Original

Cooking-integrated Nutrition Education Program Affects Stages of Behavior Change among Fourth-Grade Students in Vegetable, Fruit and Sugar-Sweetened Beverage Consumption

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ABSTRACT *Background.* Studies have shown that integrating cooking activities with nutrition education can improve children's preferences for and intake of fruits and vegetables (FV). However, evidence regarding its impact on sugar-sweetened beverages (SSB) and stages of behavior change remains limited. This pilot study aimed to evaluate the effect of an experiential cooking and nutrition education intervention on stages of behavior change related to FV and SSB consumption among elementary school students. *Methods.* A total of 35 fourth-grade subjects were recruited through purposive sampling. Using crossover design, the effects of cooking integrated nutrition education curriculum on nutrition knowledge (NK), selecting attitude (AT), and consuming behavior (BE) towards FV and SSB, as well as stages of behavior change (SOC), were examined. Subjects were divided into Group A (n=16) and Group B (n=19), randomized to begin with either cooking or nutrition education curriculum, before switching to the alternate curriculum. The intervention comprised eight lessons over two 4-week periods, with five assessments conducted at pretest (W_0), midterm test (W_4), posttest (W_8), follow-up test (W_{10}) and a final test (W_{20}). *Results.* Results indicated significant improvements in NK and BE score ($p<.05$). The overall intervention facilitates subjects' behavior change to progress to a later stage by 20%, 25.7% and 37.1% towards vegetables, fruits and sugar sweetened beverages, respectively. *Discussion.* The intervention improved NK with retention and carryover effects. BE increased especially when nutrition education preceded cooking. Cooking was more effective for FV, while education reduced SSB. *Conclusion.* The integration of cooking activities with nutrition education effectively supported students' advancement through stages of behavior change and yielding stronger outcomes, particularly in reducing unhealthy SSB consumption. This approach shows promises for promoting healthy eating behaviors in elementary school settings.

Keywords: Cooking program, Knowledge Attitude Behavior (KAB), Stages of Change, Fruits and Vegetables, Sugar-sweetened Beverages

INTRODUCTION

The epidemic of childhood obesity has emerged as an important public health problem worldwide. In 2016, the prevalence of childhood obesity increased at an alarming rate. This is associated with various diseases such as type 2 diabetes mellitus, hypertension, nonalcoholic fatty liver disease, Obstructive sleep apnea, and dyslipidemia later in their adult age (1).

In Taiwan, the prevalence rate of overweight and obesity among elementary school children aged 6-12 years old was increasing substantially since year 2008 (25.0%) to 2013 (30.4%) but decreasing steadily to 27.6% in 2017 (2). Despite the decreasing trend being observed over the past five years, Taiwan Nutrition and Health Survey in Taiwan Elementary School Children (NAHSIT IV Children) in year 2012 reported that the highest prevalence rate of obesity was noticed among 4th grade male students (17.1%) and 5th grade female students (15.6%) (3).

Diet plays an important role in preventing overweight and obesity. Study reviewed that there was an inverse association between a prudent/healthy dietary pattern and overweight/obesity risk and a positive association between a western/unhealthy dietary pattern and overweight/ obesity risk (4). Fruits and vegetables (5), fiber (6), fat (7), fast food (8) and sugary drinks (9) are included but not limited to as important dietary determinants of obesity in childhood and adolescence. It is plausible that dietary pattern that are

energy- and fat- dense but low in fiber may be predictive of later overweight and obesity in children (10). By consuming recommended amounts of fruits, vegetables, and whole grains would result in a healthier dietary pattern. Unfortunately, children often have poor compliance with dietary guidelines for these foods (11). Furthermore, evidence that decreasing sugar- sweetened beverage (SSB) consumption will reduce the prevalence of obesity andobesity- related diseases is increasingly clear (9).

Health Promotion Administration, Ministry of Health and Welfare of Taiwan has implemented the daily dietary guidelines to combat the problem of imbalance diet among school-aged children. In term of consumption of fruits and vegetables, dietary patterns of students reflected that 72.9% of students do not fulfill the recommended intake which is five servings per day. Among all, only 12.3% of school-aged children fulfill the daily recommended intake of three servings of vegetables and two servings of fruits at the same time. Nutrition and Health Survey in Taiwan Elementary School Children (NAHSIT II Children) year 2001-2002 documented that energy intake from carbohydrate was inadequate. In addition, 7.2% of the carbohydrate source was from sugar sweetened beverages. This issue should be addressed wisely because the more sugar- sweetened beverage (SSB) consumed, both weight and body mass index (BMI) of children will increase (12,13).

Many studies focused on the evaluationof nutrition education intervention towards students' knowledge, attitude and behavior, most studies showed the same outcome that there was a significant increase in students' knowledge, attitude and behavior. The concept of experiential learning such as cooking, gardening and tasting has emerged and incorporating in nutrition education program which helps to improve the preference of students towards fruits and vegetables (14,15,16).

Unfortunately, there are lack of researches done in assessing stages of behavioral change after implementing cooking-integrated nutrition education intervention. It is utmost important as stage-tailored intervention concept is believed to increase the effectiveness of nutrition education program (17). Thus, this study aims to evaluate the effectiveness of experiential cooking program and nutrition education intervention through nutrition knowledge (NK), selecting attitude (AT) and consuming behavior (BE). Also, its effect towards stages of behavioral change (SOC) on consumption of fruits, vegetables and sugar sweetened beverages were evaluated as well.

MATERIALS AND METHODS

Study Design This was a 5-months evaluation of experiential cooking and nutrition education program. By adapting cross-over design concept in nutrition education intervention (18), the research design called for a random assignment of all 41 subjects to either Group A (n=20) or Group B (n=21). A total of 8 lessons of curriculum were delivered in two 4-week periods. Group A subjects were randomized to begin with cooking curriculum in first 4-weeks period, whereas Group B begin with nutrition education curriculum, and then both groups switch to the remaining curriculum in second 4-weeks period. Both programs had a similar delivery and length. Each subject completed a pretest (W_0), a midterm test (W_4), a posttest (W_8), a follow-up test (W_{10}) and a final test after semester break (W_{20}) as shown in Figure 1.

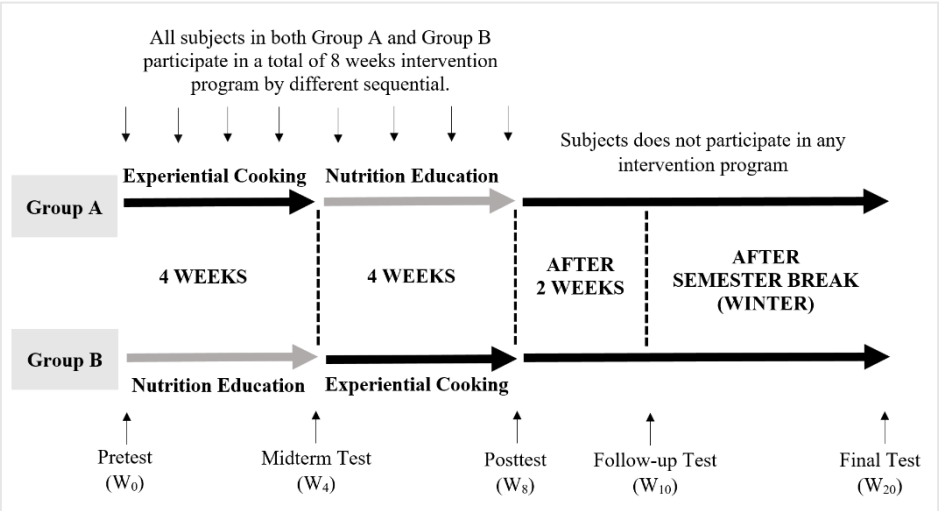

Figure 1 Study design

Participants and Recruitment The evaluation included 41 subjects selected through purposive sampling from an elementary school located in *Daliao* district, Kaohsiung. Application was opened for all Fourth-grade students one month prior to the intervention. Students applied to participate according to their own willingness. The inclusion criteria for the program were subjects without food allergy history especially milk, eggs and nuts. Subjects with asthma history were also excluded. Application packets, which contain informed consents for both parents and subjects were distributed to selected subjects.

Ethical Approval This research was reviewed and approved by the institutional review board in Antai Medical Care Corporation Antai Tian-Sheng Memorial Hospital. (Protocol No. 18-109-B)

Interventions Both experiential cooking and nutrition education curriculum were discussed and designed by nutrition teacher and third year nutrition students, incorporating the service- learning courses that is selective among undergraduate students. The experiential cooking curriculum was designed to focus primarily on simple hands on preparing hand- hold food rather than cooking skills. However, simple cutting and preparing skills were also imparted to subjects to ensure that they could experience food ingredients. The nutrition education curriculum was designed with aims of instilling nutrition knowledge towards subjects through different teaching methods including didactic instruction, drama in education, practice instruction and team-games-tournament. Both curriculums were reviewed by registered dietitian to ensure that recipes created were aligned with principles of good nutrition and the appropriateness of nutrition knowledge imparted. Lessons were led by nutrition students and they were required to went through food tasting and rehearsal training at least 2 times (1 hour per time) by nutrition teacher and registered dietitian. The whole program consisted of 8 30-minutes lessons taught during the self-study period in the morning. All lessons were taught in Mandarin and nutrition principles illustrated was aligned with new version of Dietary Guideline of Taiwan in 2018. Subjects were formed into teams of four to five, which were maintained throughout the course, to practice food preparing skills, and carry out team games throughout the lessons.

Instruments and Measures The evaluation of the intervention was assessed by self-developed survey questions. The survey was first developed by adapting questions from publicly available sources (19,20), then was reviewed by five experts in nutrition education and/or public health to ensure content validity and audience appropriateness. A total of 50-items including subject's demographic data (8 items), NK (15 items), AT (12 items), BE towards FV and SSB (12 items) and SOC (3 items) were collected through the written surveys. The survey was pilot tested among 65 subjects which were not participated in the study. Average item discrimination index (D) for nutrition knowledge-testing questions reported was 0.41, considered very usable (21). Internal consistency was assessed with Cronbach alpha coefficient; scale structure was analyzed using principle components extraction with varimax rotation. Cronbach alpha coefficient of 0.72 and 0.84 were achieved for both scale of selecting attitude and consuming behavior which were measured in five-point Likert scale. Due to the poor time frame estimation among elementary school students, excluding question regarding time frame in stage of behavior change was necessary. Thus, instead of five stages, three stages of behavior change were used including precontemplation (PC, do not know/plan to change), contemplation/preparation (C/P, plan to change) and action/maintenance (A/M, have changed unhealthy behavior) (3).

Survey Administration Surveys were administered for all subjects present on the day of administration. Teacher was present in the classroom but not directly involved in survey administration. Instructions for all parts of survey were read aloud by researchers in preferred language (Mandarin) with guidance to students to complete the rest of the page independently. Measuring instrument (10cm circumference bowl) was used to guide students on the portions of fruits and vegetables being consumed. Completion of survey took around 20 minutes. Upon collecting the survey form, researcher ensure that all parts were answered.

Data Analysis Subjects who missed out at least two lessons or surveys that contains one third uncomplete parts will be excluded for analysis. Statistical analysis was performed using IBM SPSS Statistics Version 22 (SPSS Inc., Chicago, IL, USA). For each scale except for the SOC, item responses were summed to create a scale score. Desired outcomes were noted by higher scores. Wilcoxon Signed Rank test was used to compare the median difference of NK, AT, and BE from pretest to final test within both Group A and B. Median difference between Group A and B were tested using Mann-Whitney U test. Subjects' behavioral stage distribution at each time point and the congruence of stages between pretest, midterm test and posttest were examined using frequency distribution and cross-tabulations. $P<.05$ were considered statistically significant.

RESULTS

Demographics Of all 41 applicants, 35 subjects remained and completed the whole program and surveys, survey response rate was 85.3%. Subjects were predominantly female (68.6%), with cooking experience (71.4%) and cooking interest (97.1%) (Table 1). Data between Group A and B showed no statistically different ($p>.05$), which are comparable. Subjects' stage of behavioral change for vegetables and fruits were predominantly at precontemplation stage whereas for sugar sweetened beverage was at action/maintenance stage during pretest. (Table 2).

Table 1 Demographic data of fourth-grade subjects, n(%)

	Total Subjects (n=35)	Group A (n=16)	Group B (n=19)
Gender			
Male	11(31.4)	4(25.0)	7(36.8)
Female	24(68.6)	12(75.0)	12(63.2)
Cooking Experience			
No	10(28.6)	3(18.8)	7(36.8)
Yes	25(71.4)	13(81.3)	12(63.2)
Cooking Interest			
No	1(2.9)	0(0.0)	1(5.3)
Yes	34(97.1)	16(47.1)	18(94.7)

Table 2 Subjects' stage of behavioral change during baseline (pretest), n (%)

	Total subjects (n=35)			Group A (n=16)			Group B (n=19)		
	PC	C/P	A/M	PC	C/P	A/M	PC	C/P	A/M
Vegetables	18(51.4)	9(25.7)	8(22.9)	6(37.5)	4(25.0)	6(37.5)	12(63.2)	5(26.3)	2(10.5)
Fruits	19(54.3)	6(17.1)	10(28.6)	6(37.5)	3(18.8)	7(43.8)	13(68.4)	3(15.8)	3(15.8)
Sugar Sweetened Beverages	11(31.4)	9(25.7)	15(42.9)	3(18.8)	5(31.3)	8(50.0)	8(42.1)	4(21.1)	7(36.8)

PC indicates precontemplation or do not plan to change; C/P indicates contemplation/preparation or plan to change; A/M indicates action/maintenance or have changed unhealthy behavior.

Nutrition Knowledge (NK) Subjects in Group A which attend cooking class first increased the median score for nutrition knowledge by 1.5 ($p<.05$) during midterm test whereas subjects in Group B which attend nutrition education class first showed and increased by 3.5 ($p<.05$). (Table 3). Both Group A and Group B showed significantly increase in median score during posttest compared to pretest. It was also noticed that median score for both Group A and B during final test, showed a significantly increase ($p<.05$) compared to pretest. Subjects in Group B who attend nutrition education curriculum first then experiential cooking showed a maintenance in median score at 10 since midterm test, however subjects in Group A who attend experiential cooking curriculum first then nutrition education showed a significant decreased of median score by 1 ($p<.05$) during the final test.

Selecting Attitude (AT) Attitude score for subjects in Group B showed a significantly higher than Group A by 2.5 ($p<.05$) during the final test (Table 3). After the whole program, both Groups showed a decrease in attitude score, but it did not show statistically significant. Median score for selecting attitude of subjects within both groups considered the same during pretest and final test.

Consuming Behavior (BE) The median of Group A subjects' behavior towards FV and SSB does not show significantly increase in neither midterm test nor posttest compared to pretest, yet it showed a significantly increased by 4.5 ($p<.05$) during follow-up test. However, median of Group B subjects showed a significant increased by 2 and 2.5 ($p<.05$) during midterm test and posttest respectively, but there was no statistically different between midterm test and posttest.

Table 3 Nutrition knowledge, selecting attitude and consuming behavior score of vegetables, fruits and sugar sweetened beverages during pretest, midterm test, posttest, follow-up test and final test, median (IQR)

	Group A (n=16)[1]					Group B (n=19)[1]				
	W_0 (Pretest) (Before intervention)	W_4 (Midterm Test) (After cooking)	W_8 (Posttest) (Cook-Education)	W_{10} (Follow-up Test (2 weeks after program)	W_{20} (Final Test) (After winter break)	W_0 (Pretest) (Before intervention)	W_4 (Midterm Test) (After Education)	W_8 (Posttest) (Education-Cook)	W_{10} (Follow-up Test (2 weeks after program)	W_{20} (Final Test) (After winter break)
Nutrition Knowledge [2]	6.5 (5-8)^a	8 (7-10.75)^b	10.5 (9-11)^{bc}	10 (9-11)^c	9 (8-10)^b	6.5 (5-8)^a	10 (8-11.25)^b	10 (9-12)^b	10 (9-12.25)^b	10 (9-11)^b
Selecting Attitude [2]	52 (49.25-54.75)	50.5 (48-54)	50.5 (46.25-56.5)	52 (43.25-55)	52* (43.25-55)	54.5 (49.5-57.25)	54 (49-56)	53 (46-56.25)	52 (47.75-55.25)	54.5* (49.25-57)
Consuming Behavior [2]	46.5^a (34.25-54.25)	49^a (33-54.75)	48 (37.5-56.75)	51^b (35.25-58.5)	48 (38.5-57.25)	43^a (33.75-53.5)	45^b (38.5-58.25)	45.5^b (41.25-56.25)	47 (40-53)	46.5 (38.75-58.25)

1. Median in the same row with * marks are significantly different ($p<.05$)
2. Median in the same row with different letters are significantly different ($p<.05$)

Score range: Nutrition Knowledge 0-15; Selecting Attitude 12-60; Consuming Behavior 12-60

Stages of Behavior Change Behavior change in this study indicated that subjects consumed two daily servings of vegetables, one daily serving of fruits and less than four times per week of sugar- sweetened beverages. Regress indicates backward movement to an earlier stage, stable indicates no change in stage, while progress indicates forward movement to a later stage. Data in Table 4 represents the percentages of subjects evidencing each pattern in experiential cooking curriculum, nutrition education curriculum and the overall intervention. In terms of vegetables and fruits, percentage of progress was more desirable in cooking curriculum than that of nutrition education curriculum which were 20.0% and 25.71% respectively. However, it shows a contrast in terms of sugar sweetened beverage. Percentage of progress was more favorable in nutrition education curriculum (25.71%). As an overall intervention which including both cooking and nutrition education intervention, all subjects either in Group A or Group B, showed a better outcome which progressed to a later stage by 20.0%, 25.71% and 37.14% for vegetables, fruits and sugar sweetened beverages respectively as shown in Table 4.

Table 4 Patterns of stability and change in stage after cooking curriculum, nutrition education curriculum and overall intervention, n (%)

	Cooking Curriculum (n=35) W_4-W_0(A)+W_8-W_4(B)			Nutrition Education Curriculum (n=35) W_8-W_4(A)+ W_4-W_0(B)			Overall Intervention (n=35) W_8-W_0(A)+W_8-W_0(B)		
	Regress	Stable	Progress	Regress	Stable	Progress	Regress	Stable	Progress
Vegetables	3 (8.57)	25 (71.43)	7 (20.0)	8 (22.86)	24 (68.57)	3 (8.57)	3 (8.57)	25 (71.43)	7 (20.0)
Fruits	1 (2.86)	25 (71.43)	9 (25.71)	4 (11.43)	29 (82.86)	2 (5.71)	1 (2.86)	25 (71.43)	9 (25.71)
Sugar-Sweetened Beverages	6 (17.14)	22 (62.86)	7 (20.0)	4 (11.43)	22 (62.86)	9 (25.71)	5 (14.29)	17 (48.57)	13 (37.14)

W_0, Pretest (before intervention); W_4, Midterm test (after first period/4 weeks of curriculum); W_8, Posttest (after second period/4 weeks of curriculum)

DISCUSSION

This study examined the effectiveness of experiential cooking and nutrition education intervention through NK, AT and BE towards FV and SSB. Besides, readiness of subjects to consume two daily servings of vegetables, one daily serving of fruits and less than four times per week of sugar sweetened beverages were assessed by stages of behavior change (SOC) among Fourth-grade elementary school students. Results showed a significant increase in both subjects' nutrition knowledge after cooking program in Group A and after experiential learning in Group B during the first 4-week curriculum. These results are consistent with a meta-analysis of a wide variety of school-based nutrition education programs found that experiential learning programs such as hands-on cooking or gardening can improve nutrition knowledge and vegetable consumption in elementary school children (22). Even though the knowledge score of both Group A and Group B subjects were not significantly improved after the second 4-week curriculum, but both groups of knowledge score during posttest was significantly higher than during pretest. This may be explained by the retention of knowledge gained during the first 4-weeks when Group B received nutrition education intervention before crossover took place, which in crossover design is referred to as a carryover effect (23). Carry-over effect in this situation explained that the subjects from both groups have obtained nutrition knowledge during the first 4-weeks of curriculum. Then, the knowledge obtained was carried forward to the second 4-weeks of curriculum. In addition, knowledge score was able to retain for two weeks and up to ten weeks in Group A and Group B subjects, respectively.

In terms of selecting attitude towards FV and SSB by subjects, no significant difference in attitude score was noticed by both groups after 8- weeks intervention. This might be due to the duration of both cooking and nutrition education programs that could influence children's food-related preferences (24). Median duration of most nutrition education intervention was found to be 10 sessions with duration of 90 minutes. Due to time constraint consideration, the duration in this study was only held for 4 weeks each with a duration of 30 minutes each week. It was relatively low compared to most studies. Subjects' diet -related behavior reported as significant higher immediately after 4-weeks of curriculum and after the whole intervention which was another 4- weeks after. This phenomenon was noticed in Group B subjects which started with nutrition education curriculum first and then cooking curriculum. Even though there was no instant significant increase in behavior score for Group A subjects, yet a significant higher in behavior score was noticed during follow-up test (2-weeks after the intervention) compared to pretest and midterm test. This might show that whenever there was experiential and contextual knowledge program, a lasting impact on diet-related behavior could be noticed (25).

Behavior change in consuming FV and SSB was assessed further through stages of change. No comparison of food consumption frequency between different stages of change was made. Subjects were compared individually beginning from pretest to posttest to obtain the pattern of stability and change in stage after different curriculum. Despite review demonstrated that stage-tailored intervention is preferable to increase the effectiveness and success of nutrition education intervention, nonetheless, this study reported that the whole program which included both cooking and nutrition education curriculum could facilitate subjects' behavior change to progress to a later stage rather than only one type of curriculum. The results also indicated that different curriculum might be suitable for different food items. For instance, the effect of cooking curriculum was found to be more suitable for vegetables and fruits while nutrition education curriculum which mainly carried out through lecturing, drama in education, and games were more effective for sugar sweetened beverages. Surprisingly, as the result suggested, a combination of both cooking and nutrition education curriculum would eventually provide a better outcome in terms of facilitating subjects to move forward to a later stage which lastly changed their unhealthy behavior especially for sugar sweetened beverages.

CONCLUSION

The findings of this study demonstrate that both the cooking curriculum and the nutrition education curriculum independently contributed to significant improvements in nutrition knowledge and dietary behaviors among elementary school children, particularly in relation to fruit and vegetable (FV) intake and reduced consumption of sugar-sweetened beverages (SSB). Importantly, the most compelling outcome emerged when both curricula were implemented together. The integration of practical cooking skills with structured nutrition education produced a synergistic effect, reinforcing knowledge while simultaneously enabling children to apply it in real-life contexts. This dual approach facilitated progression to more advanced stages of behavioral change, suggesting that children were not only learning but also internalizing and practicing healthier habits.

Such progression is critical, as it reflects the potential for sustained lifestyle modifications rather than short-term improvements. By combining experiential learning with theoretical understanding, the intervention empowers children to make informed food choices and actively engage in their own health management. This integrated model is particularly effective in the elementary school setting, where early interventions can establish foundational habits that persist into adolescence and adulthood.

In conclusion, the combined cooking and nutrition education curricula provide a comprehensive framework for promoting healthy eating concepts in schools. Beyond improving knowledge and immediate behaviors, this approach supports long-term behavioral change, offering valuable insights for educators, policymakers, and health professionals seeking to design impactful school-based interventions. The evidence underscores the importance of holistic strategies that address both knowledge and practice in fostering lifelong healthy eating behaviors.

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