

Effectiveness of nutrition education in fruit and vegetable consumption in Saudi Arabia: A pre-post intervention study

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Abstract: Despite the well-established benefits of fruit and vegetable (FV) consumption for weight management and chronic disease prevention, intake among Saudis remains below recommended levels. This study aimed to evaluate the effectiveness of a nutrition education intervention in improving FV consumption among Saudi female college students. A pre-post intervention design guided by the logic model was employed. A total of 207 Saudi female students completed an assessment questionnaire before and after a 1.5-hour nutrition education session. The program emphasized the importance of FV consumption, provided practical strategies and recipes to increase intake, and incorporated an interactive game to promote engagement. Data were analyzed using the Wilcoxon signed-rank test. Findings: Post-intervention results indicated significant improvements in daily FV consumption ($p < 0.001$), awareness of personal FV intake recommendations for fruits ($p < 0.001$) and vegetables ($p = 0.006$), and the frequency of cooking vegetables at lunch ($p = 0.007$). Nutrition education effectively enhanced FV consumption behaviors and knowledge among participants. Implementing similar educational programs and awareness campaigns through curricula and across media platforms may help increase FV intake and promote healthier dietary habits in Saudi society.

Keywords: College students, Fruits, Intervention, Nutrition education, Vegetables.

1. Introduction

Sufficient consumption of fruits and vegetables (FV) is essential for a healthy lifestyle. FV are low in calories and fat, and high in vitamins, minerals, and dietary fibers [1]. These nutrients have been shown to protect against cell damage, reduce inflammation, and improve blood vessel function. In addition, eating FV is linked to numerous health benefits, such as a reduced risk of chronic diseases, weight management, improved gut health, and sharper cognitive function [2]. A meta-analysis of 95 prospective studies revealed that consuming an additional 200 grams of fruits and vegetables daily was significantly associated with reduced risks of coronary heart disease, stroke, cardiovascular disease, cancer, and premature mortality [3]. The World Health Organization (WHO) recommends a minimum of five servings of fruits and vegetables (FV) daily for adults [1].

Despite the benefits of FV consumption on weight and decreased risk for non-communicable diseases, the Saudi Arabia World Health Survey report indicated that 93% of Saudi adults (ages 15 and above) had an insufficient intake of FV [4]. Insufficient intakes of FV decreased as age increased, and this was reported in both female and male Saudi university students [5, 6]. To cultivate a healthier nation, it is essential to raise awareness among Saudi individuals and households regarding the crucial role of FV in their diet.

Nutrition education is one way to promote increased fruit and vegetable (FV) consumption. It can provide individuals with the knowledge and skills they need to make healthy food choices. It can also help make FV more appealing and accessible. Several studies have been conducted on the effectiveness of nutrition education in increasing FV consumption [7-9]. These interventions included lectures,

discussions, recipe handouts, cooking classes, group sessions, and hands-on activities. The results of these studies suggest that nutrition education can be an effective intervention for increasing fruit and vegetable consumption, but more research is needed to determine the optimal approach.

In Saudi Arabia, a study found that a school-based nutrition education program was effective in increasing fruit and vegetable consumption among Saudi adolescents [10]. The program included six 90-minute sessions delivered over three months on healthy and unhealthy eating, body image, and physical activity. In addition, a large nutrition awareness program at a Saudi female university ($n = 3,555$ across pre-/post-independent samples) improved knowledge scores substantially but did not produce a significant change in reported dietary practices overall [11]. The study authors recommend tailoring activities to specific target groups (students vs. staff) and using repeated or more intensive behavior-change strategies to translate knowledge into practice.

Interventions to increase FV intake among young adults can yield long-term health benefits [12]. This is especially crucial for females, as early adulthood dietary patterns often carry into later life. Adequate nutrition during adolescence can help address any nutritional gaps from childhood and reduce the risk of various health problems later in life. Therefore, this study aimed to assess the effectiveness of an interactive session of nutrition education in improving FV consumption among Saudi female college students using pre-post measurements.

2. Materials and Methods

To structure this pre-post intervention study, the Community Nutrition Education Logic Model, a framework developed by the United States Department of Agriculture, was employed to clarify objectives, determine resource requirements, and outline an evaluation framework (Figure 1) [13]. The model presents the shared relationships among the inputs, outputs, and outcomes of the nutrition education program. The inputs of the program involved the baseline assessment, resources, and materials (such as recruited participants, the nutrition educator, and culturally relevant curriculum) required to implement the program.

The outputs of the program encompassed the following intervention activities: 1) An informative presentation about the benefits of fruit and vegetable (FV) consumption and daily servings of FV intake; 2) Handouts of recommendations to increase FV intake; 3) Distributions of mixed dried FV; and 4) An interactive game of ideas to incorporate FV into dishes. The outcomes of the program included the assessment and short-term and long-term impacts, which were: 1) increased knowledge about the benefits of FV intake; 2) improved behaviors and attitudes towards FV; 3) enhanced self-efficacy for incorporating FV into meals; 4) developed skills for selecting, preparing, and consuming FV; 5) improved overall health and well-being; 6) sustainable healthy eating habits throughout life; and 7) positive influence on family and community by promoting healthy dietary choices.

This study included three phases: 1) The Pre-Intervention Phase; 2) The Intervention Phase; and 3) The Post-Intervention Phase. Using a convenience sampling method, this pre-post intervention study was conducted among female students. At the Pre-Intervention Phase, undergraduate female students from the College of Agriculture Sciences and Foods at King Faisal University were invited through digital announcements to participate in the study and completed a baseline electronic questionnaire (The Pre-Intervention Phase). The questionnaire was available in Arabic for the participants and began with an informed consent document outlining the study's objectives, estimated completion time, and the voluntary nature of participation. To proceed, participants were required to electronically acknowledge their consent by clicking an "agree to participate" button. They also retained the right to withdraw from the questionnaire at any point.

The first section of the questionnaire collected sociodemographic data, such as age, marital status, and monthly household income level. Additionally, the study participants' self-reported height and weight were collected to compute body mass index (BMI) using the formula: $\text{weight (kg)} / [\text{height (m)}]^2$. BMI is categorized as follows: underweight (below 18.5), normal weight (18.5-24.9), overweight (25-29.9), and obese (30 and above) [14]. The second section of the questionnaire included participants'

dietary preferences for FV, average daily consumption of FV, knowledge and meeting daily requirements (servings) of FV, FV consumption in different forms and dishes, and barriers to daily FV consumption. The questionnaire also included questions on the average frequency of eating out and requesting food from restaurants. The questions related to FV consumption were adopted from the study of Epuru et al. [6] conducted on female university students in Saudi Arabia [6]. In addition, the questionnaire contained a set of questions related to physical activity to assess the participants' interest in following a healthy lifestyle. The physical activity questions were based on the Behavioral Risk Factor Surveillance System (BRFSS) questionnaire [15].

After collecting all the data for the Pre-Intervention Phase, a date (the week following the Pre-Intervention Phase) and a location (at the College of Agricultural Sciences and Foods) were designated for the assigned nutrition education. The Intervention Phase comprised five nutrition education programs, each involving approximately 50 study participants and lasting between 1.5 to 2 hours. Each session included a lecture delivered by the investigator on the importance of consuming fruits and vegetables (FV), the nutritional and health benefits of FV intake, the recommended daily servings based on physical activity levels, and strategies for incorporating FV into various home-cooked recipes and restaurant dishes. Additionally, an interactive game was conducted, where participants wrote ideas for adding FV to dishes on colored paper clips, which were then hung on a lighted tree to promote increased FV consumption. Handouts with suggestions and ideas for boosting daily FV intake were distributed, along with snack bags containing dried FV. After one or two weeks, during the Post-Intervention Phase, participants were invited to complete a post-assessment questionnaire, which included the same questions as the baseline assessment. The study protocol and survey received approval from King Faisal University's Research Ethics Committee (KFU-REC/2020-05-12).

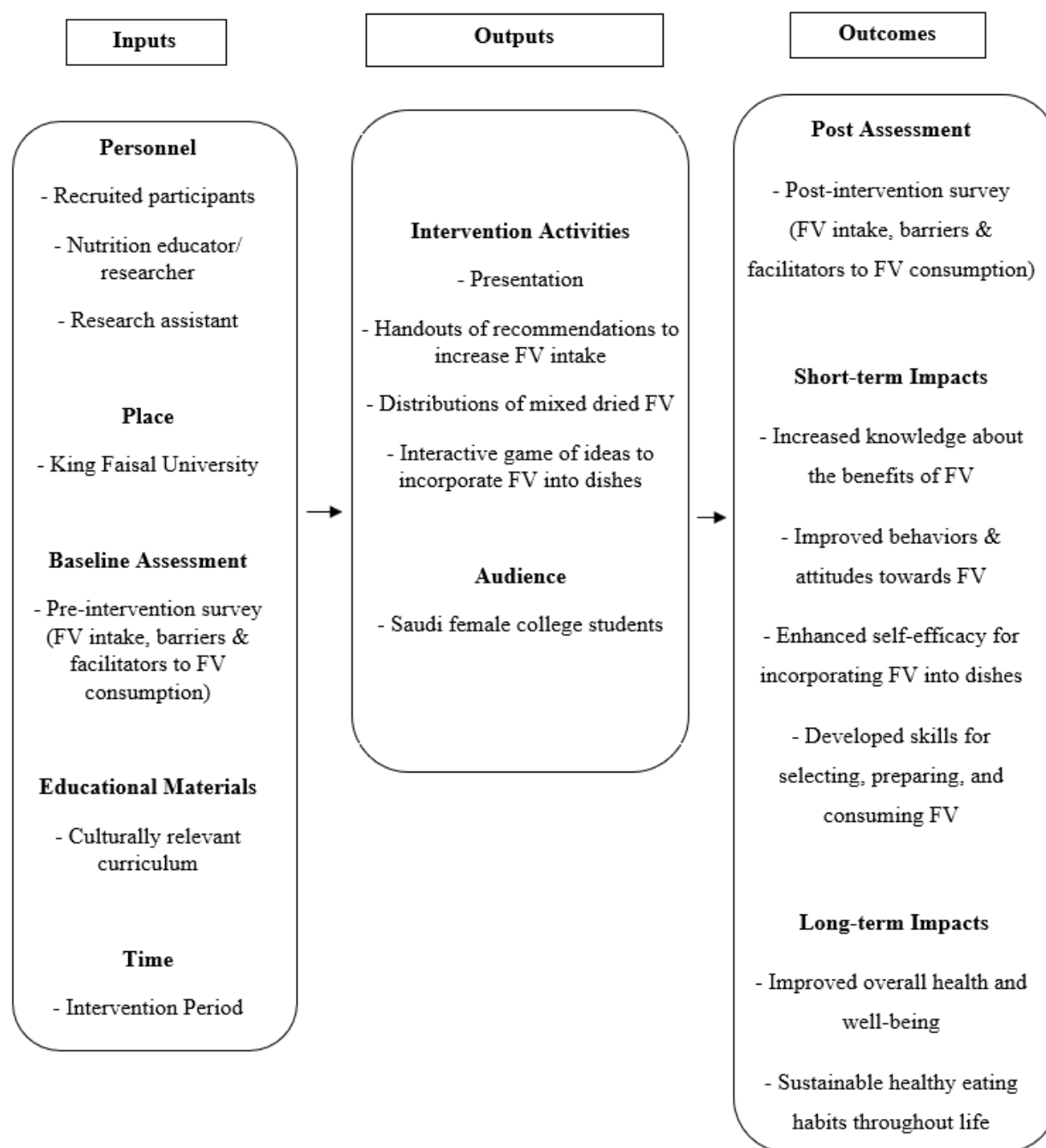


Figure 1.
The Framework Logic Model for the Pre-Post Intervention Development.

Statistical analysis was conducted using IBM SPSS Statistics for Windows, Version 27.0. Relative proportions were derived from various socio-demographic characteristics. Categorical data were presented in terms of frequencies and percentages, whereas continuous data were expressed as means and standard deviations. The proportions agreeing in various dimensions pre- and post the nutrition education program were also determined and compared using the Wilcoxon signed-rank test. A p-value of less than 0.05 was considered statistically significant.

3. Results

In this study, 250 female students completed the baseline assessment questionnaire during the pre-intervention phase. After excluding those who did not complete the post-assessment questionnaire in the post-intervention phase, the final participation sample consisted of 207 Saudi female students aged 18 years and above.

Table 1 presents the distribution of the students according to various socio-demographic characteristics. The mean (SD) age of the students was 22 (1.30) years, and over 90% of the students were from the Al Ahsa Governorate. More than 50% of the students were single and had a monthly household income of less than SR 10,000 (~ USD 2,666). Based on self-reported weight and height, over 55% of the students had a normal weight.

Table 1.

Distribution of college students' socio-demographic characteristics (n= 207).

Socio-demographic Characteristics	f (%)	M (SD)
Age		22.10 (1.30)
Marital Status		
Single	108 (54.59)	
Married	94 (45.42)	
Place of Origin		
Within Al Ahsa Governorate	191 (92.27)	
Outside Al Ahsa Governorate	16 (7.73)	
Household Income		
Less than SR 6,000	58 (28.02)	
SR 6,000 – 9,999	66 (31.88)	
SR 10,000 – 13,999	35 (16.91)	
SR 14,000 – 18,999	22 (10.63)	
SR 19,000 and over	26 (12.56)	
Body Mass Index		22.88 (4.62)
Underweight	37 (17.87)	
Normal weight	117 (56.52)	
Overweight	36 (17.39)	
Obese	17 (8.21)	

Table 2 presents the comparison of FV intake before and after the intervention. Statistically significant differences in the proportions before and after the intervention were noted in the following domains: eating fruits daily ($p = < 0.001$), eating vegetables daily ($p = < 0.001$), eating leafy vegetables daily ($p = 0.007$), knowing one's daily needs for fruits ($p = 0.001$), knowing one's daily needs for vegetables ($p = 0.006$), ensuring the intake of daily needs for fruits ($p = 0.003$), and ensuring the intake of daily needs for vegetables ($p = < 0.001$).

Table 2.
Comparison of fruit and vegetable intake before and after the intervention.

Domain	Baseline		Post		Wilcoxon signed rank statistic	p-value
	Agree	Disagree	Agree	Disagree		
	f (%)	f (%)	f (%)	f (%)		
Like eating fruits	198(95.7)	9(4.3)	204(98.6)	3(1.4)	11.000	0.033
Like eating vegetables	185(89.4)	22(10.6)	188(90.8)	19(9.2)	120.000	0.272
Eating fruits daily	63(30.4)	144(69.6)	95(45.9)	112(54.1)	265.000	< 0.001*
Eating vegetables daily	74(35.7)	133(64.3)	104(50.2)	103(49.8)	220.500	< 0.001*
Eating leafy vegetables daily	51(24.6)	156(75.4)	69(33.3)	138(66.7)	495.000	0.007*
Knowledge of the daily personal needs of fruits	152(73.4)	55(26.6)	168(81.2)	39(18.8)	87.000	0.001*
Knowledge of daily personal needs for vegetables	153(73.9)	54(26.1)	166(80.2)	41(19.8)	98.000	0.006*
Making sure of eating the daily need of fruits	62(30.0)	145(70.0)	84(40.6)	123(59.4)	630.000	0.003*
Making sure of eating the daily need of vegetables	55(26.6)	152(73.4)	82(39.6)	125(60.4)	527.000	< 0.001*
Eating fresh fruits daily is costly	49(23.7)	158(76.3)	49(23.7)	158(76.3)	333.000	0.504
Eating fresh vegetables daily is costly	40(19.3)	167(80.7)	42(20.3)	165(79.7)	94.500	0.335

Note: * P value is considered significant at < 0.05.

Table 3 presents a comparison of FV consumption frequency before and after the intervention. Statistically significant differences in the proportions before and after the intervention were noted in the number of days of fruit (fresh, seasonal, frozen, canned) consumption last week ($p = 0.049$) and the number of cups of fruit juice consumed each day last week ($p < 0.001$). Regarding vegetable consumption, statistically significant differences in the proportions before and after the intervention were observed in the following domains: the number of servings of vegetables consumed each day last week ($p = 0.003$), the number of days of consumption of corn (boiled, steamed, grilled) last week ($p = 0.046$), the number of times vegetables were cooked in lunch meals last week ($p = 0.007$), and the number of times vegetables were consumed with foods (e.g., egg sandwich with tomato, vegetable stock) last week ($p = 0.006$).

Table 3.

Comparison of fruit and vegetable consumption frequency before and after the intervention.

Domain	Baseline f (%)	Post f (%)	Wilcoxon signed rank statistic	p-value
During last week, a number of days of consuming fruits (fresh, seasonal, frozen, canned)				
None	14(6.8)	6(2.9)	1494.000	0.049*
1 day	47(22.7)	45(21.7)		
2-4 days	115(55.6)	119(57.5)		
Over 4 days	31(15.0)	37(17.9)		
Number of servings of fruits consumed each day last week				
None	12(5.8)	8(3.9)	1875.000	0.220
1 serving	73(35.3)	74(35.7)		
2-4 servings	114(55.1)	112(54.1)		
Over 4 servings	8(3.9)	13(6.3)		
During last week, a number of days of consumption of fruit juice (fresh, fruit drink, canned)				
None	53(26.6)	46(22.2)	1401.500	0.447
1 day	78(37.7)	81(39.1)		
2-4 days	60(29.0)	66(31.9)		
Over 4 days	16(7.7)	14(6.8)		
Number of cups of fruit juice consumed each day last week				
None	59(28.5)	47(22.7)	508.000	< 0.001*
1 cup	120(58.0)	105(50.7)		
2-4 cups	24(11.6)	49(23.7)		
Over 4 cups	4(1.9)	6(2.9)		
Number of times of consuming dates (fresh, dried, with sweets) last week				
Never	57(27.5)	51(24.6)	1799.500	0.372
Once	59(28.5)	53(25.6)		
2-4 times	54(26.1)	74(35.7)		
Over 4 times	37(17.9)	29(14.0)		
Number of servings of dates consumed last week				
None	61(29.5)	54(26.1)	1026.000	0.289
1 serving	73(35.3)	79(38.2)		
2-4 servings	62(30.0)	59(28.5)		
Over 4 servings	11(5.3)	15(7.2)		
Number of days of consumption of vegetables (salad, green onion, chilies, pickles) last week				
None	21(10.1)	19(9.2)	2145.000	0.100
1 day	54(26.1)	48(23.2)		
2-4 days	103(49.8)	105(50.7)		
Over 4 days	29(14.0)	35(16.9)		
Number of servings of vegetables consumed each day last week				
None	17(8.2)	19(9.2)	1404.500	0.003*
1 serving	102(49.3)	76(36.7)		
2-4 servings	78(37.7)	97(46.9)		
Over 4 servings	10(4.8)	15(7.2)		
Number of days of consumption of French fries last week				
None	65(31.4)	68(32.9)	631.000	0.145
1 day	95(45.9)	82(39.6)		
2-4 days	40(19.3)	51(24.6)		
Over 4 days	7(3.4)	6(2.9)		
Number of servings of French fries consumed each day last week				
None	69(33.3)	69(33.3)	598.000	0.342
1 serving	100(48.3)	99(47.8)		
2-4 servings	33(15.9)	31(15.0)		
Over 4 servings	5(2.4)	8(3.9)		
Number of days of consumption of corn (boiled, steamed, grilled) last week				
None	168(81.2)	148(71.5)	57.000	0.046*
1 day	32(15.5)	43(20.8)		
2-4 days	6(2.9)	16(7.7)		

Over 4 days	1(0.5)	0(0.0)		
Number of servings of corn consumed each day last week				
None	167(80.7)	148(71.5)	45.000	0.181
1 serving	33(15.9)	48(23.2)		
2-4 servings	6(2.9)	10(4.8)		
Over 4 servings	1(0.5)	1(0.5)		
Number of times of cooking vegetables in lunch meals last week				
Never	62(30.0)	51(24.6)	759.000	0.007*
Once	66(31.9)	57(27.5)		
2-4 times	62(30.0)	80(38.6)		
Over 4 times	17(8.2)	19(9.2)		
Number of times of consuming tomato sauce with foods (pizza, pasta) last week				
Never	65(31.4)	70(33.8)	929.000	0.548
Once	79(38.2)	79(38.2)		
2-4 times	58(28.0)	49(23.7)		
Over 4 times	5(2.4)	9(4.3)		
Number of servings of tomato sauce consumed each time last week				
None	67(32.4)	70(33.8)	2028.000	0.889
1 serving	60(29.0)	67(32.4)		
2-4 servings	71(34.3)	63(30.4)		
Over 4 servings	9(4.3)	7(3.4)		
Number of times of consuming vegetables with foods (egg sandwich with tomato, vegetable stock) last week				
Never	38(18.4)	26(12.6)	1313.500	0.006*
Once	81(39.1)	72(34.8)		
2-4 times	78(37.7)	95(45.9)		
Over 4 times	10(4.8)	14(6.8)		

Note: * P value is considered significant at < 0.05 .

Table 4 presents the comparison of eating out and requesting food from restaurants before and after the intervention. Statistically significant differences in the proportions before and after the intervention were noted in average eating out ($p = 0.004$).

Table 4.

Comparison of the eating habits between before and after the intervention.

Comparison of the eating habits between before and after the intervention.				
Domain	Baseline	Post	Wilcoxon signed rank statistic	p-value
	f (%)	f (%)		
Eating out				
Never	1(0.5)	6(2.9)	1860.500	0.004*
Once a year	3(1.4)	6(2.9)		
2-4 times a year	8(3.9)	5(2.4)		
Once a month	71(34.3)	70(33.8)		
Once a week or more	124(59.9)	120(58.0)		
Requesting food from restaurants				
Never	4(1.9)	7(3.4)	967.000	0.113
Once a year	5(2.4)	5(2.4)		
2-4 times a year	10(4.8)	11(5.3)		
Once a month	75(36.2)	75(36.2)		
Once a week or more	113(54.6)	109(52.7)		

Note: * P value is considered significant at < 0.05 .

Table 5 presents a comparison of physical activity practices before and after the intervention. Statistically significant differences in the proportions before and after intervention were noted in knowing the time needed for physical activity based on gender, physiological status, and age ($p = 0.002$).

Table 5.

Comparison of the frequency and duration of engaging in moderate and vigorous physical activity between before and after intervention.

Domain	Baseline	Post	Wilcoxon signed rank statistic	p-value
	f (%)	f (%)		
Engaging in physical activity regularly				
Agree	69(33.3)	74(35.7)	304.000	0.208
Disagree	138(66.7)	133(64.3)		
Knowing the time needed for physical activity based on gender, physiological status, and age				
Agree	124(59.9)	145(70.0)	432.000	0.002*
Disagree	83(40.1)	62(30.0)		
The average of engaging in moderate physical activity				
Agree	171(82.6)	171(82.6)	637.500	0.502
Disagree	36(17.4)	36(17.4)		
Number of days of engaging in moderate physical activity for at least 10 mins				
Never	37(17.9)	27(13.0)	3557.000	0.423
Once/week	43(20.8)	39(18.8)		
2-3 days/week	57(27.5)	83(40.1)		
4-5 days/week	43(20.8)	37(17.9)		
Over 5 days/week	27(13.0)	21(10.1)		
Total time of engaging in moderate physical activity				
Never	49(23.7)	33(15.9)	1422.000	0.082
10-30 min/day	113(54.6)	130(62.8)		
31-60 min/day	33(15.9)	30(14.5)		
Over 60 min/day	12(5.8)	14(6.8)		
Average of engaging in vigorous physical activity				
Agree	95(45.9)	95(45.9)	1387.500	0.501
Disagree	112(54.1)	112(54.1)		
Number of days of engaging in vigorous physical activity for at least 10 mins				
Never	97(46.9)	97(46.9)	2598.000	0.603
Once/week	14(6.8)	46(22.2)		
2-3 days/week	39(18.8)	40(19.3)		
4-5 days/week	46(22.2)	17(8.2)		
Over 5 days/week	11(5.3)	7(3.4)		
Total time of engaging in vigorous physical activity				
Never	108(52.2)	108(52.2)	1432.500	0.282
10-30 min/day	74(35.7)	68(32.9)		
31-60 min/day	16(7.7)	20(9.7)		
Over 60 min/day	9(4.3)	11(5.3)		

Note: * P value is considered significant at < 0.05 .

4. Discussion

The nutritional habits adopted during young adulthood significantly influence long-term physical health outcomes. Adequate nutrient intake not only supports present well-being but also mitigates the risk of developing chronic diseases later in life. Furthermore, a balanced diet plays a crucial role in preventing excessive weight gain, a major contributor to various health issues. This study assessed the effect of a nutrition education program, guided by the Logic Model, in increasing FV consumption in Saudi female college students. The intervention strategies involved an informative presentation about the nutritional benefits of FV and recommended daily servings, distribution of handouts with tips for increasing FV intake, provision of mixed dried FV samples, and an interactive game to encourage creative ideas for incorporating FV into meals.

The intervention improved several dietary behaviors related to FV, including daily consumption of FV and ensuring daily intake of FV. These findings, aligned with previous research, demonstrated that a structured nutrition program could effectively enhance participants' FV consumption frequency and suggested that targeted interventions could play a pivotal role in promoting healthier dietary habits [9, 16, 17]. The study findings also revealed increased nutrition knowledge of personal daily needs of FV.

This finding was similar to previous studies conducted among college students and revealed an increase in knowledge regarding portion sizes and the number of servings of FV after intervention [8, 11].

In addition, the intervention increased consumption of fruits in various forms, including fresh, seasonal, frozen, canned, and juice, aligned with previous research highlighting the effectiveness of nutrition education in promoting fruit intake [8, 18, 19]. The observed improvement in vegetable consumption, both in terms of daily servings and cooking frequency, was also consistent with the findings of other studies [20, 21].

The intervention effectively increased vegetable intake by providing practical tips, recipes, and encouraging meal planning. The specific finding of increased corn consumption in various preparation methods (boiled, steamed, grilled) is intriguing. While corn is a common vegetable, its specific consumption patterns and the impact of nutrition education on its intake have not been extensively studied. This result suggests that targeted education on the nutritional benefits of corn and diverse cooking methods can significantly influence dietary choices that are culturally acceptable in this population of female Saudi college students.

The practice of consuming vegetables with other foods, such as egg sandwiches with tomato and vegetable stock, is a promising, culturally acceptable strategy for increasing vegetable intake. Combining vegetables with familiar and preferred foods can make them more appealing and increase their consumption. This approach is supported by previous research on food pairing and its impact on dietary behavior [22, 23]. A study found a correlation between increased frequency of cooking, enhanced culinary skills, and the implementation of meal planning strategies, with greater FV consumption and lower BMI among college students [24].

Furthermore, there was a positive impact of the nutrition education program on dietary habits, particularly eating out, and physical activity knowledge. Research has demonstrated the effectiveness of nutrition education interventions in modifying dietary behaviors and improving knowledge of healthy lifestyles [25, 26]. Nutrition education programs can encourage individuals to prepare meals at home more frequently [27]. This shift can lead to healthier dietary choices, as home-cooked meals often contain fewer calories, less saturated fat, and more nutrients compared to restaurant food. By providing participants with specific guidelines regarding physical activity requirements based on individual factors, nutrition education programs can provide individuals with the knowledge and tools needed to tailor their exercise routines to their specific nutritional needs [28].

Establishing positive eating habits, including increased fruit and vegetable consumption, during young adulthood is crucial for both individual health and global sustainability [20]. Public policies and innovative strategies are essential to encourage these healthy dietary practices among college students. Overall, this study demonstrated the positive impact of nutritional interventions on female university students. By increasing their FV consumption and reducing fried food intake, participants significantly improved their overall nutritional status and engaged in more regular physical activity. These findings underscore the importance of targeted nutritional interventions for this demographic and highlight the need for broader community-based initiatives to promote healthy eating habits.

This study included several strengths. First, the nutrition education intervention was grounded in a robust logic model framework. Second, the intervention strategically targeted specific behavioral factors linked to FV consumption, including enhancing knowledge, preference, and self-efficacy. Third, the designed nutrition lessons, handouts, and activities significantly enriched the intervention, ultimately aiming to facilitate the desired behavior change. Yet, the study had some limitations. The three-week duration restricted the assessment of long-term behavior change. Future research could explore the sustainability of the observed changes over a longer period and investigate the factors influencing long-term adherence to healthy dietary habits. Additionally, participants' self-reported FV intake may have been overestimated due to social desirability bias. Including a comparison group would help to rule out the effect of non-intervention influence on the study results. Moreover, the study focused on Saudi female college students. It would be beneficial to replicate the intervention in diverse settings to determine its generalizability. Further research could also investigate the cost-effectiveness of such

interventions and explore innovative approaches to deliver nutritional education, such as digital platforms and mobile applications to provide additional targeted messages and establish healthy eating communities where challenges and successes could be shared.

5. Conclusion

This study investigated the efficacy of a nutritional intervention targeting female college students in Saudi Arabia. The intervention successfully promoted increased consumption of FV, leading to significant improvements in overall dietary habits. To optimize the effectiveness of future interventions, it is recommended to employ a diverse range of strategies, including lectures, educational texts, social media campaigns, and interactive games. Continuous monitoring and follow-up are essential to ensure sustained adherence to recommended FV intake. Moreover, enhancing the dissemination of reliable nutritional information through accredited entities on social media and incorporating FV education into curricula and media platforms may further increase awareness of the need for increased consumption. Future research should extend beyond university students to encompass the broader Saudi community, including schools, workplaces, and diverse demographic groups. Moreover, future nutritional interventions should integrate other healthy lifestyle behaviors such as physical activity, adequate sleep, and stress management to promote overall health and prevent chronic diseases.

Institutional Review Board Statement:

The study protocol and survey were approved by the King Faisal University's Research Ethics Committee (KFU-REC/2020-05-12).

Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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