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Research Note

A pilot investigation of a combined food literacy and exercise program for college students: a one-group pre-post intervention study

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Objectives: A campus-based intervention to enhance food literacy (FL) and establish exercise habits among college students was developed and the program's effectiveness was evaluated.

Methods: The 13-session program was developed based on the transtheoretical model and social cognitive theory. Junior and senior students majoring in food and nutrition and physical education were asked to participate as mentors, with freshmen and sophomores from varied majors as mentees. The program encompassed food, nutrition, and exercise lessons including cooking sessions. Data were collected via pre- and post-program surveys using a questionnaire consisting of items on FL and nutrition behaviors and physical fitness measurements.

Results: Among 39 participants (35.9% male, 64.1% female), the overall FL score increased significantly from 64.1 to 70.6 post-program (P = 0.001). Significant increases were observed in the nutrition and safety (P < 0.001), cultural and relational (P = 0.023), and socio-ecological (P = 0.001) domains, as well as knowledge (P = 0.001), self-efficacy (P = 0.013), attitude (P < 0.001), and behavior (P = 0.005) items in three domains of FL. Additionally, meal duration increased significantly (P = 0.007) and sit-up performance among female showed a meaningful change (P = 0.046). Changes in dietary behaviors significantly progressed (P = 0.015) while that in exercise habits approached a marginal significance (P = 0.053) after the intervention.

Conclusion: The results reveal positive changes in FL and some modifications in eating habits, although the program had limited effects on physical activity and fitness measurements. These findings suggest that strategic approaches to foster exercise behavior changes in college students are required. This pilot program can serve as foundational data for improving and expanding multicomponent health promotion programs for this population.

Keywords: food; literacy; students; nutrition; exercise

INTRODUCTION

College students are in a transitional phase from adolescence to adulthood [1, 2]. This intermediate developmental stage is characterized by increased physical and mental activities, independence, autonomy, and responsibility [3, 4]. Irregular eating habits formed during this phase can persist in adulthood and trigger diverse health problems in later life [5]. Therefore, it is crucial to establish appropriate eating habits in college students and ensure that they receive balanced diet [6]. However, many college students are uninterested in health-related issues and healthy habits. They often do not recognize the importance of balanced diet [7] but even when they do apprehend the significance, implementing such beneficial habits becomes challenging because of campus living environments, irregular personal routines, and economic difficulties [8, 9].

The social distancing measures imposed during the COVID-19 pandemic affected every population globally with limited outdoor activities, closed exercise facilities, and increased online classes for students. For college students, these measures resulted in poor nutrition and lack of physical activity [10] and adversely impacted their health, with consequences such as emotional stress, decreased immunity, and weight gain. College students tend to prioritize convenience and taste over health and nutritional value of their food choices and an increase in the consumption of high-calorie foods, delivery food, ready-to-eat meals, and processed foods has been observed since the pandemic [11-13]. In addition, an excessive intake of calories and sodium and imbalances in essential nutrients have been reported because of irregular meals, skipping breakfast, and high alcohol consumption among this population [11].

Physical activity helps reduce the risk of chronic diseases by lowering blood pressure and body fact and better controlling blood sugar, making it one of the most effective ways to prevent cardiovascular and mental diseases and improve overall fitness [14]. However, approximately 28% of adults worldwide and over half of the university students in South Korea do not meet the World Health Organization's physical activity guidelines, which recommend at least 150 minutes of moderate-intensity activity per week. The participation rate of Korean adults in physical activities has declined over the last seven years [15]. The physical activity of college students tends to decrease because of new living environments and increased time spent on academic and extracurricular activities, raising the risk of obesity and chronic disease [16-19]. Therefore, it is crucial to understand the patterns of physical activities in which college students engage and to actively encourage them to exercise regularly [20].

Food literacy (FL) encompasses the ability to select, understand, and utilize appropriate foods. FL plays a pivotal role in promoting healthy dietary choices and preventing chronic diseases [21-23] and its significance has grown substantially in recent years. Among young adults, enhanced FL is particularly crucial as it fosters healthy eating habits that support disease prevention and long-term health maintenance [24, 25]. While the importance of FL interventions among college students is well-recognized, research in this field, especially in South Korea, remains in its early stages. Furthermore, there is limited evidence on the effectiveness of FL interventions that incorporate exercise components. Understanding how complementary strategies, such as establishing regular exercise habits, can enhance the overall health outcomes of FL interventions among college students warrants further investigation [23, 26, 27].

Ko *et al.* [26, 27] designed a campus-based intervention program to strengthen FL in college students and support them in forming healthy eating habits. This program was developed to align with the campus environment and students' lifestyle patterns, aiming to improve FL and promote healthier eating habits among college students. The present study builds on this previous study and aims to develop a pilot multicomponent intervention program through hands-on experiences of all the aspects of FL and exercise training [28, 29]. The program tested whether it is feasible and acceptable for college students to combine FL and exercise components with the help of senior students in one curriculum during one semester.

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METHODS

Ethics statement

The written informed consent was obtained from all participants. This study was conducted with the approval of the Research Ethics Committee of Hallym University Institutional Review Board (HIRB-2021-009-3-RRRR).

1. Study design

This study was conducted as a one-group, pre-post intervention pilot study and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement, available at https://www.strobe-statement.org/.

2. Intervention overview

This pilot study was conducted from September to December 2023, targeting 39 university students aged 19–29 who were enrolled at a university in Chuncheon, Gangwon Province. Participants were recruited from July to August 2023 via popular mobile apps frequently used by college students. The study initially recruited 40 applicants through online platforms, of whom 39 satisfied the eligibility criteria and provided informed consent, resulting in an effective recruitment rate of 97.5%. Among these, 35 participants completed the post-intervention assessments, yielding a final completion rate of 89.7%. Students with specific medical conditions or eating disorders requiring special dietary management or those who had difficulty engaging in general physical activities were excluded. The sample size was determined using the average FL score and standard deviation from the previous study [27], with calculations performed using G*power 3.1.9.7 software, accounting for a 10% dropout rate, an alpha of 0.05, and a power of 0.80. This study employed a one-group, pre-post intervention design to evaluate the effects of a pilot program aimed at improving FL and physical activity among college students. The survey was administered online through Google Forms, with a pre-survey and physical fitness assessment in September and a post-survey and physical fitness assessment in December. Participants were compensated with a gift certificate worth approximately 4,000 KRW when they completed post-intervention survey. The program was offered as a 3-credit interdisciplinary course through the Department of Food Science and Nutrition and the Department of Physical Education.

3. Program design

This study developed and implemented a program based on the transtheoretical model (TTM) and social cognitive theory (SCT). Based on SCT, practical sessions were organized with 3rd and 4th-year students enrolled in the Departments of Food and Nutrition and Physical Education as mentors and 1st and 2nd-year students majoring in various subjects as mentees. Each group comprised between six and seven members and the participant cohort was divided into a total of six groups. Mentors underwent three training sessions including a pre-orientation meeting and worked with instructors to design and execute group programs for mentees. The stage of change of every participant was assessed during the initial phase of the program and mentors offered tailored advice on nutrition and exercise based on the individual assessments. Mentors helped their mentees advance their self-efficacy through practical activities and conducted group activities to help mentees learn and reinforce new behaviors.

4. Intervention components and implementation

The 13 sessions of the intervention program are overviewed as follows. Session 1 oriented the participants to the program, and Session 2 covered balanced eating habits using a dietary guideline. A simple individual nutrition assessment using Nutrition Quotients survey questionnaire was implemented in Session 3 to diagnose the dietary habits of the participants and engage them in discussions on the desired dietary improvements [30, 31]. During Session 4, the participants were divided into two segments: one group made salads and learned about vegetarianism, animal welfare, and food storage and preparation, while another group participated in a yoga class. Session 5 reversed the focus of Session 4, alternating the cooking and exercise segments. In Session 6, the participants were encouraged to practice the contents from previous session as a group, with modification for their groups' own needs. Participants were invited to engage in a forest experience in Session 7 aimed at reducing their academic stress,

which included a board game centered on environmental conservation and tree planting activities. Session 8 featured a lecture by a sports expert on the principles of exercise and customized exercise methods for different body types. In Session 9, participants developed a meal plan based on dietary guidelines and participated in group cooking sessions led by peer mentors. This session also emphasized the importance of mindful eating, encouraging participants to increase the time spent on each meal. Session 10 included a lecture by an expert on emotional eating, and students learned how to keep meal record and address their emotions while choosing food. Sessions 11 and 12 required students to use exercise equipment as well as engage in biweekly group activities on zero-waste cooking. Session 13 concluded the program with a feedback session and a certificate ceremony (Table 1).

5. Measurements

The survey items of FL were from the 2021 Seoul Food Survey [32]. The questionnaire has been reported to have a Cronbach's alpha of 0.82 for internal consistency reliability and demonstrated construct validity through factor analysis in previous studies. The FL scale comprised 33 items classified into three domains: nutrition and safety (14 items), cultural and relational (8 items), and socio-ecological domain (11 items). The nutrition and safety domain assessed the ability of respondents to acquire, understand, and utilize knowledge related to food and nutrition, and cooking competency. The cultural and relational domains evaluated the interest and understanding participants exhibited toward food culture and probed their pursuit of enjoyment and meaning through food, their gastronomic curiosity, and their contribution to personal and community wellbeing through food. The socio-ecological aspect measured the ability of participants to understand and value diverse social and ecological outcomes related to food choices, including their awareness of food-related inequalities. This section also included items on environmental sustainability, animal welfare, fair trade, and the relationships between food choices and climate crisis. For each of the three domains, questions were further categorized into subcomponents of knowledge, self-efficacy, attitude and behavioral skills to capture changes in sub-elements of FL. Responses were rated on a five-point scale (1: strongly disagree, 5: strongly agree) [32].

Physical fitness assessments were conducted in accordance with the grading criteria established by the university's fitness experts at the Department of Physical Education, utilizing standardized tools and procedures to ensure reliability and validity. A total of 38 students participated in the pre-program assessment and 35 students completed the post-program assessment, with three dropouts due to personal injuries. Participants undertook four types of tests both before (September) and after (December) the intervention, measuring muscular endurance (sit-ups), explosive power (vertical jump), flexibility (sit-and-reach), and cardiorespiratory endurance (step test). Each assessment method was validated in peer-reviewed studies [33], and measurements were conducted using standardized procedures to ensure consistent and accurate results.

Participants performed as many sit-ups as possible in one minute starting from the signal, lying on a mat with their legs bent at an angle of 70°–80°, feet secured in ankle straps, and arms crossed over their chest. Sit-ups (HMS-103; HMS Medical Systems) were measured as repetitions per 60 seconds and recorded on a log. Participants stood on a measuring pad for the vertical jump, their feet shoulder-width apart, their knees bent at around 90°, and jumped vertically at the signal. They were required to land on the pad without bending their knees while they were in the air. The vertical jump was recorded in 0.1-second intervals using the equilibrium measurement device (HMS-108A; HMS Medical Systems). The sit-and-reach test required participants to sit barefoot with their legs extended and feet flexed. Participants were then asked to reach forward as far as possible and press the measurement device. Sit-and-reach (HMS-101; HMS Medical Systems) was measured in 0.1 cm increments. Finally, male participants used a box with 40 cm height and female participants used a box with 35 cm for the step test, stepping up and down in time with a Harvard step rhythm. After three minutes, the participants sat on the box for 3 minutes and 30 seconds and measured their pulse rate. Heart rates were recorded three times immediately after the exercise (1–1.5 minutes, 2–2.5 minutes, and 3–3.5 minutes). The measurement tools included the step box, a mobile

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Table 1. Overview of the pilot food literacy and exercise program for college students

Session[1)]	Topic	FL components or PA	Time	Content	Main in-class activity
Session 1	Introduction to food literacy and exercise program	All[2)]	1 hour	- Describing the flow of the health promotion program combining FL and exercise - Each group comprised 2 mentors and 3 or 4 mentees - Establishing individual and group goals	- Orientation to the health promotion program
Session 2	Dietary guidelines: components of healthy meals	NS	2 hours	- Discussion healthy bodies and the role of nutrition intake - Creating balanced diet using a food balance wheel	- Learning dietary guideline
Session 3	My nutritional status	NS	2 hours	- Using the NQ questionnaire to understand individual's food intake - Assessing my own food intake quality	- Simple nutrition assessment using NQ questionnaire
Session 4–5	Making a healthy meal: a bowl of salad	NS, CR	2 hours	- Making a salad bowl using sweet pumpkin and ricotta cheese - Increasing awareness of vegetarianism and animal welfare	- Learning about vegetarian diets and animal welfare
	Mind control through a yoga session	PA	90 minutes	- Learning about controlling stress through yoga	- Yoga practice
Session 6	Group cooking and exercising	NS, CR	2 hours	- Cooking and exercising in groups - Group meal planning using vegetarian and animal welfare products (Kito gimbap) - Engaging in yoga and physical activities	- Group sessions for cooking and exercising
Session 7	Mind control through forest experience	SE	1 day	- Field trip to the rural areas of the region - Board game activities - Tree planting	- Understanding environmental protection through a forest experience
Session 8	The exercise my body needs	PA	90 minutes	- Identify your body type - Understanding exercise methods	- Learning exercises suitable for specific body types
Session 9	Nutritional diets	NS, CR	2 hours	- Attending a lecture on nutrient-balanced diets - Designing a meal with balanced nutrients	- Cooking practice using meal plans
Session 10	Emotional eating	NS, CR	2 hours	- Writing diet logs - Understanding eating psychology	- Emotional eating and eating psychology
Session 11–12	Do you understand zero-waste?	SE	2 hours	- How to reduce food waste - Cooking a meal with minimal food waste	- Group cooking
	Creating exercise habits	PA	90 minutes	- Making habits of participating in physical activity	- Weight training
Session 13	Course completion ceremony	-	1 hour	- Sharing personal experiences of the course	- Group feedback
Additional activity	Mentor-mentee individual activities	PA	1 hour	- Mentor explains exercise methods and conducts group workouts (running, walking, basketball)	- Group exercise

FL, food literacy; PA, physical activity; NS, nutrition and safety FL; CR, cultural and relational FL; SE, socio-ecological FL; NQ, nutrition quotient.
[1)]The class is divided into two groups for session 4–5, 11–12.
[2)]All: nutrition and safety FL + cultural and relational FL + socio-ecological FL.

application used to guide the step test procedure, and a stopwatch. The physical efficiency index (PEI) of the participants was calculated through scores recorded in 0.1-point increments using the following formula [33]:

PEI = D / (2 × P) × 100
D: the duration of step exercise (seconds),
P: the sum of heart rates measured in three intervals (1–1.5, 2–2.5, 3–3.5 minutes).

Dietary and exercise activity sheets based on the TTM were designed for this study, and participants completed these sheets three times (in Sessions 1, 10, and 15). The developed activity sheets included the change stages of precontemplation, contemplation, preparation, action, and maintenance. Participants rated their level of agreement with each item on a 5-point scale (1: precontemplation, 5: maintenance).

6. Statistical analysis

Initially, this study measured the three subdomains of FL using a five-point scale. The responses were then recoded and standardized to a 4-point scale to make it easier to present as a 100-point scale. The overall tally was obtained by summing the scores from the three subdomains and then dividing this number by three to convert it to a 100-point scale. The Wilcoxon signed-rank test, a non-parametric test, was used to compare the pre- and post-intervention results and to assess the differences in mean FL and physical fitness scores based on the demographic characteristics of the participants. Statistical analysis was performed using Stata 17.0 (StataCorp LLC), with the significance level set at $P < 0.05$.

RESULTS

1. Sociodemographic characteristics

Table 2 presents the demographic characteristics of the study participants. The total sample of 39 college students included 14 male (35.9%) and 25 female (64.1%). Of them, 13 students (33.3%) were food and nutrition majors. In terms of living arrangements, 13 students (33.3%) lived independently, 12 (30.8%) lived with their families, and 12 (30.8%) resided in dormitories.

2. Changes in food literacy levels

Table 3 displays the pre- and post-intervention FL level changes according to subdomains. The overall FL score increased significantly from 64.1 points at the baseline to 70.6 points post-intervention ($P = 0.001$). Specifically, all subdomains showed statistically significant improvements: nutrition and safety ($P < 0.001$), cultural and relational ($P = 0.023$), and socio-ecological ($P = 0.001$). The subcomponents of FL also demonstrated significant improvements: knowledge ($P = 0.001$), self-efficacy ($P = 0.013$), attitude ($P < 0.001$), and behavior ($P = 0.005$).

3. Changes in eating habits

Table 4 shows the changes in eating habits from pre- and post-intervention assessments. Meal frequency and late-night snack consumption did not show significant changes. However, the frequency of eating breakfast with others increased from 1.3 times at the baseline to 1.4 times post-intervention, a statistically significant value ($P = 0.044$). Moreover, the average time spent on each meal increased significantly from 18.7 minutes at the baseline to 21.0 minutes post-intervention ($P = 0.007$). The meal venue analysis revealed no significant changes in visits to convenience stores ($P = 0.568$), use of delivery food ($P = 0.849$), restaurants ($P = 0.184$), catering ($P = 0.242$), ready-to-eat meals ($P = 0.822$), and home-cooked meals ($P = 0.766$).

4. Changes in physical activity and physical fitness

Table 5 displays the outcomes of the pre- and post-in-

Table 2. Sociodemographic characteristics of the participants

Characteristic	Participant (n = 39)
Total	39 (100)
Sex	
Male	14 (35.9)
Female	25 (64.1)
Department	
Food and nutrition	13 (33.3)
Others	26 (66.7)
Household types	
Living with family	12 (30.8)
Dormitory	12 (30.8)
One person households	13 (33.3)
Others	2 (5.1)

n (%).

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Table 3. Changes in food literacy scores from pre- and post-intervention assessments by sub-domains and sub-elements

Variable	Pre-intervention	Post-intervention	*P*-value[1]
All FL[2]	64.1 ± 12.6	70.6 ± 13.5	0.001
Nutrition and safety	67.9 ± 13.7	74.6 ± 13.0	< 0.001
Cultural and relational	63.2 ± 16.3	67.7 ± 15.5	0.023
Socio-ecological issues	61.1 ± 15.7	69.5 ± 17.4	0.001
Scores for sub-elements[3]			
Knowledge	20.4 ± 4.0	22.6 ± 4.6	0.001
Self-efficacy	19.7 ± 2.9	20.6 ± 2.8	0.013
Attitudes	52.5 ± 8.2	56.6 ± 8.4	< 0.001
Behavioral skills	25.5 ± 4.2	27.2 ± 4.3	0.005

Mean ± SD.
FL, food literacy.
[1]Wilcoxon signed-rank test for pre- and post-intervention comparisons effected for each group; $P < 0.05$.
[2]All FL score: This score encompasses the nutritional and safety, cultural and relational, and socio-ecological dimensions of FL.
[3]Subelements: The full FL domain was reclassified into four categories: knowledge, self-efficacy, attitude, and behavioral skills.

Table 4. Changes in eating habits from pre- and post-intervention assessments

Eating habit	Pre-intervention	Post-intervention	*P*-value[1]
Meal frequency (times per week)			
Breakfast	1.4 ± 2.0	1.5 ± 1.8	0.560
Lunch	4.6 ± 1.4	4.6 ± 1.4	0.964
Dinner	5.0 ± 1.1	5.1 ± 1.2	0.493
Frequency of eating with others (times per week)			
Breakfast	1.3 ± 0.5	1.4 ± 0.5	0.044
Lunch	1.3 ± 0.5	1.3 ± 0.5	>0.999
Dinner	1.1 ± 0.3	1.1 ± 0.3	0.964
Frequency of late-night snacking			
1 times per week	1.9 ± 0.8	2.0 ± 0.9	0.760
Average per-meal duration (min)	18.7 ± 7.0	21.0 ± 6.9	0.007
Meal location (times per week)			
Convenience store	2.6 ± 1.6	2.4 ± 1.4	0.568
Delivery food	1.5 ± 1.2	1.5 ± 1.3	0.849
Restaurant	2.5 ± 1.4	2.8 ± 1.7	0.184
Group catering	1.1 ± 1.8	0.8 ± 1.4	0.242
Ready-to-eat meals	1.6 ± 1.6	1.6 ± 1.8	0.822
Home-cooked meals	3.0 ± 3.0	3.1 ± 3.3	0.766

Mean ± SD.
[1]Wilcoxon signed-rank test for pre- and post-program comparisons effected for each group; $P < 0.05$.

tervention of physical activity and physical fitness test. No significant differences were observed in vigorous physical activity ($P = 0.064$), flexibility exercises ($P = 0.404$), or strength training ($P = 0.909$). Male did not show significant pre- and post-intervention changes ($P = 0.624$) in the sit-up test but female demonstrated a significant post-intervention increase ($P = 0.046$) in their physical fitness. Neither male ($P = 0.344$) nor female ($P = 0.526$) demonstrated statistically significant changes in the vertical jump test. Similarly, neither male ($P = 0.861$) nor female ($P = 0.427$) showed significant differences in the sit-and-reach test, and no significant changes were observed in the step test for both male ($P = 0.937$) and female ($P = 0.280$).

5. TTM-based stages of change in diet and exercise behavior

Table 6 presents the results of the TTM-based stages of change in diet- and exercise-related behavior before and after the intervention. The stage of change in dietary habits increased significantly from a baseline average of 2.7 to 3.1 post-intervention, indicating a shift from the contemplation stage to the preparation stage ($P = 0.015$). In contrast, the stage of change in exercise habits increased from 3.0 to 3.4, but this change approached statistical significance without advancing to the action stage, remaining within the preparation stage ($P = 0.053$). All 39 participants attended all scheduled sessions of the program, confirming its feasibility. After

Table 5. Changes in frequencies of physical activities and physical fitness from pre- and post-intervention assessments

Variable	Pre-intervention	Post-intervention	*P*-value[1)]
Physical activity (frequency per week)			
Intense physical activity[2)]	2.4 ± 1.8	1.8 ± 1.5	0.064
Flexibility exercise	2.1 ± 2.1	1.7 ± 1.7	0.404
Strength exercise	1.4 ± 1.9	1.3 ± 1.8	0.909
Physical fitness assessment			
Sit-ups (number/min)[3)]			
Male	45.5 ± 8.9	45.2 ± 10.6	0.624
Female	25.4 ± 6.3	27.8 ± 5.9	0.046
Vertical jump (sec)[4)]			
Male	30.2 ± 12.3	33.8 ± 8.0	0.344
Female	18.8 ± 4.5	19.3 ± 4.8	0.526
Sit-and-reach (cm)[5)]			
Male	3.9 ± 10.6	3.9 ± 8.6	0.861
Female	8.9 ± 10.6	8.1 ± 9.8	0.427
Step test (steps per min)[6)]			
Male	56.5 ± 6.7	58.2 ± 9.8	0.937
Female	60.5 ± 7.8	59.3 ± 7.1	0.280

Mean ± SD.
[1)]Wilcoxon signed-rank test for pre- and post-program comparisons effected for each group; $P < 0.05$.
[2)]Intense physical activity: Physical activities that are very strenuous or cause heavy breathing, such as running, swimming, cycling, and hiking.
[3)]A sit-up measurement device was used to count the number of sit-ups performed in one minute.
[4)]A Sargent jump tester was utilized to measure the vertical jump height and physical efficiency index (PEI) was calculated.
[5)]A flexibility tester was employed to measure flexibility via a sit-and-reach test.
[6)]A step test measurement device was used to obtain the values to calculate the PEI.

Table 6. Changes in values of the stages of change model[†] from pre- and post-activity assessments

Variable	Pre-intervention	Post-intervention	*P*-value[1)]
Dietary habits	2.7 ± 1.0	3.1 ± 1.0	0.015
Exercise	3.0 ± 1.2	3.4 ± 1.1	0.053

Mean ± SD.
[1)]Wilcoxon signed-rank test for pre- and post-activity comparisons effected for each group; $P < 0.05$.
[†]The average values of the stages of change model: 1 = precontemplation, 2 = contemplation, 3 = preparation, 4 = action, and 5 = maintenance.

the completion of the entire program, the satisfaction evaluation showed a high level of satisfaction, with an average score of 8.26 out of 10.

DISCUSSION

This pilot study aimed to develop and evaluate an intervention program focused on FL and physical exercise for college students in the Gangwon region, South Korea. College students need to receive proper nutrition education to form healthy eating habits and reduce the risks of chronic diseases later in life [7]. However, very few nutrition intervention programs are currently offered to college students in Korea, and research on FL is even more scarce [23]. This study is based on the previous study that designed and implemented FL improvement program for college students on campus [26, 27] and developed further to enhance FL and establish exercise habits in college students. In-depth interviews conducted by previous studies identified that existing programs did not adequately address the lack of cooking practice and the importance of exercise [27]. This study sought to bridge this gap by designing a pilot program incorporating more cooking practices and forming beneficial exercise habits with the help of peer groups. In addition, the program was conducted as a part of classes held on campus and was designed to enhance self-efficacy through mentor–mentee interactions over the course of a semester. The study aimed to test whether this multicomponent program can be feasible and acceptable among students and to test any impact on enhancements of FL and physical activities.

The general participant characteristics revealed that 33.3% lived independently, confirming that single-person households represented the primary living arrangement of college students. Previous studies have indicated that single-person households exhibit higher rates of skipping breakfast, eating out, and alcohol consumption than multi-person households [11, 34]. The 2021 Seoul Food Survey also disclosed that single-person households evinced lower scores in the nutrition and safety domain in FL scores than multi-person households [32, 35]. Currently, despite Seoul and other local governments have implemented relevant programs targeting single-person households, there is insufficient

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data evaluating their effectiveness [36, 37]. This study emphasizes the need for well-designed evaluation programs for FL among this population.

The analysis of FL levels by subdomain in this study revealed significant improvements across all three subdomains and their subcomponents among participants, consistent with previous studies showing that nutrition programs lead to improvements in FL domains [38]. Our previous study also successfully showed the increased knowledge and the overall score of FL among intervention participants. However, it is noteworthy that the previous program failed to show significant improvement when compared to control group [27]. Additionally, aside from knowledge, their study observed no significant changes in the domains of self-efficacy, attitude, and behavior. These results suggest that while targeted FL program could enhance food-related knowledge within the intervention group, more effort is needed to produce larger and more sustainable outcomes in terms of fostering self-efficacy, attitudes, and behaviors.

The study found that the participants did not increase their physical activity as much as expected after participating in the program. College students find it difficult to engage in physical activities because they lack the time and because of their paucity of knowledge about exercise [39]. Also, programs focusing on developing physical activity habits in college students remain scant. Therefore, it is important to develop programs and offer continuous monitoring support to help college students maintain regular exercise habits despite busy academic schedules.

According to the fitness assessment, only female showed a statistically significant improvement in sit-ups ($P = 0.046$) after the intervention. This may be due to female tend to be more influenced by social environment and support, which was one of the main strategies of this pilot program [40]. To effectively enhance fitness for both male and female, universities need to integrate sustainable exercise programs into their academic schedules, leveraging existing extracurricular activities, students-initiated events, and capstone projects [41,42]. Developing programs that promote healthy eating and exercise habits, along with continuous monitoring of their effectiveness, can help create a campus environment where students can participate in regular physical activities and improve their fitness despite their busy academic schedules.

This study confirmed that the stages of change for diet and exercise improved within a relatively short period after the 13-session intervention program, suggesting that such programs can initiate positive behavioral changes if provided for longer period of time. However, some participants remained in the preparation stage for both dietary and exercise changes and did not advance to the action stage. This stage is characterized by the intention to make changes without actions, making it likely that concrete behavioral changes may not follow. Previous studies emphasize that moving program participants from the preparation to the action stage often requires at least six months of sustained TTM-based interventions. This will reinforce behavioral changes and achieve substantial lifestyle modifications [43,44]. In this study, the 13-session TTM-based intervention program revealed significant improvements in the stages of dietary change, while the stages of exercise change showed a marginal significance. These results suggest that greater benefits could be achieved if continuous support and interventions are provided at each stage.

Limitations

One of the limitations of this study is that the pilot program was conducted with a small number of students from one university in the Gangwon region without control groups, making it difficult to generalize the results to college students nationwide and to confirm the causality of the effect. Although the 13-session health promotion program effectively improved overall FL score, it was limited in promoting the sustained practice of healthy behaviors. Additionally, while the study aimed to measure changes in physical ability through objective indicators, it has been confirmed that a long-term and rigorous study of at least six months is necessary to assess the impact of the intervention on physical activity. Despite of limitations, this study shows some potential that this type of multicomponent health promotion program can be implemented as a part of curriculum on college campus and the results are showing some potentials.

Conclusion

This 13-session of multicomponent intervention showed that curriculum-based intervention on college campus can be feasible and may be effective in improving FL and participants' motivation toward healthier food and exercise choices. It is meaningful that integrated nutrition and exercise interventions are still rare on college campuses. Specifically, this study demonstrated the improvement of FL among participants and the high completion rates. Findings indicate that while the intervention programs effectively enhance FL and dietary habits, additional strategies are necessary to promote changes in physical activity and fitness measurements. Future research should explore specific and effective strategies to improve dietary habits through enhanced FL and increase physical activity among larger group of college students.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

Research data is available upon a reasonable request to the corresponding author.

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