RESEACH NOTE

The Effect of A School-based Nutrition Education Program on Japanese Elementary School Children's Nutrition Knowledge and The Revaluation after One and A Half Year.

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ABSTRACT *Background and purpose*. Nutrition knowledge is one of the factors influencing on diet. Children's nutrition knowledge was reported to increase after they received nutrition education classes. However, there were few reports about the continuation of effect after the nutrition education on children's nutrition knowledge. This study aim was to evaluate the continued efficacy of a school-based nutrition education program on children's nutrition knowledge specializing in food grouping for one and a half year among elementary school children using pre-post survey. *Methods.* Participants were Japanese elementary school students in second grade (n=53). Two-time nutrition education lectures on the "three-color food groups" held as part of a school-based seven-month dietary education program. The changes in children's nutrition knowledge scores by the nutrition education program of "Three-color food groups" evaluated by a questionnaire about "Three-color food groups" including two sections of "Color" and "Function" from Pre-intervention to After-class (immediately following lectures), Post-intervention (immediately after all programs for seven months) and After-a-year-intervention (one year following the intervention). The Friedman test and Scheffe's method were used to those analyses. *Results.* Both "Color" and "Function" scores were higher at After-class, Post-intervention, and After-a-year-intervention than Pre-intervention ($P < 0.001$ for all), while the "Function" score declined at Post-intervention and A-year-after-intervention compared to After-class. *Conclusion.* A single program specialized in "Color" of "Three-color food groups" may improve knowledge and continue its effect among children aged 7-8 years, although repeated familiarization may be needed until they understand difficult or unfamiliar concepts or words such as "Function".
Keywords: School-based nutrition education, Nutrition knowledge, Elementary schools, Children, Food groups

INTRODUCTION

School age is crucial years for normal physical and mental development, and the diet and eating behaviour that develop during these years tend to persist throughout life (1) is a period in which food preference and eating habits are formed. Childhood is a time of greater openness to modification of food choice (2), therefore, the eating habits and behaviors formed in childhood may be difficult to change later in life (2-4).

Children's diet is influenced by various factors, such as their own knowledge (5), their parents' nutrition knowledge (6,7), and home food environment (6,8). In particular, nutrition knowledge is necessary for making healthier food choices (7,9-11), and it has been found to predict dietary quality (11). Moreover, the knowledge about food and its health benefits that children gain in childhood can influence their dietary choices and preferences later in life (5,12). For example, a Japanese study reported that elementary school students with higher nutrition knowledge consumed more vegetables than students with lower nutrition knowledge (13). Thus, it might be necessary to obtain nutrition knowledge during childhood in order to benefit health later in life.

A number of nutrition-education programs are designed to improve nutrition knowledge, with the aim of supporting sound dietary intake within the community or a specific target population (6,8). Nutrition-education programs that present positive dietary messages can potentially improve dietary behavior and increase nutrition knowledge in children (6). In fact, several studies about nutrition education have been reported. A review reported that school-based, nutrition education programs can lead to moderate increases in vegetable consumption

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among children (14). A UK study reported that nutrition education improved 5-7 year-olds' nutrition knowledge (15). Several studies have reported that gardening improved preference and consumption of fruits and vegetables in younger generations (16-18). In particular, school-based nutrition education can be delivered in a way that is easily understood by children, and teach the skills and knowledge required to improve or strengthen healthy eating habits (19). For example, it is reported that school food policies may encourage healthy eating and discourage consumption of unhealthy foods and sweetened drinks (20,21). The previous study showed that nutrition education on food groups for young Japanese children improved their nutrition knowledge (22). Another study reported that nutrition education on healthy food was effective in helping young children increase nutrition knowledge (23). That is to say school-based nutrition education has impacted improving children's nutrition knowledge and food behavior.

The ultimately goal is to increase nutrition knowledge and positive behavior change, which can have a beneficial effect on the long-term health of children enrolled in any such nutrition-education programs (15). However, there are few studies on the effect of the continuousness of these programs. It is important to investigate what undermines the continuousness of such programs in order to implement effective interventions. Therefore, the aim of this study was to assess the continued efficacy of a school-based nutrition education program on 7-8 year old elementary school children's nutrition knowledge for one and a half years.

METHODS

Study design. This before-after trial evaluated a school-based nutrition education program on nutrition knowledge of "Three-color food groups" for second grade students (7-8-year-olds) in a public elementary school in Saitama city of Japan. The nutrition-education program was conducted as part of a school-based, seven-month, dietary education program.

Pre-intervention assessment of nutrition knowledge was conducted using a questionnaire for participants in May 2012 (Pre-intervention). The school-based, dietary education program was conducted for seven months after the Pre-intervention assessment. This program included a series of nutrition-education lectures on the "Three-color food groups", which was conducted twice in October and November of 2012. The nutrition knowledge assessment using the same questionnaire as Pre-intervention was conducted after the series of lectures (After-class), immediately after all programs for seven months (Post-intervention), and one year after the Post-intervention in February 2014 (After-a-year-intervention).

The present study was granted ethical approval by the ethics committee of Seitoku University in accordance with the "Helsinki Declaration: Ethical Principles for Research Involving Human Subjects" (H24U003).

Subjects. The Figure 1 shows an overview of the number of participants in the present study. Seventy-nine second grade students of an elementary school in Saitama city in Japan were recruited. There were no exclusion criteria. A total of 59 students completed all interventions, including four nutrition-knowledge assessments and the nutrition-education program on "Three-color food groups". Finally, 53 (28 male and 25 female) students completed all programs.

The nature of the study was explained to the school principal and homeroom teachers by the

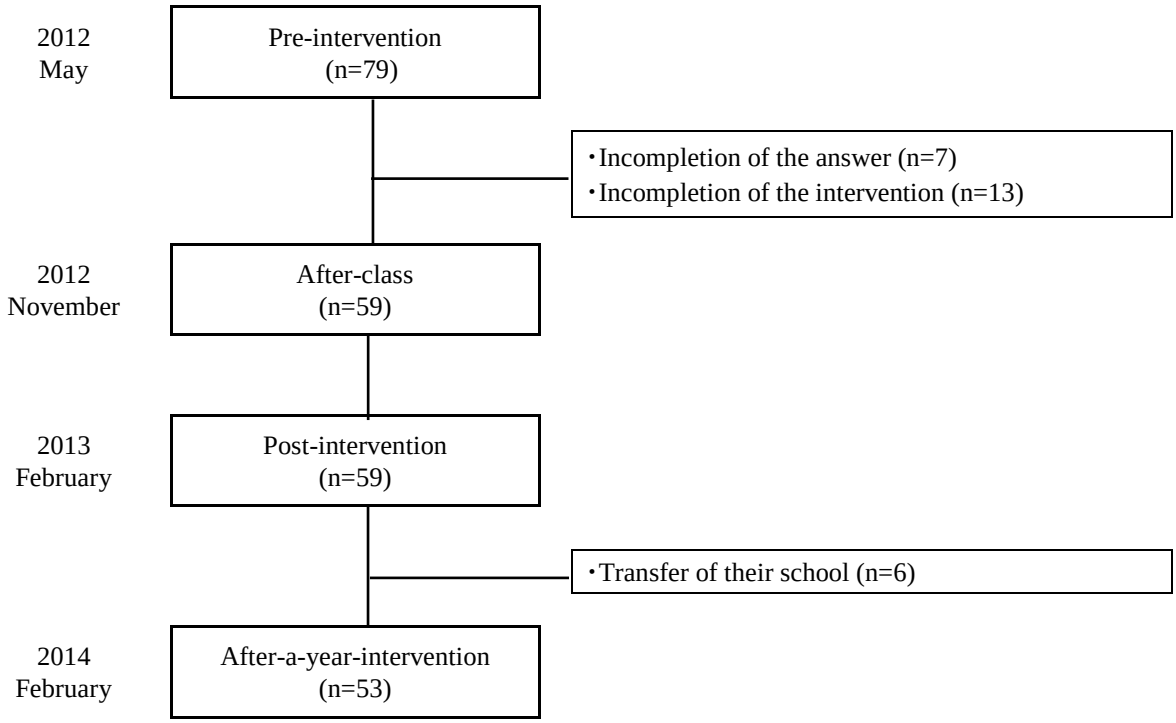

Figure 1. Overview of the number of participants contained in this study

researcher and distributed by mail to the parents of children who participated in the study. Written consent forms were obtained from parents before the commencement of the study.

Intervention program. The school-based, seven-month dietary education program was composed of lectures on six topics: "Breakfast and life-rhythm", "Healthy snacking behavior", "Food poisoning", "Three-color food groups", "Eating manner" and "Seasonal foods". The program was developed for the school by teachers and the researcher, based on the principal components of "Basic Law on Shokuiku" (24), "Basic Program for Shokuiku Promotion" (25) and "Elementary school curriculum guideline" (26). The lecture on the "Three-color food groups" was conducted twice, while the others were conducted once. "Three-color food groups" is a classification system recommended to be taught in home economics at Japanese elementary schools for students to easily understand well-balanced dietary intake (26). According to the system, food can be classified into three color groups, including "Red", "Green," and "Yellow" by the function of the dominant nutrients in each food. The "Red" food group includes meat, fish, soybeans, and eggs, which are all rich in protein, and work to build the blood and body. The "Green" food group includes vegetables and fruits, which are rich in vitamins and minerals, and work to keep the body healthy. The "Yellow" food group includes rice, bread, noodles, potatoes, and oil, which are rich in carbohydrates or fats, and work as the source of the body's energy. The example of lecture about "Three-color food groups" is shown in Figure 2. The lectures included the definition and classification of food groups based on "Three-color food groups" system so the children could understand the differences of nutritional functions in the various food groups and their combination to achieve a well-balanced diet. The other lectures in the program provided information on basic dietary behaviors. For example, the lectures on "Breakfast and life-rhythm" and "Healthy snacking behavior" comprised the roles of eating breakfast and snaking in children's lifestyle. The lecture on "Food poisoning" provided information on preventing food poisoning and related behaviors. In the lecture on "Eating manner", children were taught a good table manner, such as how to use chopsticks. The lecture on "Seasonal food" comprised the best season for eating vegetables and fruits.

The program was completed by a participatory approach, using a black board and card games aimed at building students' nutrition knowledge, which amounted to seven interventions in total. Each lecture was given for a 30-minute period and were conducted by the same registered dietitians. Since the duration of a lecture at elementary schools in Japan is 45 minutes, a 30-minute lecture was deemed suitable for the study participants.

Nutrition Knowledge Questionnaire on the "Three-color Food Groups" for Young Children. A questionnaire was developed to assess students' nutrition knowledge focusing on the "Three-color food groups" and based on the contents of the nutrition-education program. The contents of the questionnaire are shown in Table 1.

The questionnaire consisted of six items asking students of their nutrition knowledge of "Three-color food groups". It took approximately 5 to 10 minutes to complete the questionnaire, which is a suitable length of time for children of the participants' age group (27). This questionnaire is a multiple-choice test in which participants were given a choice of four answers, plus an option of "I don't know". Before the first assessment, the components of the questionnaire were reviewed by the school principal, teachers (n=3), and registered dietitians (n=2) to ensure its appropriateness. Internal consistency of the questionnaire was calculated by using Cronbach's α was 0.603 among 25 children, age 6 in the pilot study (data not shown). The questionnaire was conducted by an anonymous self-completed method in each class. A researcher read questions aloud to each class because it was reported that it was preferable for the proctor to read questions aloud in order to minimize the impact of reading levels on results (27).

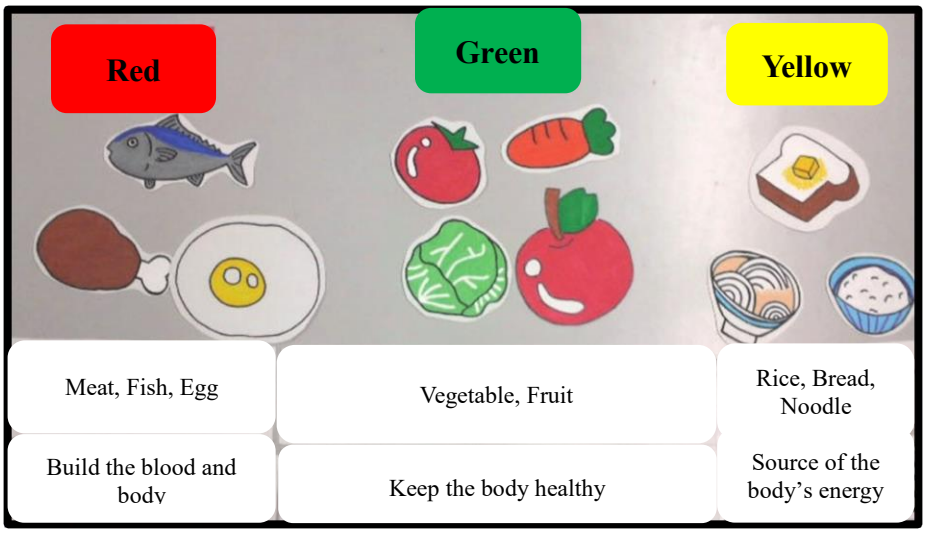

Figure 2. The content of lecture about "Three-color food groups" system

Table 1. Content of the Questionnaire for Children

Category	Sub-category	Question number	Content
Three-color food groups	Color	No.1	"Three-color food groups" Which food is included in the "red group"?
		No.2	"Three-color food groups" Which food is included in the "green group"?
		No.3	"Three-color food groups" Which food is included in the "yellow group"?
	Function	No.4	"Three-color food groups" Which food is the source of energy?
		No.5	"Three-color food groups" Which food is the source of blood or muscle?
		No.6	"Three-color food groups" Which food helps maintain proper bodily functions?

Table 2. Anthropometric Data for Students who Participated in Study

	All (n=53)		Male (n=28)		Female (n=25)		p
	Median value	(IQR)	Median value	(IQR)	Median value	(IQR)	
Body height (cm)	120.0	(118.0-125.0)	120.0	(118.5-125.5)	121.0	(118.0-123.0)	0.713
Body weight (kg)	22.5	(20.0-25.0)	22.0	(20.5-25.0)	22.8	(20.0-25.0)	0.781
Body mass index (kg/m^2)	15.3	(14.4-16.9)	15.3	(14.1-17.5)	15.1	(14.5-16.8)	0.915

The p values were calculated by Mann-Whitney test.

Other Variables. Body weight and body height were obtained by school health check data. Body mass index (BMI) was calculated as body weight (in kilograms) divided by the square of body height (in meters).

Statistical analysis. All statistical analyses were performed using the IBM SPSS statistics software package (version 22.0, SPSS Inc., Chicago, IL, USA). The responses of the nutrition-knowledge questionnaire were converted to scores of '1' and '0' for correct and incorrect answers, respectively. The answer of "I don't know" was scored as '0'. Scores were calculated by summing the total number of correct answers. A higher score reflected a higher knowledge level. The difference of body height, weight, and BMI between male and female students participating in the study was compared by the Mann-Whitney test. The effect of the continuousness of the nutrition-education program was assessed by comparison of nutrition knowledge of the "three-color food groups" for a total of four interventions, including Pre-intervention, After-class, Post-intervention, and A-year-after-intervention by the Friedman test, using Scheffe's method to compare the score between each intervention.

RESULTS

Demographic characteristics of the study participants are presented in Table 2. Median body height, weight, and BMI were not significantly different between male and female students.

Table 3 shows the scores of the "Three-color food groups" knowledge questionnaire at Pre-intervention, After-class, Post-intervention, and After-a-year-intervention. The knowledge score of "Color" was improved at After-class, Post-intervention, and A-year-after-intervention from Pre-intervention, respectively ($P < 0.001$). The knowledge score of "Function" of each color was improved at After-class, in comparison to Pre-intervention ($P < 0.001$). The score of "Function" declined at Post-intervention and A-year-after-intervention from After-class, while these scores were significantly higher compared to the score of Pre-intervention. The difference in sex did not affect these results (data not shown).

DISCUSSION

In this study, we examined whether the effect of a school-based nutrition education program on the nutrition knowledge of 7-8 year-olds continued for

Table 3. Score of Knowledge of Questionnaire to Assess Effect of Nutrition Education of the "Three-color food groups" (n=53)

	Pre-intervention		After-class		Post-intervention		A-year-after-intervention		p
	Median value	(IQR)	Median value	(IQR)	Median value	(IQR)	Median value	(IQR)	
"Color"	1.0	(1.0-2.0)[a]	3.0	(3.0-3.0)[b]	3.0	(3.0-3.0)[b]	3.0	(3.0-3.0)[b]	< 0.001
"Function"	1.0	(1.0-2.0)[a]	3.0	(2.0-3.0)[b]	2.0	(2.0-3.0)[c]	2.0	(2.0-2.0)[c]	< 0.001

IQR, interquartile range.

The p values were calculated by Friedman test.

[a b c] There is significant difference between different alphabet in the same row using by Scheffe's method to compare the score between each intervention

one and a half years. To the best of our knowledge, the present study is the first study to examine the continued efficacy of a nutrition-education program on children's nutrition knowledge for over a year. Our findings suggest that that the nutrition education specialized in "Color" of "Three-color continued has led to a one and a half year effect among 7-8-year-old children.

The effect of school-based nutrition education programs have been examined in various settings. For example, Connell, et al. and Resnicow, et al. reported that the evaluation of school health education improved healthy food behavior for elementary school students (28,29). In addition, the effect of school-based nutrition education specializing in nutrition knowledge has also been reported. Bargen reported that the evaluation of school health education showed that 10 to 15 hours were required to expect "large" effects in a program about specific knowledge (30). Morgan et al. found that a three-hour, school-based nutrition education program was a promising tool to improve 11-12-year-olds' nutrition knowledge and food preferences (8). The results of the previous studies were similar to our results, which showed that a nutrition-education program improved 7-8-year-olds' nutrition knowledge. Our participants obtained low scores (median 2 points out of 6) at the baseline assessment (Pre-intervention), while they obtained median 5-6 points after the intervention. A previous study showed that 4-6-year-olds did not have considerable knowledge on "Three-color food groups" used for the intervention (31). Together with this result, our participants were likely to obtain the knowledge in question from the intervention program, which indicated that nutrition-education programs focusing on nutrition knowledge may have an effect in improving and establishing nutrition knowledge for 7-8-year-olds.

For nutrition education, our study focused on the food grouping and nutrient functions using "Three-color food groups" system, both in education and assessment of nutrition knowledge. We selected this classification system because it has been employed for children to easily understand a balanced diet and is the tool to teach children food grouping in Japanese elementary schools. Previous studies comprised nutrition-knowledge questionnaires for young children, including the concept of food grouping in the view of nutrient function or healthy food intake (32,33), which made us assess the knowledge similarly. In this study, the assessment was conducted from two viewpoints: "Color" and "Function", which represented food grouping and nutrient function, respectively. A number of differences were observed between the results. Recognition of "Color" was maintained for an extended time after the improvement realized through the intervention. Therefore, a single nutrition education about "Color" may be appropriate for children of this age. However, although recognition of "Function" of each color improved in the After-class phase, the score slightly decreased following that (Post-intervention). A previous study using "Three-color food groups" reported that recognition of "Color" was significantly improved after an intervention while recognition of "Function" did not significantly improve among young Japanese children (22). Based on these findings in our results, it might be difficult for children to fully acquire knowledge on nutritional function. One possible reason for this could be familiarization after the intervention. Most Japanese elementary schools provide parents with monthly school-lunch program letters, which usually include information to classify the foods used in the lunch menu to the "Three-color food groups". After the children received nutrition education on "Three-color food groups", it is possible that consciousness of the monthly school-lunch program letter led to the foundation of the knowledge. On the contrary, it might be too difficult for the children to understand the definition of nutritional function, as the score declined after an extended period. In fact, nutrition education using "Three-color food groups" is mostly employed targeting fifth grade (10-11-year-olds) in Japan (34). Our subjects were much younger than the targeted children and it is possible that the words used for the functions were too complicated to remember. Birch et al. reported that five to six times more education were needed until children became familiar with vegetables or vegetable names that were new to them in 1987 (35). In addition, a study about children's nutrition knowledge showed that they had poor nutrition knowledge about food function and nutrients contained in food (32, 36). Thus, it may take a longer period of time for children to understand new or difficult words, particularly words that are unfamiliar to them. A follow-up strategy may be needed to maintain the nutritional knowledge such as "Function" gained in a nutrition-education program. Therefore, further study will be needed to resolve this question. Additionally, our results showed the improvement or continuance of nutrition knowledge did not significantly differ according to sex (data not shown). These results were similar to a previous study among 5-7-year-old children (15). Thus, the differences by sex in children of our participants' ages may have little influence in gaining nutrition knowledge.

Several limitations of the present study warrant highlighting. First, the number of subjects was small (n=53). However, several studies of nutrition education for children were conducted for a similar number of subjects (37). In addition, participants in this study were limited to children belonging to a public elementary school in Saitama city in Japan, not random samples from the general population. The participants were therefore likely not representative of Japanese children. Second, before-after trials without a control group was used in the present study. However, there are few studies on the effects of nutrition education on young children in Japan, and the effects of improvement and its continuousness for nutrition education were not found. It is said that sufficient information is needed to complete a randomized-controlled trial and the effects should be investigated without a control group before such a trial is completed (38). Thus, it is important that the effect of improvement of continuousness on nutrition education was investigated without a control group, such as the previous study (37) the present study completed. Third, the Cronbach's α value of the questionnaire was lower in comparison to the reference value of 0.7 (39). Cronbach's α coefficient is estimated to be higher when the number of items increases (40). The low α value obtained in this questionnaire may be attributed to the small item numbers. Fourth, in the present study, the same

questionnaire was used for each nutrition-knowledge assessment, and it was possible that children remembered the correct answers of the questionnaire. However, according to previous studies reporting reproducibility of questionnaires of nutrition knowledge targeting children, our questionnaires were conducted 2-4 weeks apart because children were likely to forget the correct answers during that time (27,41). Our examination was conducted within at least three-month intervals; as such, we believed that using the same questionnaire did not influence the current results. Lastly, we did not ask participants about household income, family environment, and their parents' nutrition knowledge. It was reported that household income and family environment affected nutrition knowledge (42,43), and parents' knowledge made an impact on children's knowledge (41). Additional studies that include those factors that influence children's nutrition knowledge should be conducted.

CONCLUSION

In conclusion, a school-based nutrition education program focused on the "Three-color food groups" improved nutrition knowledge among 7-8-year-old Japanese children. Moreover, the obtained knowledge specialized in "Color" was likely to remain for one and a half years. Therefore, a single nutrition education about "Three-color food groups" specialized in "Color" may be appropriate for children of this age. In order for children to gain knowledge, repeated familiarization may be needed until they understand difficult or unfamiliar concepts or words such as "Function". Future studies are needed to determine the contents and components of effective nutrition-education programs to improve both nutrition knowledge and dietary behavior of young children further.

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