on the basis of the survey data, the cutoffs are established to divide the response values into three categories. We also considered the school dietitians' participation in community programs and their training experiences and created one item with a scoring range of 1 to 3 based on the data's distribution. Lastly, if the dietitians were regular teachers, the school received 1 point; if not, the school received 0 points.

With regard to the school lunch menu, schools with higher percentages of fruit and salad items received the higher score (3 points); moreover, schools with a lower percentage of deep- and pan-fried foods and sugary desserts also received the higher score (3 points).

Using this scoring method, the total possible score for a complete survey questionnaire was 40 points from 18 items. The mean value was 22.5 (standard deviation ± 3.2 ; range 17-28) among the 15 participating schools. The scores for the index subcomponents are presented in Table 4. Among the four subcomponents, resource availability was the only component that had a statistically significant difference between elementary and middle schools.

DISCUSSION

Herein, we have described the creation of a school nutrition environment index for elementary and middle schools in urban South Korea. To our knowledge, this study is the first of its kind to measure various aspects of the school nutrition environment and to provide a relative scoring system for assessing that environment in Asia. Many studies in Western countries have extensively examined the availability and quality of 'competitive food' in schools; such foods are not part of school lunch programs and are therefore not officially regulated. Vending machines and à la carte menus were the major foci of these previous studies into school nutrition environments [1-3,14]. However, our formative research revealed that competitive foods were not the issue in our study setting. Vending machines are currently prohibited by law in every school in South Korea; similarly, school food stores are also banned in elementary schools and are rare in middle schools [21]. This information confirms the importance of assessing the food environment in a way that can detect unique aspects of the study setting [22].

Another difference between previously developed measures and the tools developed for this study was in the measurement of school health policies. The School Health Policies and Programs Study in the U.S.A. measured school health programs and policies that differ by state and district within the country [10]. However, in South Korea, the School Health Guidelines and the Guidelines for School Lunch are distributed by the Ministry of Education, Science, and Technology every year, and the regional Office of Education forwards the guidelines, with some minor modifications, to individual schools [23]. Consequently, the policies and school curricula that might affect the school health and nutrition environments do not exhibit notable variability in city schools, or even within the entire country.

According to the interviewees, the factors that might vary by school in South Korea are the teachers' mindset and their proactive actions that make some programs and initiatives available to students. The interviewees also indicated that teachers' perceptions of their available resources, such as support from principals and other teachers, can make substantial differences in providing a healthy school environment, given those resources. We used the term 'school's social nutrition environment' when addressing these elements, and the term was included in the developed questionnaires. Because of the lack of previous studies measuring school social environments in urban South Korea, future research should be conducted to examine the reliability and validity of questions that are used to measure a school's social nutrition environment.

Because of this study's small number of schools sampled, statistical analysis of the collected data was not within the scope of this study. However, some factors did show notable differences between elementary and middle schools. For instance, middle schools tended to have more contract-based school dietitians compared to that in elementary schools where all school dietitians were tenured government employees. Moreover, it is reasonable to conclude that the absolute lunch price for middle school students is higher than that for elementary school students because the amount of food provided is larger for middle school students than for elementary school students; regardless, the percentage of the lunch price that is spent on purchasing ingredients is lower in middle schools. This might imply that some aspects of the school nutrition environment in middle schools are less favorable than in elementary schools. Indeed, as shown in Table 4, the subcomponent of resource availability showed a statistically significant difference between elementary and middle schools.

Analysis of the two-month lunch menus showed that fruit was provided only in 14.7% of the total meals served to

students. Given the fact that only 22.9% of adolescents met the nutritional guidelines for consuming fruit at least once a day in 2015 [24], there is a serious need to improve school lunch programs to help students meet this dietary guideline. This need can be greater for children from socioeconomically disadvantaged households, as previous studies have found that disadvantaged populations consumed substantially less fruit than that consumed by more advantaged populations [24,25].

Despite the contributions of this study to understanding a school's nutrition environment, some limitations should be noted. First, the participating schools were all from Seoul, which means that the data presented in this paper do not represent school nutrition environments in South Korea as a whole. Second, in creating the school nutrition-environment index, we made some assumptions when scoring components of the measures based on our understanding of the component. These assumptions should be investigated in future studies involving a greater number of schools. Lastly, we tried to ensure content and face validities of the developed measure through extensive formative research and expert reviews. However, more criterion-related validities, such as predictive validity, should be affirmed through studies involving larger school sample sizes and individual behavior data collected from various regions of the country.

When the use of previously developed tools may not plausible or relevant, the methods used to capture the healthiness of a school nutrition environment in this study could be adopted in different countries with different culture and policy environments. The school nutrition environment in South Korea is somewhat unique as competitive foods and vending machines are tightly controlled by government; even so, there are nutritional issues among South Korean youth. This may provide an important example that schools in other countries may consider when they attempt to resolve issues associated with competitive foods. The presence of competitive foods increases the school nutrition environment challenges that other countries may confront.

To further improve the instrument developed in this study, more observational and interventional studies should be conducted in schools to refine the measurement elements and confirm the roles of the school's nutrition environment on students' eating behaviors and health.

CONFLICTS OF INTEREST

The authors declare no potential conflicts of interests.

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