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Original Article

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Effects of Multidisciplinary Health Promotion Program Among Children in Community Childcare Center

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ABSTRACT

In this study, the effects of a 12-month multidisciplinary education program on the health status, dietary quality, and eating habits of children and adolescents attending community childcare centers were investigated. A total of 88 participants aged 7 to 17 years from 7 community childcare centers in Gyeonggi-do were enrolled. The intervention consisted of 12 multidisciplinary education sessions covering topics such as nutrition, exercise, and psychological education. All participants received the same education, and the effectiveness of the program was evaluated by categorizing them into a high participation group (HPG) and a low participation group (LPG) based on their participation rates. After intervention, in physical activities, moderate-intensity exercise was significantly reduced in the LPG, and there was no significant difference in psychological parameters. However, notable differences were observed in nutritional data. After intervention, intakes of calorie, carbohydrate, protein, and fat were significantly increased in both groups, and in particular, the change was found to be greater in HPG. Additionally, dietary fiber intake compared to the 2015 Korean Dietary Reference Intakes was increased in both groups. Daily food intake also increased dietary fiber intake in HPG, and meat and fruit intake was increased in LPG. In the nutrition quotient, there was a significant difference in HPG's pre- and post-scores in the diversity category, and in nutrient adequacy ratio (NAR), the NAR of phosphorus was increased in both groups. The findings of this study suggest that multidisciplinary education implemented at community childcare centers primarily enhanced nutrition-related factors rather than physical activity or psychological aspects.

Trial Registration: Clinical Research Information Service Identifier: KCT0002718

Keywords: Community childcare center; Multidisciplinary education; Nutrition education; Exercise education; Psychology education

INTRODUCTION

Childhood and adolescence are one of the most critical periods of life in terms of physical and psychological development [1]. Therefore, adopting appropriate lifestyle habits and engaging

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Conflict of Interest
The authors declare that they have no competing interests.

Author Contributions
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in health promotion activities is crucial during this period to establish the foundation for adult health [2,3]. Adequate nutrition intake, physical activity, and emotional stability during this time can influence the development of dietary and lifestyle habits, as well as health promotion activities. Thus, it is particularly important for these aspects to be addressed appropriately and effectively [4,5]. Recently, there has been an increase in the number of children and adolescents from economically disadvantaged households, such as single-parent families and multicultural backgrounds, attending community childcare centers [6]. These centers provide various programs, including meals, education, and emotional support, to assist in the physical and psychological changes that can occur during childhood and adolescence [7]. While some nutrition programs are offered for children and adolescents using community childcare centers [8], it is often challenging for them to voluntarily choose or effectively implement these programs due to the specific circumstances of the centers [9]. Due to this realistic situation, it is difficult for community childcare centers to conduct mid- to long-term or the multidisciplinary education related to compliance was rare.

Children and adolescents, especially those from vulnerable households who utilize community childcare centers, are exposed to relatively disadvantaged environments. The issues of obesity, ongoing and inappropriate weight control, as well as psychological and emotional problems, have emerged, leading to a polarization of physical development among children and adolescents in Korea [10-12]. To assess the nutrition and health status of children and adolescents, various factors such as individual factors (personality, secondary sexual characteristics), family factors (family dietary habits, genetics), and social factors (socioeconomic environment, food production and supply, school meals, popular culture) are interrelated [13]. However, there is limited research on children and adolescents using local community childcare centers.

Furthermore, community childcare centers often have a limited focus on physical activity compared to home environments, resulting in a tendency for children to not meet the recommended guidelines for physical activity and sedentary behavior, ultimately impacting their overall health status [14,15]. Moreover, many children and adolescents using community childcare centers may experience low self-esteem, higher levels of depressive tendencies, low responsiveness, psychological anxiety resulting from social exclusion, and interaction with peers [16-20].

Currently, most studies conducted in community childcare centers regarding nutrition focus on the nutrition quotient (NQ) of children and adolescents utilizing these centers. Additionally, previous research on health promotion through physical activity has mainly targeted children from general households [14,21], resulting in a lack of research specifically on physical activity among children using community childcare centers [22,23]. Previous studies on children and adolescents utilizing community childcare centers have primarily concentrated on academic achievement or psycho-social development, with limited exploration of factors related to psychological characteristics, depression, anxiety, or distress [17,18,24,25].

The aim of this study was to conduct 12 months of multidisciplinary education in nutrition, exercise and psychology to children and adolescents in community childcare centers, and to assess improvements in overall health status based on education participation level.

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MATERIALS AND METHODS

Participant and study design

This study selected community childcare centers through official communication with the local government of Gyeonggi province. Participants were recruited from children and adolescents registered in the selected community childcare centers, and subjects were assigned to respective groups based on their desired participation in the centers. A total of 118 individuals aged between 7 and 17 years were recruited, and information regarding their general characteristics was obtained. For the analysis, a total of 88 participants who did not withdraw from the community childcare centers or refuse to participate in the education were included. This study aimed to conduct a 12-month health education program, including nutrition, exercise, and psychological education, to improve lifestyle habits among children and adolescents using community childcare centers in South Korea. The study received approval from the Institutional Review Board of Hallym University Sacred Heart Hospital (approval No.: 2016-I135). All participants and their parents or guardians were informed about the study and provided consent. Previous studies have used the median visit to categorize participants into high participation group (HPG) and low participation group (LPG). In this study, referring to a previous research, the median participation ratio was determined as 83% [26]. Participants with a participation ratio higher than the median value were classified into the HPG, while those with a lower rate were classified into the LPG.

Multidisciplinary education

Table 1 describes multidisciplinary education according to nutrition, exercise and psychology education for participants in this study. The multidisciplinary education of this study, including nutrition education, exercise education, psychology education once a month, consisted of 3 times per month. All education in this study was conducted by experts in each field and the 1-time education lasted from 40 minutes to 1 hour.

Nutrition education

Nutrition education aims at ultimately promoting health through acquiring concepts and knowledge about nutrition and education for the formation of correct eating habits. Nutrition education was carried out by nutrition experts. Nutrition education focused on education that can lead to a balanced diet of nutrients needed for growth. In 1st education, "I eat evenly," the subjects took the time to explore the 5 food groups and the importance of nutrient intake. In 2nd education, the nutritionist taught about the types and roles of proteins, and the importance of proteins and amino acid. The 3rd educational theme was "Vegetable every

Table 1. Composition of education program curriculum throughout the 12-month study

Education sessions	Educational theme		
	Nutrition	Exercise	Psychology
1	I eat evenly!	Growth stretching	Program/Self-/Mindfulness introduction listen to mindfulness
2	Healthy protein story	Following exercise	Listen to/Coloring/Collaborate with mindfulness
3	Vegetable every day	Who is stronger?	Mindfulness breathing
4	Adjusting meal by hand	Learning my muscles	Mindfulness stretching
5	Children's health guard: traffic light meal	Stretching with friends	Mindfulness eating introduction and exercise
6	Nutrition activity day	Outdoor activities	Body scan
7	Safe snacks, choose smartly: high calorie, low nutrition food	Get to know sports	Mindfulness walking
8	Water vs. drinks, my choice?	Learning our body	Mindfulness eating
9	Reduce sodium, raise health	Exercise quiz contest	Mindfulness gratitude and charity meditation
10	Fat!! Knowing and eating right	What is obesity?	Create a message to me and my family
11	Norovirus food poisoning, be careful!	Practice healthy exercise	Mindfulness breathing
12	Nutrition activity day	Should I walk? or run?	Mindfulness eating

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day." The goal of 3rd education was to get the 5 colors in the food. The 4th education was "Controlling the amount of food by hand" for the proper amount of food in all 5 food groups: cereals, proteins, vegetables, fruits, and oil. The 5th education was the theme of "Traffic light meal" for children's health keeper. Teaching about food additives that can adversely affect children's health, and nutritional labeling for choosing healthy foods. The 7th education, to identify high-calorie and low-fat foods, and select healthy snacks through nutrition labeling, taught about safe snacks and smart choices using high-calorie and low-nutrition foods. The 8th education was the subject of "Water vs. drinks, what is my choice?" The problem of excessive drinking in children and adolescents was identified and the correct method of drinking water was educated. The 9th education was conducted to improve health by ingesting it by taking the problem of excessive sodium intake. The 10th education was conducted to know and eat fat properly. The nutritionist identified the problems of trans-fat and saturated fat excess and taught them how to eat fat. The 11th education consisted of contents related to norovirus food poisoning. The nutritionists were trained on the characteristics of norovirus, prevention of norovirus food poisoning, and proper handwashing.

Exercise education

Exercise education established the concept of a healthy weight and taught the necessity of exercise and the importance of physical activity in daily life. Exercise education was carried out by exercise experts. Exercise education consisted of the following for each time this period: "Growth stretching," "Following exercise," "Who is stronger?," "Learning my muscles," "Stretching with friends," "Outdoor activities," "Get to know sports," "Learning our body," "Exercise quiz contest," "What is obesity?," "Practice healthy exercise," and "Should I walk? or run?" This education encouraged them to be interested in outdoor activities and games and put them into practice.

Psychology education

Psychology education, including self-esteem improvement education, was conducted to establish proper awareness of food ingredients and good eating habits. Psychology education was carried out by psychology experts. Psychology education consisted of the following for each time: "Program introduction," "Self-/Mindfulness introduction and listen to mindfulness," "Listen to/coloring/collaborate with mindfulness," "Mindfulness breathing," "Mindfulness stretching," "Mindfulness eating introduction and exercise," "Body scan," "Mindfulness walking," "Mindfulness eating," "Mindfulness gratitude and charity meditation," "Create a message to me and family," "Mindfulness breathing," and "Mindfulness eating." The education was organized into cooperative work and group activities that could lead to improved psychological stability and self-esteem (**Table 1**).

Assessment

General characteristics and anthropometrics measurement

In order to grasp the general characteristics of the participants, the name, age, date of birth, sex, grade of school, number of family members and monthly family income were investigated using the questionnaire, and the name was processed with initials. The subjects were measured anthropometrics to the nearest 0.1 kg or 0.1cm, all measurement data were gathered by trained researchers. The height was measured using a stadiometer (DS-103; Dong Sahn Jenix, Seoul, Korea), and the body weight (BW), body mass index (BMI) were measured using bioelectrical impedance analysis (BIA) (Inbody 720 Body composition Analyzer; BioSpace Co., Ltd., Seoul, Korea). Since maintaining a normal weight in childhood and adolescence can be seen as an improvement in overall health, weight status was analyzed using BMI z-score

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to analyze changes in the participants' weight status before and after the intervention. BMI z-score was calculated based on the LMS data for each boys and girls' monthly age provided by the Centers for Disease Control and Prevention and the BMI of the subjects in this study [27]. Weight status was classified into four categories based on the calculated BMI z-scores. BMI z-score of less than −2 was categorized as underweight, a BMI z-score greater than −2 but less than 1 was categorized as normal weight, a BMI z-score of 1 to less than 2 was categorized as overweight, and a BMI z-score of 2 or more was categorized as obesity.

Physical activity and psychological assessment

To evaluate the effects of exercise and psychological education, pre-education and post-education assessments were conducted among the participants. Valid questionnaires were used to assess physical activity, while reliable questionnaires were used for psychological factors, including the Children's Depression Inventory (CDI), self-esteem, and self-efficacy. Participants completed the surveys to assess changes in physical activity through exercise education. The physical activity factors assessed included high-intensity exercise time, moderate-intensity exercise time, and sedentary time. The high-intensity, moderate-intensity, and sedentary times were converted into minutes. Participants also completed questionnaires regarding psychological factors. The psychological factors assessed in this study included family functioning, CDI, self-esteem, and self-efficacy. Scores were assigned to family functioning, CDI, self-esteem, and self-efficacy.

Nutrition assessment

Participants and their parents or guardians were taught how to record a 24-hour diet diary by trained nutritionists. All participants were provided with a booklet to freely record their diet diary for a total of 3 days (2 weekdays and 1 weekend day). Skilled nutritionists utilized measurements and weights from the food exchange table provided by the Korean Diabetes Association to convert and assess the food weights recorded in participants' food diaries. The foods consumed by subjects were categorized into groups, including the grain group, fish/meat group, vegetable group, fruit group, and fat group. Food portions were estimated using small rice bowls, plates with a diameter of 16.5 cm, 200 mL cups, and baseballs. The dietary intake data obtained from the participants were analyzed using CAN-pro ver. 5.0 (Computer Aided Nutritional Analysis Program, 2016; Korean Nutrition Society, Seoul, Korea). The analysis results were compared with the Recommended Intake (RI) or Adequate Intake (AI) values and expressed as percentages based on the 2015 Korean Dietary Reference Intakes (2015 KDRIs) (published in 2016, Korean Nutrition Society). Additionally, a survey was conducted to investigate the average daily intake of food groups consumed by the participants. Baseline and 12-month follow-up surveys were conducted to assess habitual dietary patterns and recent dietary habits. The overall quality of food and dietary habits was evaluated using the NQ (published in 2012, Korean Nutrition Society), which comprehensively measures the dietary quality and habits of Korean children. The 19 items of the NQ were classified into five factors: balance, variety, moderation, regularity, and practice, based on grouping similar types of questions. Lastly, to evaluate the adequacy of nutrient intake, the nutrient adequacy ratio (NAR) was calculated for nine nutrients, including protein, vitamin A, thiamin, riboflavin, niacin, vitamin C, calcium, phosphorus, and iron. NAR was calculated as the ratio of individual nutrient intake to the recommended nutrient intake, and values equal to or greater than 1 were considered adequate. Mean adequacy ratio (MAR) was used to evaluate the overall dietary quality.

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Statistical Analysis

The statistical software used for this study was SPSS ver. 23 (IBM Corp., Armonk, NY, USA). The significance level was set at $p < 0.05$. Significant differences between groups were analyzed using the chi-square test for categorical variables and the Student's t-test for continuous variables. Significant differences before and after intervention were analyzed by paired t-test. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as number (%). Also, we used general linear model to analyze the results of the difference in change in physical activity, psychological and nutrition factors by between 2 groups after adjusting for age and sex.

RESULTS

Baseline characteristics by education participation level

In this study, a total of 88 children and adolescents were included in the analysis, with 45 participants in the HPG and 43 participants in the LPG. The general characteristics of the participants were examined (**Table 2**). The mean age of the HPG was 9.53 years, with 40.0% male and 60.0% female participants. The mean age of the LPG was 10.76 years, with 34.9% male and 65.1% female participants. There was a significant difference in age between the 2 groups ($p < 0.01$). The majority of participants in both groups had 4–5 family members, and the monthly household income was mostly less than 4 million won. There were no significant differences in sex, family size, and monthly household income between the 2 groups.

Comparison of weight status by education participation level

In the HPG, the percentage of normal weight was 64.4% compared to 62.2%, and the percentage of obesity was 13.3% compared to 15.6%. However, in the LPG, the obesity rates at baseline and after 12 months remained the same, with underweight at 2.3%,

Table 2. General characteristics of subjects according to education participation level at baseline

Variables	All (n = 88)	HPG (n = 45)	LPG (n = 43)	p*
Age (yr)	10.13 ± 2.16	9.53 ± 1.84	10.76 ± 2.30	**0.007**
Sex				0.620
Boys	33 (37.5)	18 (40.0)	15 (34.9)	
Girls	55 (62.5)	27 (60.0)	28 (65.1)	
Number of family members				0.393
≤ 3	16 (18.2)	10 (22.2)	6 (13.9)	
4–5	40 (45.4)	22 (48.9)	18 (41.9)	
≥ 6	10 (11.4)	5 (11.1)	5 (11.6)	
No response	22 (25.0)	8 (17.8)	14 (32.6)	
Monthly family income (₩)				0.911
≤ 2,000,000	28 (31.8)	14 (31.1)	14 (32.6)	
> 2,000,000 and ≤ 4,000,000	30 (34.1)	17 (37.8)	13 (30.2)	
> 4,000,000 and ≤ 6,000,000	8 (9.1)	4 (8.9)	4 (9.3)	
> 6,000,000	0 (0.0)	0 (0.0)	0 (0.0)	
No response	22 (25.0)	10 (22.2)	12 (27.9)	
Weight status				0.750
Underweight	1 (1.1)	0 (0.0)	1 (2.3)	
Normal weight	56 (63.7)	28 (62.2)	28 (65.1)	
Overweight	20 (22.7)	10 (22.2)	10 (23.3)	
Obesity	11 (12.5)	7 (15.6)	4 (9.3)	

Values are presented as number (%) or mean ± standard deviation. Participation rate for a total of 12 sessions: HPG ≥ 83%; LPG < 83%. Weight status was classified into four categories based on the calculated BMI z-scores: underweight < –2; –2 ≤ normal weight < 1; 1 ≤ overweight < 2; obesity ≥ 2.
HPG, high participation group; LPG, low participation group.
*Significant difference between the groups by Student's t-test at $p < 0.05$ (bold-face).

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Table 3. Comparison of physical activities and psychology difference between the baseline and after 12-month by education participation level

Variables	All (n = 88)		HPG (n = 45)		LPG (n = 43)		p‡
	Pre-	Post-	Pre-	Post-	Pre-	Post-	
Physical activities							
High strength (min/day)	32.97 ± 51.30†	22.11 ± 43.10	19.24 ± 31.58	16.89 ± 33.70	47.33 ± 63.19†	27.58 ± 50.97	0.323
Moderate strength (min/day)	35.17 ± 96.74	14.10 ± 26.57*	30.07 ± 107.75	11.93 ± 25.23	40.51 ± 84.66	16.37 ± 28.01*	0.198
Sedentary time (min/day)	268.45 ± 264.75	305.67 ± 250.82	231.33 ± 262.77	267.56 ± 214.14	307.30 ± 264.27	345.56 ± 281.22	0.459
Total MET score (points)	3,005.36 ± 4,874.14	2,462.30 ± 3,604.78	2,020.36 ± 3,563.75	1,948.80 ± 3,090.05	4,036.19 ± 5,811.95	2,999.67 ± 4,041.76	0.355
Psychology							
Family function	6.84 ± 2.75	7.05 ± 3.37	6.96 ± 2.69	6.56 ± 3.56	6.72 ± 2.84	7.56 ± 3.13	0.449
CDI	11.58 ± 7.24	9.36 ± 8.37*	12.00 ± 6.74	8.51 ± 8.46	11.14 ± 7.78	10.26 ± 8.38	0.185
Self-esteem	25.23 ± 7.82	26.30 ± 9.99	25.49 ± 6.81	26.29 ± 11.02	24.95 ± 8.82	26.30 ± 8.92	0.874
Self-efficacy	39.82 ± 12.24	41.14 ± 16.08	41.56 ± 11.50	39.71 ± 17.85	38.00 ± 12.85	42.63 ± 14.04	0.450

Values are presented as mean ± standard deviation. Participation rate for a total of 12 sessions: HPG ≥ 83%; LPG < 83%.
HPG, high participation group; LPG, low participation group; MET, metabolic equivalent of task; CDI, Children's Depression Inventory.
*Significant difference between the times by paired t-test at $p < 0.05$.
†Significant difference between the times by Student's t-test at $p < 0.05$.
‡p value presented as pre- and post- comparison of the amount of change between 2 groups adjusted age and sex by general linear model.

normal weight at 65.1%, overweight at 23.3%, and obesity at 9.3%. However, there were no significant differences between baseline and post-data (**Table 2**).

Comparison of physical activity and psychological factors by education participation level

Comparing the differences in physical activity and psychological factors between baseline and after 12 months according to education participation level provides insights into the changes in physical activity and psychological well-being (**Table 3**). In the HPG, there were no differences observed between groups, and there were no significant changes noted in any of the physical activity factors between baseline and post-data. On the other hand, moderate-intensity exercise significantly decreased from 40.51 ± 84.66 min/day to 16.37 ± 28.01 min/day in the LPG ($p < 0.05$). In terms of psychological factors, there were no significant differences between groups and no significant differences baseline and post-data. Also, a general linear model used to compare the amount of change before and after in physical and psychological factors in the two groups. We adjusted for age and sex, which may affect the results. The results showed no significant differences between the data of the 2 groups.

Comparison of total energy and macronutrient intake, ratios to 2015 KDRIs, and daily food group consumption by education participation level

Table 4 compares the total energy and macronutrient intake, ratios to the 2015 KDRIs, and daily food group consumption for nutrient analysis. Energy (kcal) significantly increased in both groups, with the HPG increasing from 1,523.54 ± 480.76 kcal to 1,834.95 ± 652.82 kcal, and the LPG increasing from 1,328.74 ± 395.22 kcal to 1,594.50 ± 436.60 kcal ($p < 0.05$). Energy (%) increased significantly in the HPG from 83.41% ± 25.15% to 94.09% ± 30.52% ($p < 0.05$). Dietary fiber (%) increased significantly in both groups, with the HPG increasing from 66.04% ± 30.46% to 76.32% ± 20.68%, and the LPG increasing from 58.55% ± 24.16% to 72.14% ± 28.46% ($p < 0.05$). Daily average food intake increased in the LPG from 975.90 ± 300.33 g to 1,176.93 ± 344.15 g ($p < 0.05$). Especially, Vegetable consumption increased in HPG from 136.68 ± 67.39 g to 178.94 ± 84.80 g ($p < 0.05$). After adjusting for age and gender by using a general linear model, the amount of changes in total energy and macronutrient intake was significantly greater in HPG compared to LPG. In comparison to the 2015 KDRIs, after adjustment, the amount of changes in protein (%) and sodium (%) in HPG were significantly greater than those in LPG. Meanwhile, in the LPG group, the amount of changes

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Table 4. Comparison of total energy and macronutrient intake, ratios compared to 2015 KDRIs, and daily food group consumption between baseline and after 12-month by education participation level

Variables	All (n = 88)		HPG (n = 45)		LPG (n = 43)		p‡
	Pre-	Post-	Pre-	Post-	Pre-	Post-	
Total energy and macronutrient intake							
Energy (kcal)	1,428.87 ± 449.43†	1,717.46 ± 567.60*†	1,523.54 ± 480.76	1,834.95 ± 652.82*	1,328.74 ± 395.22†	1,594.50 ± 436.60*†	**0.000**
Carbohydrate (g)	215.30 ± 67.72†	247.48 ± 72.99*†	230.42 ± 72.05	263.97 ± 75.76*	199.48 ± 59.68†	230.21 ± 66.53*†	**0.000**
Protein (g)	49.67 ± 16.61	61.37 ± 25.33*	52.82 ± 17.59	64.69 ± 28.36*	46.37 ± 15.02	57.90 ± 21.50*	**0.001**
Fat (g)	39.49 ± 15.62	53.30 ± 28.31*	42.44 ± 17.15	57.30 ± 31.85*	37.02 ± 13.48	49.12 ± 23.70*	**0.000**
C:P:F ratio	61:14:25	59:14:27	61:14:25	59:14:27	60:14:26	59:14:27	
Compared to 2015 KDRIs							
Energy (%)	77.28 ± 25.42†	85.95 ± 28.28*†	83.41 ± 25.15	94.08 ± 30.52*	70.86 ± 24.36†	77.43 ± 23.14†	**0.000**
Protein (%)§	13.88 ± 1.66†	14.15 ± 2.50†	147.32 ± 47.99	156.64 ± 66.48	120.42 ± 53.90†	127.81 ± 54.24†	**0.009**
Dietary fiber (%)‖	62.38 ± 27.67	74.27 ± 24.73*	66.04 ± 30.46	76.32 ± 20.68*	58.55 ± 24.16	72.14 ± 28.46*	**0.011**
Vitamin C (%)§	95.56 ± 174.53†	88.37 ± 69.56	128.36 ± 238.29	82.66 ± 53.71	61.23 ± 35.40	94.35 ± 83.25*	0.114
Vitamin D (%)‖	22.42 ± 29.99	27.01 ± 29.21†	25.94 ± 33.56	32.39 ± 30.99	18.74 ± 25.62	21.38 ± 26.41	0.145
Vitamin E (%)‖	33.30 ± 26.11	38.56 ± 22.90†	36.99 ± 31.35	43.39 ± 23.80	29.44 ± 18.77	33.50 ± 21.02†	0.053
Folic acid (%)§	21.88 ± 25.41†	26.57 ± 14.42†	27.70 ± 32.96	30.42 ± 14.96	15.80 ± 11.18†	22.53 ± 12.80*†	**0.005**
Zinc (%)§	64.47 ± 35.23	58.97 ± 31.06	70.20 ± 33.81	63.76 ± 30.83	58.47 ± 36.07	53.95 ± 30.86	0.118
Calcium (%)§	45.08 ± 22.03	45.47 ± 23.16	47.58 ± 24.60	47.52 ± 22.47	42.45 ± 18.92	43.32 ± 23.94	0.595
Sodium (%)‖	185.68 ± 66.94	191.40 ± 61.74†	196.52 ± 66.72	209.37 ± 59.35	174.33 ± 66.05	172.58 ± 59.13†	**0.016**
Daily food intakes (g)	1,075.71 ± 442.04†	1,195.87 ± 340.82*	1,171.09 ± 530.30	1,213.98 ± 340.50	975.90 ± 300.33†	1,176.93 ± 344.15*	**0.022**
Grains (g)	278.03 ± 117.49†	283.72 ± 102.80†	307.46 ± 118.29	309.01 ± 101.89	247.24 ± 109.71†	257.26 ± 98.05†	**0.008**
Meats (g)	98.81 ± 58.03	119.16 ± 93.01*	109.91 ± 65.28	120.74 ± 100.52	87.40 ± 47.40	117.52 ± 85.62*	0.184
Vegetables (g)	141.66 ± 69.88	171.28 ± 80.65*	136.68 ± 67.39	178.94 ± 84.80*	146.87 ± 72.83	163.26 ± 76.24	**0.047**
Fruits (g)	139.82 ± 298.91	171.11 ± 153.05	178.63 ± 402.43	150.51 ± 153.47	99.20 ± 110.07	192.67 ± 151.38*	0.271
Milk and dairy (g)	149.49 ± 143.64	149.06 ± 155.92	153.04 ± 155.23	154.63 ± 165.83	145.78 ± 132.17	143.22 ± 146.57	0.981

Values are presented as mean ± standard deviation. Participation rate for a total of 12 sessions: HPG ≥ 83%; LPG < 83%.
KDRIs, Korean Dietary Reference Intakes; HPG, high participation group; LPG, low participation group; C:P:F ratio, ratio of carbohydrates, proteins, and fats to total calories; RNI, Recommended Nutrient Intake; AI, Adequate Intake.
*Significant difference between the times by paired t-test at $p < 0.05$.
†Significant difference between the times by Student's t-test at $p < 0.05$.
‡Significant difference for pre- and post- comparison of the amount of change between 2 groups adjusted age and sex by general linear model at $p < 0.05$ (boldface).
§Ratio of RNI to actual intake; RNI is an intake estimate that meets 97%–98% of the nutrient requirements of a healthy population.
‖Ratio of AI to actual intake; AI is used when accurate data on nutrient requirements are lacking or the RNI amount cannot be calculated.

in energy (%), dietary fiber (%), and folic acid (%) were significantly greater than those in HPG. In daily food intakes, LPG showed a significantly greater amount of changes in total food intake and grains, while HPG exhibited a significantly greater in vegetable intake.

Comparison of diet quality and diversity by education participation level

Table 5 shows the changes in diet quality and diversity assessed by NQ scores, NAR, and MAR. Diversity factors shows a significant increase from 63.64 ± 22.37 to 69.91 ± 19.24 in the HPG ($p < 0.05$). NAR results were examined for protein, vitamin A, thiamin, riboflavin, niacin, vitamin C, calcium, phosphorus, and iron. NAR of phosphorus increased from 0.84 ± 0.20 to 0.96 in the HPG ($p < 0.05$), and, in the LPG, it increased from 0.76 ± 0.26 to 0.93 ± 0.14 ($p < 0.05$). There were no significant differences between baseline and post-data in terms of MAR. As a result of analysis by adjusting for age and sex using a general linear model, the amount changes in NAR of protein, thiamin, niacin, phosphorus, and iron increased significantly greater in HPG than LPG. However, In the case of riboflavin, HPG increased significantly greater than LPG.

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Table 5. Comparison of NQ score, NAR, and MAR changes between baseline and after 12-month by education participation level

Variables	All (n = 88)		HPG (n = 45)		LPG (n = 43)		p‡
	Pre-	Post-	Pre-	Post-	Pre-	Post-	
Total NQ score	60.72 ± 12.31	61.64 ± 10.08	60.37 ± 13.07	62.46 ± 9.25	61.09 ± 11.61	60.79 ± 10.93	0.835
Balance	52.11 ± 18.76	52.08 ± 20.37	54.49 ± 18.67	54.21 ± 17.56	49.62 ± 18.75	49.85 ± 22.95	0.486
Diversity	66.20 ± 23.03	71.06 ± 18.40*	63.64 ± 22.37	69.91 ± 19.24*	68.89 ± 23.67	72.26 ± 17.62	0.260
Moderation	64.10 ± 21.48	64.74 ± 18.94	62.26 ± 23.01	62.41 ± 17.58	66.03 ± 19.83	67.18 ± 20.18	0.567
Regularity	68.44 ± 24.62	66.42 ± 21.09†	69.66 ± 26.46	71.69 ± 18.22	67.17 ± 22.79	60.90 ± 22.64†	0.139
Practice	52.76 ± 21.14	53.92 ± 18.22	51.82 ± 22.72	54.08 ± 18.17	53.73 ± 19.57	53.74 ± 18.48	0.948
NAR							
Protein	0.93 ± 0.15†	0.95 ± 0.12	0.98 ± 0.06	0.97 ± 0.11	0.89 ± 0.19†	0.93 ± 0.13	**0.005**
Vitamin A	0.73 ± 0.25	0.78 ± 0.23†	0.76 ± 0.22	0.83 ± 0.20	0.70 ± 0.27	0.72 ± 0.25†	0.056
Thiamin	0.97 ± 0.10	0.99 ± 0.06	0.98 ± 0.07	1.00 ± 0.01	0.95 ± 0.13	0.97 ± 0.09	**0.036**
Riboflavin	0.87 ± 0.19†	0.85 ± 0.19†	0.92 ± 0.15	0.90 ± 0.17	0.81 ± 0.22†	0.80 ± 0.21†	**0.003**
Niacin	0.73 ± 0.25†	0.76 ± 0.23†	0.79 ± 0.21	0.82 ± 0.21	0.68 ± 0.28†	0.71 ± 0.23†	**0.018**
Vitamin C	0.65 ± 0.30†	0.65 ± 0.31	0.71 ± 0.30	0.67 ± 0.29	0.58 ± 0.29†	0.64 ± 0.33	0.197
Calcium	0.50 ± 0.24	0.53 ± 0.28	0.51 ± 0.25	0.56 ± 0.27	0.49 ± 0.22	0.50 ± 0.28	0.598
Phosphorus	0.80 ± 0.24	0.95 ± 0.13*	0.84 ± 0.20	0.96 ± 0.11*	0.76 ± 0.26	0.93 ± 0.14*	**0.000**
Iron	0.85 ± 0.20†	0.87 ± 0.19†	0.90 ± 0.16	0.93 ± 0.14	0.79 ± 0.23†	0.81 ± 0.22†	**0.002**
MAR	0.78 ± 0.16†	0.82 ± 0.13†	0.82 ± 0.12	0.85 ± 0.10	0.74 ± 0.18†	0.78 ± 0.14†	**0.001**

Values are presented as mean ± standard deviation. Participation rate for a total of 12 sessions: HPG ≥ 83%; LPG < 83%.
NQ, nutrition quotient; NAR, nutrition adequacy ratio; MAR, the mean adequacy ratio; HPG, high participation group; LPG, low participation group.
*Significant difference between the times by paired t-test at $p < 0.05$.
†Significant difference between the groups by Student's t-test a $p < 0.05$.
‡Significant difference for pre- and post- comparison of the amount of change between 2 groups adjusted age and sex by general linear model at $p < 0.05$ (bold-face).

DISCUSSION

This study aimed to examine the impact of a 12-month multidisciplinary education program on the health of children and adolescents utilizing community childcare centers, with a specific focus on the participation rate. Previous studies have demonstrated the therapeutic effects of education participation for various conditions such as hypertension, diabetes, osteoporosis, and obesity. However, there is a lack of research specifically investigating the suitability of education for children and adolescents, as well as verifying their participation and compliance in community childcare centers. Therefore, this study provided multidisciplinary education in nutrition, exercise, and psychological education to participants from community childcare centers. Based on a median participation rate of 83%, the participants were classified into HPG and LPG.

In a previous study involving children and adolescents from community childcare centers, energy consumption was reported to be 1,567 kcal [28]. However, in this study, the participants' pre-training energy intake was found to be lower at baseline, indicating an overall nutrient-poor diet. Following the training program, there was a greater improvement in energy intake compared to previous studies [28].

Regardless of the participation rate group, both groups experienced a decrease in exercise time and an increase in sedentary time after the exercise education, which aligns with findings from previous studies [29]. Notably, the LPG exhibited a significant decrease in the duration of moderate-intensity exercise. This decline may be attributed to the lack of interest in physical activities at home among children and adolescents utilizing community childcare centers [14]. Regarding psychological factors, there was no statistically significant change between both 2 groups.

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Baseline data indicated that the overall nutrient intake and dietary adequacy of the HPG were higher than those of the LPG. This difference may be attributed to the HPG's existing interest in nutrition and their strong motivation to practice healthy nutritional behaviors. On the other hand, baseline data revealed higher durations of high-intensity exercise in the LPG compared to the HPG. Psychological factors did not show significant changes regardless of the group, potentially because there is minimal difference between home and school environments in terms of psychological aspects. Furthermore, significant differences were observed before and after education based on the participation rate. Children and adolescents utilizing community childcare centers tend to have significantly lower nutritional status in terms of calories, protein, fat, calcium, vitamin A, and thiamine [30]. However, many of these nutritional factors showed improvements or positive changes after the education program, regardless of the group. The findings suggest that both the LPG and HPGs made efforts to acquire and implement basic nutritional knowledge through education.

Children from low-income families face challenges in accessing support for physical activities, such as participating in physical education classes and after-school sports activities. Factors such as dual income, absence of guardians, lack of safe living environments, limited availability of nearby sports facilities or programs, and increased sedentary behaviors act as barriers to the establishment of exercise habits [29,31]. Compared to the lifestyle patterns of children and adolescents in other countries, Korean children and adolescents have longer learning hours and less time allocated to exercise [32]. Previous studies have shown that Korean children and adolescents spend an average of 8.9 hours per day in sedentary activities [33], although the sitting time in this study was slightly lower. It is recommended that community childcare centers organize and implement diverse physical activity programs to enhance the level of physical activity among children and adolescents. Additionally, they should work on establishing partnerships with local governments to secure appropriate spaces for such activities.

Previous research has demonstrated that children and adolescents utilizing community childcare centers have higher self-esteem compared to those who do not [34]. In this study, self-esteem was higher in both groups compared to previous studies. However, in low-income families, parents spend a significant amount of time working, resulting in shorter conversations and limited supervision with their children/adolescents, which may contribute to a decrease in their self-esteem [35].

In a previous study [36] conducted on the NQ of elementary school students in certain regions of Gyeonggi-do, the scores for balance, diversity, moderation, regularity, and practice were reported as 55.63, 71.48, 67.28, 59.36, and 61.68, respectively. However, in this study, both groups showed lower scores for most NQ items compared to the previous study. Considering the characteristics of children and adolescents utilizing community childcare centers who may lack education regarding eating habits in their daily lives, it is deemed that promoting healthy eating habits is more important than merely attempting to improve and establish eating habits.

In a previous study [37] targeting infants and toddlers in community childcare centers, the NAR for protein, vitamin A, and phosphorus was reported to be 0.95 or higher, while calcium had an NAR of 0.84, iron 0.85, and the MAR was 0.92. However, in this study focusing on children and adolescents utilizing community childcare centers, the intake of vitamin A was lower, iron content was slightly higher, and calcium intake was significantly lower compared to previous studies. Calcium is a crucial nutrient for bone and tooth formation, especially

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during growth and development [38]. However, in this study, the calcium intake did not reach the recommended levels in both groups, indicating a very low intake. A previous study investigating the intake patterns of adolescents aged 13 to 19 years found that approximately 21.3% of individuals did not consume the minimum reference amount for milk and dairy products and fruits [39]. However, both groups in this study exhibited a 10% higher consumption of milk and dairy products compared to the previous study.

Furthermore, this study demonstrated a significant increase in the NAR for phosphorus approaching 1. Phosphorus plays a role in increasing the proportion of calcium in the body's skeleton, which impacts bone mineralization [40]. However, excessive phosphorus intake can hinder calcium absorption, potentially affecting the growth of children and adolescents. Given the recent increase in phosphorus intake [41], children and adolescents should limit their consumption of processed foods. Food sources of phosphorus include meat, fish, eggs, milk, as well as nuts, grains, vegetables, and tofu. In this study, the reason for the NAR approaching 1 for phosphorus seems to be an increase in the consumption of food groups such as grains, meat, vegetables, and milk and dairy products, rather than processed foods.

Additionally, sodium is a mineral necessary for maintaining the body's homeostasis, regulating osmotic pressure, neurotransmitters, and muscle contraction. Unlike other nutrients, only a minimal amount of sodium is required. However, in this study, sodium intake in the HPG was more than twice as high. Prolonged intake of excessive sodium can lead to high blood pressure and cardiovascular diseases, highlighting the importance of consuming an appropriate amount of sodium [42]. Calcium deficiency and excessive sodium intake can negatively impact growth due to increased calcium excretion from the body [38]. Therefore, continuous nutrition education at community childcare centers is crucial, and childcare teachers should also receive periodic training on promoting calcium intake and reducing phosphorus and sodium intake. Through such measures, it is deemed necessary to provide systematic education considering individualized needs for children and adolescents utilizing community childcare centers.

This study has several limitations. Firstly, it is challenging to generalize the results as it involved only community childcare centers in specific areas of Gyeonggi-do, and the total number of training sessions was relatively small, despite achieving a participation rate of 83% (more than 10 out of 12 sessions). Secondly, the education provided in this study was not tailored based on age, gender, or obesity rate. An individualized approach considering the physical, cognitive, and emotional development differences among participants is necessary [13]. However, participating in group activities within a shared space like a local children's center can have a synchronizing effect, particularly for obese children and adolescents. Therefore, the education activities were designed to include interactive elements and encourage individual questions, regardless of age, sex, or obesity rate. Thirdly, there was no control group in this study. Comparison was made between the 2 groups based on the participation rate, but without a control group, it is challenging to generalize the effects of the multidisciplinary education.

Despite these limitations, this study offered multidisciplinary education for children and adolescents utilizing community childcare centers in the medium to long term. The findings are expected to contribute to improving and maintaining body composition, food quality, and eating habits among children and adolescents attending community childcare centers. It can also serve as a program for promoting health management and healthy lifestyles in the increasing number of community childcare centers.

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In future research, considering the limitations of this study that focused on community childcare centers in specific regions, it is recommended to conduct multidisciplinary education for children and adolescents utilizing community childcare centers across various locations. Additionally, the development of supplementary programs is deemed necessary.

In conclusion, this study provided multidisciplinary education, including nutrition, exercise, and psychological education, and observed significant improvements in nutrition-related factors after the education program. Particularly in terms of nutrition, the HPG at baseline showed significantly higher food intake, intake rate compared to the 2015 KDRIs, NAR, and MAR compared to the LPG, which aligns with previous studies [26]. However, physical activity and psychological factors did not show significant changes regardless of the participation rate in this study. These findings suggest the need for long-term educational programs that can improve especially eating habits, exercise habits, and psychological factors through behavioral changes in the health management of children and adolescents utilizing community childcare centers. Furthermore, future research should focus on developing diverse programs to enhance physical activity and address psychological and emotional factors among children and adolescents using community childcare centers.

The participation rate in education was found to be a factor that influenced the research outcomes to some extent. Therefore, it is important to explore various approaches to enhance participation and develop complementary programs based on the findings of this study. Additionally, considering that low participation rates have been associated with negative effects on eating habits, reduced physical activity, increased stress, mental disorders, and depression in previous studies, it is crucial to investigate the factors influencing participation rates among the target population [26].

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