

# Effects of School-Based Nutrition Education Program on Behavioral Changes in Dietary Habits - Analysis of Elementary School Fourth Grade -

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Previously, we developed a nutrition education (shokuiku) program according to the theory of behavioral science and reported that psychological factors (e.g., cognition, emotion, and behavior) play an important role in the optimization and improvement of dietary habits with third-grade students in the elementary school.

In the present study, we carried out nutrition education to fourth-grade students in Tokushima Prefecture, Japan, to examine the versatility and issues related to the nutrition education program for the elementary school students. Evaluation analysis indicates that there was an educational impact on both genders, showing that the educational program promoted behavioral changes in dietary habits. This finding confirms that nutrition education is applicable to fourth-grade students. Since the impact of the nutrition education varies greatly by the difference of one grade in school-aged children, our study suggested that the continuity of the nutrition education program that considers cognitive development at school age is important for the acquisition of dietary literacy.

Key words : Behavioral Modification, Behavioral Science, Health Promotion,  
Lifestyle-Related Diseases, Nutrition Education

## 1. Introduction

Both the increase of lifestyle diseases associated with long-term inappropriate lifestyle habits<sup>1)</sup> and the elevated national medical expenses<sup>2)</sup> indicate the importance of nutrition education provided by registered dietitians and nutritionists. However, currently, nutrition education for patients with lifestyle diseases does not always achieve its fully expected effect. The main reason for the difficulties faced in nutrition education is maintaining the adherence to the improved dietary habits following nutrition education. So far, Heckman reported the importance of nutrition education during the childhood. He demonstrated that investing in the education during the preschool-aged children is more effective than for school-aged children or later<sup>3)</sup>, indicating that the factor which determines the effectiveness of the education once children start school is the education that each receives before they enter school. Therefore, to overcome the difficulties in nutrition education, we focused on the childhood when lifestyle habits are established and the possible effects of nutrition education intervention during this period.

On the other hand, the Basic Act on Food Education was enacted in 2005<sup>4)</sup> and the public promotion of “food education” commenced<sup>5)</sup> in the educational environment. Recently, the age of those who are susceptible to lifestyle diseases has decreased<sup>6)</sup>, and effective food education in schools is urgently required to prevent lifestyle diseases. Nutrition education is defined by the glossary of Nutrition Practice<sup>7)</sup> as “an activity that supports behavioral modification of people according to various sciences associated with nutrition science, such as behavioural science and pedagogy, toward the actualization of desired nutritional status and dietary behavior with the objective of health promotion and improvement of quality of life (QOL).”

In schools, the approach of modifying the behavior of school children using skills based on

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behavioral science is becoming important. From the 1970s to the 1980s, an individual approach was primarily taken<sup>8)</sup> according to a theory for understanding individual health behavior according to socio-psychology. For example, it was demonstrated that psychological factors are involved in the onset of lifestyle diseases, and the preventive effect of psychological support for school-aged children has been reported for the onset of diabetes mellitus, a lifestyle disease<sup>9)</sup>. According to the social cognition theory proposed by Bandura in 1986<sup>10)</sup>, cognition is closely involved with social learning by humans, with strong self-efficacy leading people to achievement and well-being (good condition) while also playing an important role in the promotion of good health. The belief in self-efficacy impacts an individual's way of thinking, feeling, motivation, and behavior. For example, increased motivation and the belief that one can control their own behavior play a very important role in changing adverse health habits. Therefore, in the previous study we hypothesized that cognition, emotion, and behavior play an important role in the optimization and improvement of dietary habits, and developed a nutrition education program according to behavioral science theory<sup>11)</sup>. We also developed novel visual aids to support this nutrition education program<sup>12)</sup> and applied this approach to the field of nutrition education to examine its effect with third-grade students in the elementary school.

In this study, to examine the versatility and problems associated with this nutrition education program, we extended nutrition education to fourth-grade students and examined its efficacy.

## 2. Methods

The nutrition education program to prevent lifestyle diseases used in this study was developed previously<sup>11)</sup>. We briefly describe the methods below.

### 2-1 Nutrition education program

This nutrition education program has hierarchical educational goals with the ultimate goal being “improved maintenance of physical health”. The hierarchical educational goals are classified into three goals. The high-level goal is “improved dietary habits to prevent lifestyle diseases.” The middle-level goal has three items that are set for dietary habits: “self-monitoring,” “cognition,” and “emotion and behavior.” For the low-level goal, we set the operational goals as the scales to measure whether the meaning of three items is understood, and whether the points to be improved is grasped, and whether modified nutritional behaviour is promoted (Table 1). The nutrition education program was designed so that the hierarchical educational goals can be reached in 3 classes (45 min each) and 3 lunch times (5 min each) as shown in Figure 1.

The program contains Shokuiku at regular class; 45 min 4 times, Shokuiku using school lunch time; 5 min 3 times, and Challenge work; 1 week.

### 2-2 Subjects and ethical considerations

A total of 62 students (33 boys and 29 girls) from two fourth-grade classes of N elementary school in Tokushima Prefecture participated in the study. As procedure for participating in this study, we provided oral and written explanations regarding the objective and methods of this study to teachers and the principal of N elementary school in N city, and obtained informed consent from them for participation. Next, we explained the objective and methods of this study through home communication to the guardians about the subjects to obtain informed consent.

Table 1 Educational Goals and Timetable for the *Shokuiku* Program

| <b><u>Intermediate goals (I - III)</u></b><br>Sub-goals (1 - 6)   | Operational goals   | Classes                                    |
|---|---|--|
| <b><u>I. Understanding one's own eating habits</u></b><br>1. Knowing your current eating habits<br>2. Understanding your current eating habits  | a. I can understand my own breakfast intake.<br>b. I can understand my own vegetable intake.<br>c. I can understand my own snacking intake.<br>d. I can understand the current state and issues with my eating habits in comparison with friends.<br>e. I can understand the current state and issues with my eating habits in comparison with national survey results. | 1st<br>(45 min)                            |
| <b><u>II. Understanding the relationship between health and eating habits, and recognizing that you should ensure your own health</u></b><br>3. Understanding lifestyle habits and their development mechanisms             | f. I can understand what lifestyle-related diseases are.<br>g. I can understand that a worsening of eating habits leads to lifestyle-related diseases and deterioration of health.  | 2nd<br>(45 min)                            |
| 4. Understanding that you can achieve appropriate eating habits by yourself   | h. I can understand what appropriate eating habits are.<br>i. I can understand the need for vegetable intake.<br>j. I can recognize that eating habits are not fixed, but are easily changeable.  | 3rd<br>(45 min)                            |
| <b><u>III. Controlling your own eating habits by increasing your motivation to "ensure your own health"</u></b><br>5. Finding the ways to improve your current eating habits and increase your motivation to become healthy | k. I can find the causes of poor eating habits and solve them by myself.<br>l. I can find the issues with my current eating habits while mutually assisting my friends.<br>m. I can set my own goals to improve my eating habits.<br>n. I can find ways to improve my eating habits.  | 3rd<br>(45 min)<br><br>4th<br>(45 min)     |
| 6. Adopting and maintaining behaviors to improve your eating habits   | o. If the state of my eating habits deteriorates in the future, I know how to address it.<br>p. I can adopt behaviors to improve my eating habits.<br>q. I can aim to improve my eating habits with the cooperation of my family.   | School lunch<br><br>4th<br>(45 min)<br>CW* |

\*CW indicates homework outside of school hours

Note: the primary goal is the development and improvement of eating habits to prevent lifestyle-related diseases

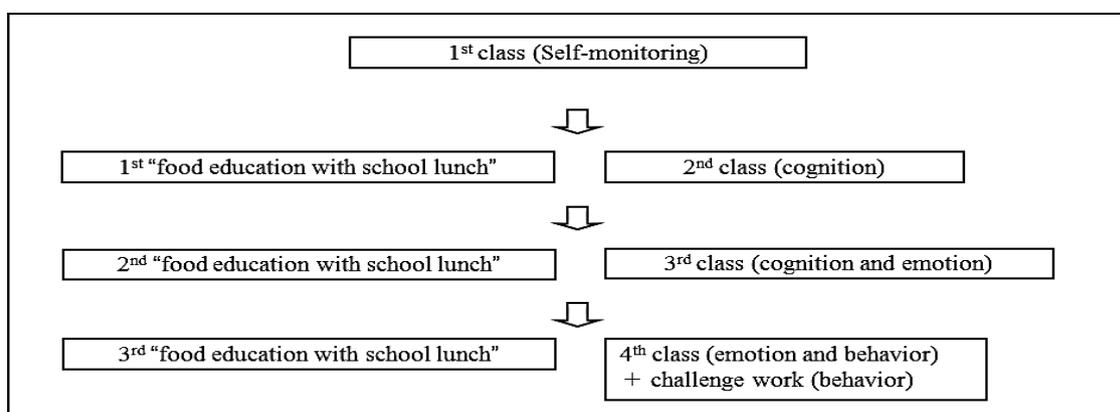


Figure 1 The flow of the nutrition education program

Table 2 Reliability of the educational impact evaluation questionnaire –Cronbach’s  $\alpha$ coefficient

|   | Overall   |
|---|-----------|
| Self-monitoring (before/after)                      | .62 / .58 |
| Cognition (before/after)                            | .34 / .52 |
| Emotion and behavior (before/after)                 | .73 / .84 |
| Health Locus of Control for children (before/after) | .71 / .79 |

### 2-3 Evaluation methods

As shown in Figure 1, the nutrition education program was implemented for 1 month starting on September 3, 2014. The implementation dates were September 3, 10, 17, and 24. The educational effects were measured before and after the implementation of the program. For evaluating the educational effects of the program, each student in the nutrition education program answered to a survey. We measured the level of increased understanding and improvement in three items of the goals: “self-monitoring,” “cognition,” and “emotion and behavior” as the index. Therefore, we used a scale prepared for each goal<sup>11)</sup>

In this study, we evaluated the educational impact on the class regarding the middle goals. This involved the students evaluating “how the whole class is changed,” and three items were set as follows; “whether everyone in the class understands what should be corrected in their dietary habits,” “whether everyone in the class understands that they can protect their own health,” and “whether everyone in the class can set up a goal and work toward improving their dietary habits.” The students were asked to answer these questions according to a five-point scale (1: not true at all to 5: very much true). In addition, the scale used in this study was the one for which content validity was confirmed in our previous study<sup>11)</sup>. For reliability, we confirmed the  $\alpha$  coefficient among the fourth-grade students. Although it was somewhat lower for “cognition” than that in the previous study (0.34–0.52), the other items were  $\geq 0.6$ , showing sufficient reliability (Table 2).

Furthermore, as the previous study, to evaluate an individual internal control of health, we used the scale from Health Locus of Control (HLC) for children, which measures internal control (internality and self-responsibility for the behavior, [i.e., the idea that solves health problems depends on the person’s own effort])<sup>12)</sup>. The reliability and validity of this scale have been shown to be high, and its clinical utility has also been confirmed<sup>13)</sup>. The high reliability were also confirmed by retest in this study (Table 2).

To examine whether improvement in each evaluation item through the implementation of the nutrition education program leads to behavior modification in dietary habits, as the previous study<sup>11)</sup>, we surveyed the condition of the students’ dietary habits using a self-administered questionnaire. Whether behavioral modification in dietary habits occurred was surveyed in a questionnaire on dietary habits consisting of eight items prepared as shown in Figure 2. Considering the eight questions regarding breakfast, sleep, snacks, and nighttime snacks, we asked students to retrospectively review the intakes over the past 5 days for “breakfast” and the past 4 days for “snacks” and “nighttime snacks.” For “sleep,” we asked the students to note their bedtime the night before and the time when they woke up on the day of the questionnaire. However, for the question “what do you do if there is food you do not like?” we used four-point scale (1 = I force myself to eat all the food, 2 = I try to eat at least some, 3 = I will not eat any, and 0 = I do not dislike any food). Furthermore, to determine intake habits for “soft drinks, etc.,” we asked, “how much do you take drinks each day?” To identify the extent of vegetable intake during breakfast, we asked: “please write down everything you ate for breakfast” (Figure 2).

|   | Questions   | day of the week  |                    |                     |                            |   |
|---|---|--|--------------------|---------------------|----------------------------|---|
| 1 | Did you eat breakfast? Please circle each day you had breakfast.  | M  | T                  | W                   | Th                         | F |
| 2 | Did you eat snacks? Please circle each day you had snacks.  | M  | T                  | W                   | Th                         | F |
| 3 | Did you have nighttime snacks (eating after dinner but before bedtime)? Please circle each day you had nighttime snacks.  | M  | T                  | W                   | Th                         | F |
| 4 | What time did you go to bed last night?   |  |                    |                     |                            |   |
| 5 | What time did you wake up this morning?   |  |                    |                     |                            |   |
|   |   | “Your current condition”   |                    |                     |                            |   |
|   |   | Please circle the condition that is closest to your current condition. |                    |                     |                            |   |
|   | Question  | I try to eat all the food.   | I try to eat some. | I will not eat any. | I do not dislike any food. |   |
| 6 | What do you do if there is food you do not like?  | 1  | 2                  | 3                   | 4                          |   |
| 7 | How many drinks other than green tea and milk do you drink each day?<br>(e.g., one bottle with 350 mL of juice).<br>*If you do not drink any other drinks, please state 0(zero).<br>( )   |  |                    |                     |                            |   |
| 8 | Please write down everything you ate this morning.<br>(e.g., rice, rice ball, toast, melon bread, sandwich, udon noodle, ramen, miso soup [with tofu, wakame, green onion, etc.], corn soup, ham and eggs, milk, orange juice, tomatoes, bananas, apples, etc.)<br>*If you did not eat breakfast, please write down “nothing.”<br>( ) |  |                    |                     |                            |   |

Figure 2 Questionnaire on dietary habits

Question items include: breakfast intake days / 5 days, snack ingestion days / 4 days, dinner intake days / 4 days, sleeping / getting up / sleeping time, responses when dislike comes out (the higher the score Good), intake other than tea and milk, how much intake of drinking water and the number of breakfast-items.

#### 2-4 Statistical analysis

PAWS Statistics ver.20 software was used for the statistical analyses (SPSS, Chicago, IL) . A  $p$  value  $< 0.05$  was considered statistically significant. Mainly, two-factor analyses of variance (period  $\times$  gender) were conducted.

### 3. Results

#### 3-1 Individual evaluation of educational impact before and after the implementation of the food education program

The scores for “individual evaluation” before and after the program implementation are shown in Figure 3A–C. The results of the two-factor analysis of variance (period × gender) are shown in Table 3.

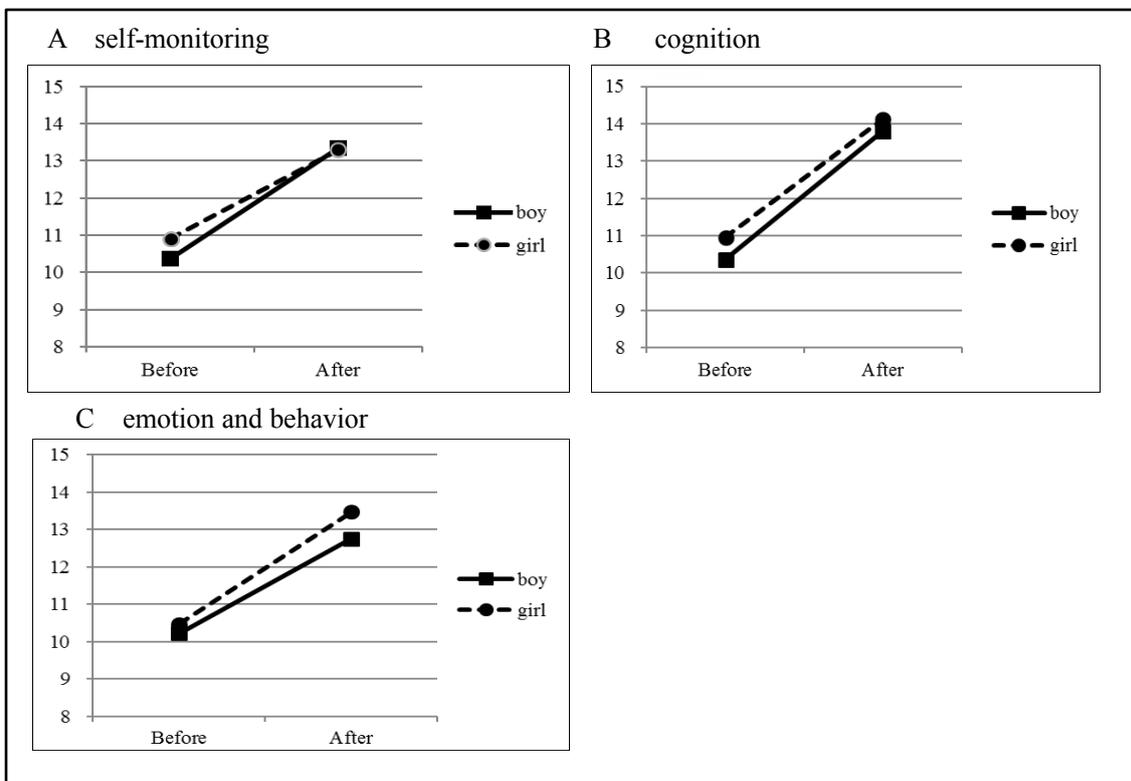


Figure 3 Individual evaluation before and after the program implementation

A, The mean score of “self-monitoring”. B, The mean score of “cognition”. C, The mean score of “emotion and behavior”. The individual score before and after in self-monitoring, cognitive, emotion and behavior were measured to evaluate the intervention effects in each item using the three questions with 5-point rating scale developed in the previous study<sup>11)</sup>.

Table 3 The results (*F* value) of the two-factor analysis of variance (period × gender) on the mean values of “self-monitoring,” “cognition,” and “emotion and behavior” before and after the program implementation

|                      | Main effect |          | Interaction   |
|----------------------|-------------|----------|---------------|
|                      | Gender      | Period   | Period×Gender |
| Self-monitoring      | .29         | 56.64**  | .69           |
| Cognition            | 1.13        | 131.63** | .22           |
| Emotion and behavior | .70         | 65.89**  | .48           |

\**p* < 0.05, \*\**p* < 0.01, *F* value is *df* = (1,57)

#### (1) Self-monitoring

Figure 3A presents the scores for “self-monitoring” before and after the implementation of the program. In both boys and girls students, scores increased after the implementation of the program. As shown in Table 3, the analysis of variance revealed the high mean value, showing the significant main effect in the “period” ( $F(1, 57) = 56.64, p < 0.01$ ). On the other hand, there

was no significant difference according to the interaction of “gender × period” and “gender”, indicating no difference in educational impact on gender.

## (2) Cognition

Figure 3B shows the scores for “cognition” before and after the implementation of the program. In both boys and girls students, the scores were increased after the implementation, indicating that there was a significant main effect for the “period” ( $F(1, 57) = 131.63, p < 0.01$ ) (Table 3). There was no significant difference according to the interaction of “gender × period” and “gender”, confirming that there was no difference regarding to gender.

## (3) Emotions and behavior

Figure 3C shows the scores for “emotions and behavior” increased after the implementation of the program. The analysis of variance shows that there was significant main effect for “period” ( $F(1, 57) = 65.89, p < 0.01$ ) (Table 3). There was no significant difference according to the interaction of “gender × period” and “gender”, confirming that there was no difference in educational impact according to gender.

### 3-2 Class evaluation

The scores of the “class evaluation” before and after the implementation of the program are shown in Figure 4A–C. The results of the two-factor analysis of variance (period × gender) are shown in Table 4.

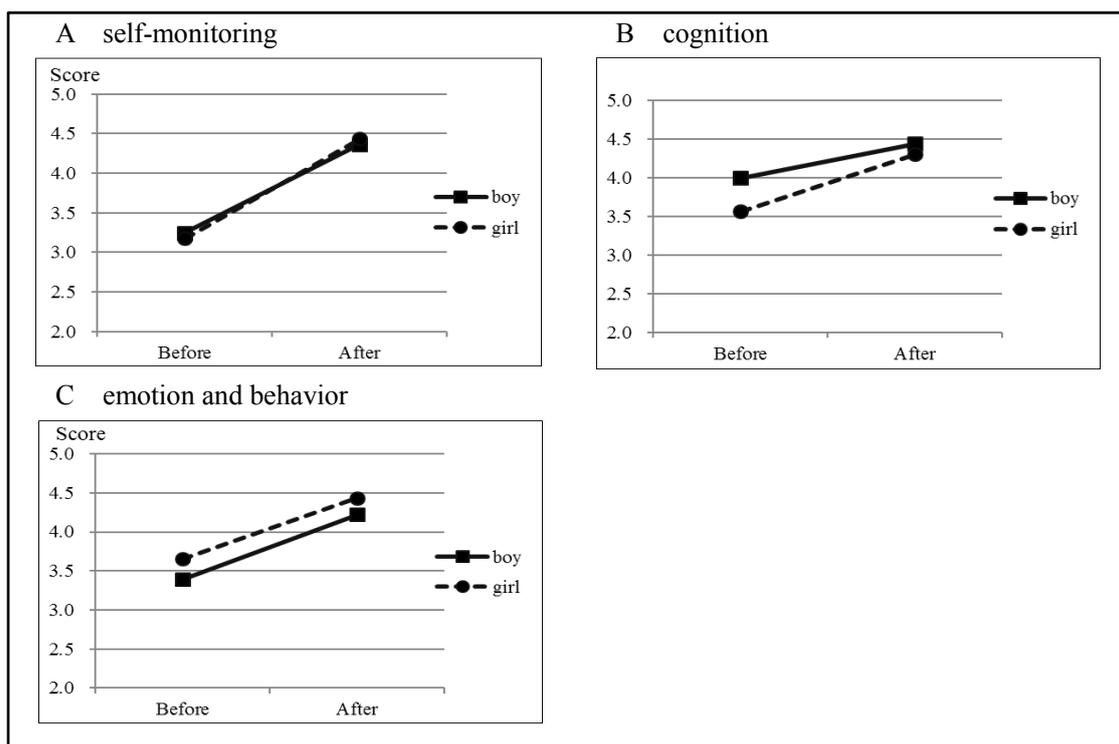


Figure 4 Class evaluation before and after the program implementation

A, The mean “class evaluation (self-monitoring)” score. B, The mean “class evaluation (cognition)” score. C, The mean “class evaluation (emotion and behavior)” score. The class score before and after in self-monitoring, cognitive, emotion and behavior were measured to evaluate the intervention effects in each item using one question with 5-point rating scale developed in the previous study<sup>11)</sup>.

Table 4 The results (*F* value) of the two-factor analysis of variance (period × gender) on the mean value of “class evaluation” before and after the program implementation

|                        | Main effect |         | Interaction   |
|------------------------|-------------|---------|---------------|
|                        | Gender      | Period  | Period×Gender |
| “Self-monitoring”      | .00         | 56.27** | .22           |
| “Cognition”            | 2.66        | 13.45** | .83           |
| “Emotion and behavior” | 1.20        | 32.18** | .03           |

\**p* < 0.05, \*\**p* < 0.01, *F* value is *df* = (1,57)

In both gender, the scores were increased after the program implementation. In the analysis of variance for all items (Table 4), “period” exhibited a significant “self-monitoring” with  $F(1, 57) = 56.27$ ,  $p < 0.01$ , “internal control of health (cognition)” with  $F(1, 57) = 13.45$ ,  $p < 0.01$ , and “internal control of health (emotions and behavior)” with  $F(1, 57) = 32.18$ ,  $p < 0.01$ .

These results indicated the impact of the there was no significant difference according to educational implementation on “period”, while the interaction of “gender × period” and “gender”.

This finding means that there is no difference in class educational impact according to gender.

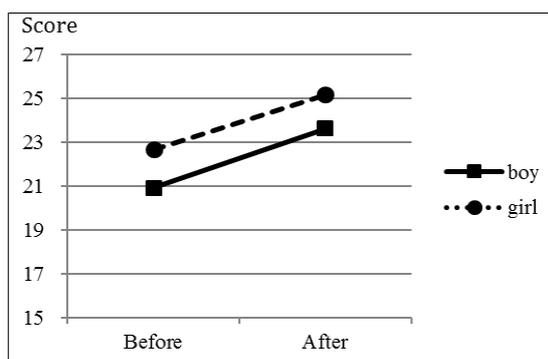


Figure5 Score of the “HLC for Children” before and after the program implementation

### 3-3 HLC for children

Figure 5 shows the mean score from the survey on the health control associated with cognition before and after the implementation. In both the boys and girls students, the scores increased after the program implementation. Furthermore, according to the results of the analysis of variance shown in Table 5, the significant main effect with “period” ( $F(1, 57) = 21.35$ ,  $p < 0.05$ ), demonstrating the educational impact of the intervention. However, there was no interaction between “gender × period” and “gender”, showing that there was no difference in the educational impact according to gender. Figure 5. Score of the “HLC for Children” before and after the program implementation. The score was measured as described in the section of methods.

Table 5 The results (*F* value) of the two-factor analysis of variance (period × gender) on the mean value of “Health Locus of Control for Children” before and after the program implementation

|                                      | Main effect |         | Interaction   |
|--------------------------------------|-------------|---------|---------------|
|                                      | Gender      | Period  | Period×Gender |
| Health Locus of Control for Children | 3.88        | 21.35** | .023          |

\**p* < 0.05, \*\**p* < 0.01, *F* value is *df* = (1,57)

### 3-4 Survey of dietary habits

Figures (6A to 6I) show the mean scores for boys and girls students for the dietary habit survey before and after the implementation of the education program.

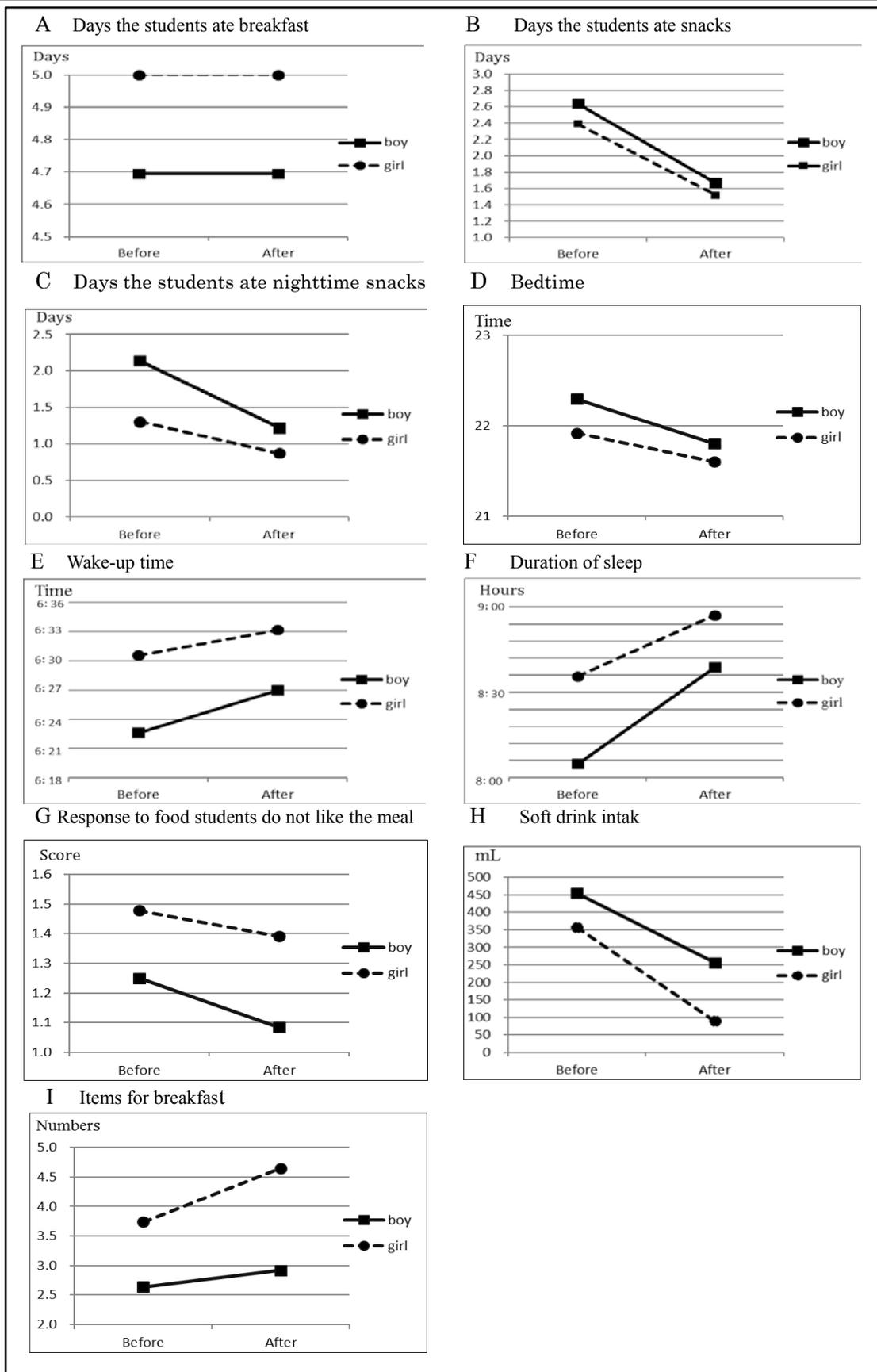


Figure 6 Changes in dietary habits associated with the program implementation

A, Number of days the students ate breakfast. B, Number of days the students ate snacks. C, Number of days the students ate nighttime snacks. D, Bedtime. E, Wake-up time. F, Duration of sleep. G, Response to food students do not like. H, Soft drink intake. I, Number of items for breakfast.

Both boys and girls students showed an improvement in dietary habits according to the scores of the following items: “breakfast,” “snacks,” “nighttime snacks,” “bedtime,” “duration of sleep,” “how to handle food they dislike,” “soft drink intake,” and “number of items for breakfast.” Specifically, the number of days when the students had “breakfast” exhibited a ceiling effect in both boys and girls students, with no change noted in the scores before and after the education program. The number of days when the students had “snacks” decreased after the education program for both boys and girls students. In addition, the number of days the students had a “nighttime snack” significantly decreased after the education program for boys students and girls students. “Bedtime” also improved for both the boys students and girls students. On the other hand, “wake-up time” did not substantially change in either the boys students or girls students. Since the bedtime is improved, the “duration of sleep” increased for both boys and girls students. “Response to food one dislikes” improved for both the boys and girls students so that foods they disliked were decreased. “Soft drink intake” significantly decreased for both the boys and girls students, and an improvement was confirmed regarding the amount of sugar intake other than the meals that had decreased. The “number of items for breakfast” increased for both the boys and girls students, resulting in the improvement of dietary balance. Table 6 presents the results of the analysis of variance.

For the items “number of days one had breakfast over 5 days,” “response to meals one dislikes,” and “wake-up time,” the significant main effect of “period” was observed. The results for “the number of days one had snacks over 4 days” ( $F(1, 57) = 22.32, p < 0.01$ ), “the number of days one had nighttime snacks over 4 days” ( $F(1, 57) = 7.52, p < 0.01$ ), “soft drink intake” ( $F(1, 57) = 14.79, p < 0.01$ ), “duration of sleep” ( $F(1, 57) = 9.47, p < 0.01$ ), and “the number of items for breakfast” ( $F(1, 57) = 4.07, p < 0.05$ ) indicated that these items had significantly increased the mean score after the nutrition education, indicating that the nutrition intervention promoted behavioral modification.

Table 6 Analytical results (F value) of the Dietary Survey score

|   | Main effect |         | Interaction   |
|---|-------------|---------|---------------|
|   | Gender      | Period  | Period×Gender |
| How many days did you have breakfast during the past 5 days?        | 7.75        | 0       | 0             |
| How many days did you have snacks during the past 4 days?           | 0.38        | 22.32** | 0.07          |
| How many days did you have nighttime snacks during the past 4 days? | 2.99        | 7.52**  | 0.96          |
| Number of items for breakfast                                       | 12.2**      | 4.07*   | 1.16          |
| The number of drinks  | 2.59        | 14.79** | 0.32          |
| What time did you go to bed last night?                             | 1.62        | 9.87*   | 0.49          |
| What time did you wake up this morning?                             | 0.21        | 0.37    | 0.02          |
| Duration of sleep   | 2.36        | 9.47*   | 0.49          |
| What do you do if you do not like the meal?                         | 2.38        | 3.06    | 0.3           |

\* $p < 0.05$ , \*\* $p < 0.01$ , F value is  $df = (1, 57)$

#### 4. Discussion

It is important for nutrition education and pedagogy in schools to incorporate behavioral science and encourage behavioral modification in students. In this study, we studied the efficacy of the nutrition education program to the fourth-grade students in elementary school. We analyzed the

educational impact of the nutrition education program on dietary habits by promoting behavioral modification.

#### 4-1 Effectiveness of the nutrition education program to prevent lifestyle diseases

For the middle-level goals such as “self-monitoring,” “cognition,” and “emotions and behavior,” all mean scores were improved in both boys and girls students with the main effect of the “period.” This finding indicates that with the implementation of the nutrition education program, elementary school students were educated to learn and understand their own dietary habits along with the relationship between health and dietary habits, leading to the perception that “one can protect one’s own health”, increasing the motivation to “protect one’s own health”, and in turn making students capable of self-controlling their dietary habits.”

#### 4-2 Class evaluation of the nutrition education program

For the class evaluation, the mean score increased for both the boys and girls students combined with the main effect of “period” for all items, confirming that the entire class was engaged with the lecture. The present nutrition education program involves group work-based lectures, with lecture content designed to take the full advantage of “peer support.” Therefore, there was a psychological effect of “even if one cannot do it on his or her own, if close friends are able to engage, he or she may be able to do it as well.”

#### 4-3 Educational impact that promotes the behavioral modification of dietary habits

In this study, for all dietary habit items, there was an improvement in the scores after the program implementation for both boys and girls students.

Firstly, a significant difference was recognized regarding the intake of “soft drinks” after the program implementation. Before the intervention, the mean for boys and girls students was 406 mL, which was nearly twice as high as the 2015 national mean<sup>14)</sup> ; however, it drastically decreased to 173 mL, which is below the national mean. In the nutrition education program used in this study, we let the children monitor their intake of “soft drinks” by themselves, and allow them to improve. This is one of the big problems to be improved in Tokushima prefecture since Tokushima prefecture reported the worst mortality rate caused by diabetes for 14 consecutive years from 1993 to 2006 and a high proportion of children with obesity tendency<sup>15)</sup>. While the N elementary school has been so far dealing with a substantial number of children with risk factors for obesity because of the large intake of soft drinks, there was no visible improvement. In this study, the remarkable educational impact was found by a measurable improvement. This finding made teachers at the N elementary school surprised including the principal, and clearly presented the advantage of this nutrition education program.

Secondly, it is important to note that there was an increase in “the number of items for breakfast” reported by the students. Both the boys and girls students presented a significant increase in the number of items they consumed at breakfast after the program implementation. The main possible factor attributed to this result was that the operational goal of the program. Because it prompted the students to find out factors for the poor dietary habits and then let the students understand how they can correct the problem on their own and change behavior to improve dietary habits including the “dietary balance”<sup>16)</sup>. Naturally, students cannot increase the number of items for breakfast by themselves, indicating that there was cooperation with other family members. Therefore, we assume that nutrition education in school involves families and a ripple effect of the nutrition education. Indeed, some students stated in the interview “My family is trying to make me a better breakfast now”. This comment indicates that the operational goal, “aim to improve the dietary habits with the support of the family” was achieved. In addition, a notable improvement was also observed in the item of “nighttime snack intake”. The number of “nighttime snack” was significantly decreased from 1.72 days to 1.05

days after the intervention. It was thought that improvement in this “nighttime snack intake” item led to an increase in the number of items for breakfast, creating a virtuous cycle.

Thirdly, for “snack intake,” the mean number of days for both the boys and girls students was 2.52 days before the intervention, however, it was significantly decreased to 1.60 days after the intervention. It was thought that letting students recognize the negative impact on “continuous eating snacks” with stories regarding bacteria found in tooth cavities was likely effective.

Fourthly, for lifestyle habits, the mean “bedtime” of the boys and girls students improved significantly from 22:12 to 21:42 after the intervention. The “duration of sleep” significantly improved from 8 hours and 20 min to 8 hours and 48 min after the intervention. This result suggested that the students learned the effects of sleep during the lecture and actively incorporated a better sleep schedule into their lives.

Fifthly, students in N elementary school have the higher ratio of children with obese, thereby the school nurses repeatedly led lifestyle instructions to guardians to date; however, there was no improvement.

Taken together, our nutrition education program modified a behavior in lifestyle habits, indicating that this nutrition education program had an educational impact.

#### 4-4 Educational effects by gender and grade differences

In this study, differences in educational effect were not observed between boys and girls, which is the same result as the previous study<sup>11)</sup>. Therefore, we concluded that nutrition education of the middle grade (3<sup>rd</sup> and 4<sup>th</sup>) in the elementary school could be dealt as a gender common program. In addition, we found that there were the statistical differences between before and after intervention in the behavioral modification of dietary habits such as “the intake of soft drinks”, “number of items for breakfast” “intake of snacks” “nighttime snacks” “bedtime” “duration of sleep”, whereas there was the differences in two dietary habits “intake of snacks” and the “wake-up time” in our previous study with third-grade students<sup>11)</sup>. This difference suggests that the nutrition education program is more effective for fourth-grade students. Kawasaki reported that the difference in one grade during childhood has an impact on the level of understanding and behavioral style associated with growth, by pointing out that classification capacity in diverse standard increases with the age in elementary school<sup>17)</sup>. Furthermore, Yuzawa reported that the simultaneous processing of different hierarchical concepts becomes possible in the fourth grade, indicating a possible involvement of developmental changes in the segmentation of hierarchical concepts and processing capacity<sup>18)</sup>. Since in this study, we found a difference in a one-grade age difference compared with our previous study. Therefore, it is suggested that this developmental difference must be considered for nutrition education and also suggested that nutrition education for a single grade in elementary school is not enough, but the continuation of nutrition education utilizing the development in cognitive ability and implementing sustainability appears to be more effective.

## 5. Conclusion

With the objective of optimizing and improving the dietary habits of school children, we implemented a nutrition education program with fourth-grade elementary school children according to the behavioral science theory from the perspective of cognition, emotion, and behavior, and evaluated the results. The educational impact of the middle level goals for the students, including “self-monitoring,” “cognition,” and “emotion and behavior” and the “HLC for children” were confirmed in both genders with no significant difference. Our results demonstrated that the implementation of this program resulted in improvement in the “internal control of health” (i.e., “protecting one’s own health”). The class evaluation also confirmed a similar educational impact. When the behavioral modification in dietary habits was established, it was recognized that educational impact involved

family members. Taken together, our nutrition education program was shown to be effective for optimizing and improving dietary habits. It is expected that this program will be applied to educational settings. Further studies are required for the nutrition education program to establish the appropriate number of interventions and the contents suitable for each grade, and the necessity of the continuity of nutrition education.

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# 小学校における食行動に対する食育の効果 —小学校4年生の分析—

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キーワード：行動変容，行動科学，健康増進，生活習慣病，食育

われわれは先行研究において，行動科学の理論に基づいた小学校中学年生向け栄養教育（食育）プログラムを開発した．本食育プログラムでは，食生活習慣を「セルフモニタリング」，「認知」，「感情・行動」の心理学的観点からとらえ，行動の自己責任，つまり人の健康問題の解決が自らの努力によることが大きいと考える内的統制力を向上させる内容とした．先行研究では，3年生において，開発した栄養教育プログラムを実施し，一部に効果が得られている．

本研究ではその食育プログラムの汎用性と課題を検討するために，徳島県の小学校4年生を対象に栄養教育を実施した．その結果，内的統制力(internality)を含めた全ての項目において，教育前後で有意差が認められた．さらに，食生活習慣調査においても，「おやつと夜食の摂取回数」，「嗜好飲料水の摂取量」，「朝食の品数」および「睡眠時間」に対して教育前後で有意差が確認された．以上から，本教育プログラムは，小学校4年生の食生活習慣の行動変容を促す教育効果があることが認められた．一方，どの項目においても性差(男女)は認められず，性別が教育結果に影響を及ぼしていないことがわかった．

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