

Effects of Nutrition Education on Snacking Patterns among College Students: An Experimental Study

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Abstract Background: The present study aimed to evaluate the impact of nutrition education on snacking patterns among college students based on the Theory of Planned Behavior (TPB). **Methods:** An experimental study design was conducted. A total of 265 students were selected through a cluster sampling method and divided into an intervention group of 128 and a control group of 137. The self-administered questionnaire was used to collect data. The intervention group received three educational sessions, each lasting 55-60 minutes and consisting of lectures, educational brochures, discussions and question-and-answer activities. The data were collected at two stages (once at baseline and once three months after the intervention). **Results:** Students who received nutrition education showed improvements in the consumption of fruits ($p = 0.002$), vegetables ($p = 0.045$), milk ($p = 0.004$) and nuts ($p = 0.019$). Furthermore, a significant decrease in the consumption of soft drinks and energy drinks ($p = 0.035$), ($p = 0.013$), respectively) was observed in the intervention group compared to the control group. No significant differences were observed in the remaining snacking patterns between the two groups. **Conclusion:** The study found that students in the intervention group showed improvements in some snacking patterns. However, we strongly recommend that policymakers consider nutrition sessions in the higher education curriculum and improve access to healthy snack options on university campuses.

Key Words Snack, Educational Intervention, College Students, Duhok Polytechnic University

INTRODUCTION

A snack typically refers to a food consumed between meals and often includes nutrient-poor choices high in sugar, sodium, or saturated fat and energy-dense [1,2]. There is a shift in dietary patterns from the traditional three meals a day to smaller and more frequent intakes or inter-meal consumption [3]. College students spend a significant amount of time away from home and on college campuses. This transition primarily affects eating habits, contributing to undesired weight gain and may have serious health effects in the future [4]. Due to a lack of time and stress associated with studying, it is difficult for college students to maintain a healthy diet. Instead, they often consume unhealthy snack products, skip meals, or eat fast food [5]. Snacks consumed on college campuses provide high amounts of solid fat, sodium and sugar [6]. According to the World Health Organization, the health status and well-being of adolescents and young adults are actually linked to lifestyle and behavioral factors that make them more susceptible to

disease and other negative effects [7]. According to research, 44% of all food purchases were quick, convenient and unhealthy snacks over two semesters in a university cafeteria, while only 22% were healthy [8]. Several factors have been identified as influencing college students' consumption of healthy and unhealthy snacks, including economic, physical, biological, psychological and social aspects [9]. Although nutrition education interventions among university students have been extensively investigated in many countries, data from Kurdistan Region are still limited. Students in our community experience nutrition challenges, such as increased availability of energy drinks and fast foods, unhealthy snacks in universities, as well as the unavailability of nutrition curriculum or education. Thus, this study offers region-specific insights into the effects of nutrition education to understand the challenges and fill this gap in research. We aimed to study the impact of nutrition education on snacking patterns among college students based on TPB.

Theoretical Framework of the Theory of Planned Behavior

A range of various theories and models has been recommended for studying different factors that may affect individual behavior. Selecting a model for health education is the first step in planning any educational program, one of which could be TPB [10]. It is one of the most widely used theories for predicting health-related behaviors and has been successfully used to explain different dietary behaviors among college students, such as the consumption of fruits and vegetables [11]. As well as altering eating habits [12]. The model, presented by Ajzen and Fishbein, is widely used to assess the attitudes and beliefs related to food selection [13]. The theory of planned behavior is an individual's behavior that is influenced directly by behavioral intention and perceived behavioral control. The attitudes shape behavioral intention, perceived behavioral control and subjective norms [14]. TPB has also been used to promote healthier snack choices among college students [15].

MATERIALS AND METHODS

Study Design and Setting

An experimental study in the form of a cluster-randomized trial was conducted among students enrolled at Duhok Polytechnic University (DPU) in the Kurdistan Region of Iraq. Technical College of Engineering, Technical College

of Duhok and Technical College of Administration were included. DPU had two campuses inside Duhok city.

Study Participants and Sampling

The clusters (i.e., classes) were selected via the application of a simple random sampling technique. During data collection, 20 eligible clusters came from three different colleges. The researcher, who was not affiliated with the study and who used SPSS software, performed a simple random sampling that resulted in the random selection of 10 clusters among the 20. After selecting clusters, a lottery-based allocation method was used, whereby the selected classes were divided into intervention and control groups. All the steps taken were subject to blind reviews by the authors involved in the study. Five clusters were randomly assigned to the intervention group ($n = 132$) and the other five to the control group ($n = 141$). The students were visited in their classes and asked to complete a pretested, validated questionnaire. The intervention group had a completion rate of 96.97%, with 128 participants completing the study; the control group had a completion rate of 97.1%, with 137 participants completing the study Figure 1. Shows details of the flow chart of the study participants. Educational sessions were carried out between September 25th and November 15th, 2024 and the three-month follow-up assessment was completed on February 15, 2025 and the posttest data collection was completed on February 15th, 2025.

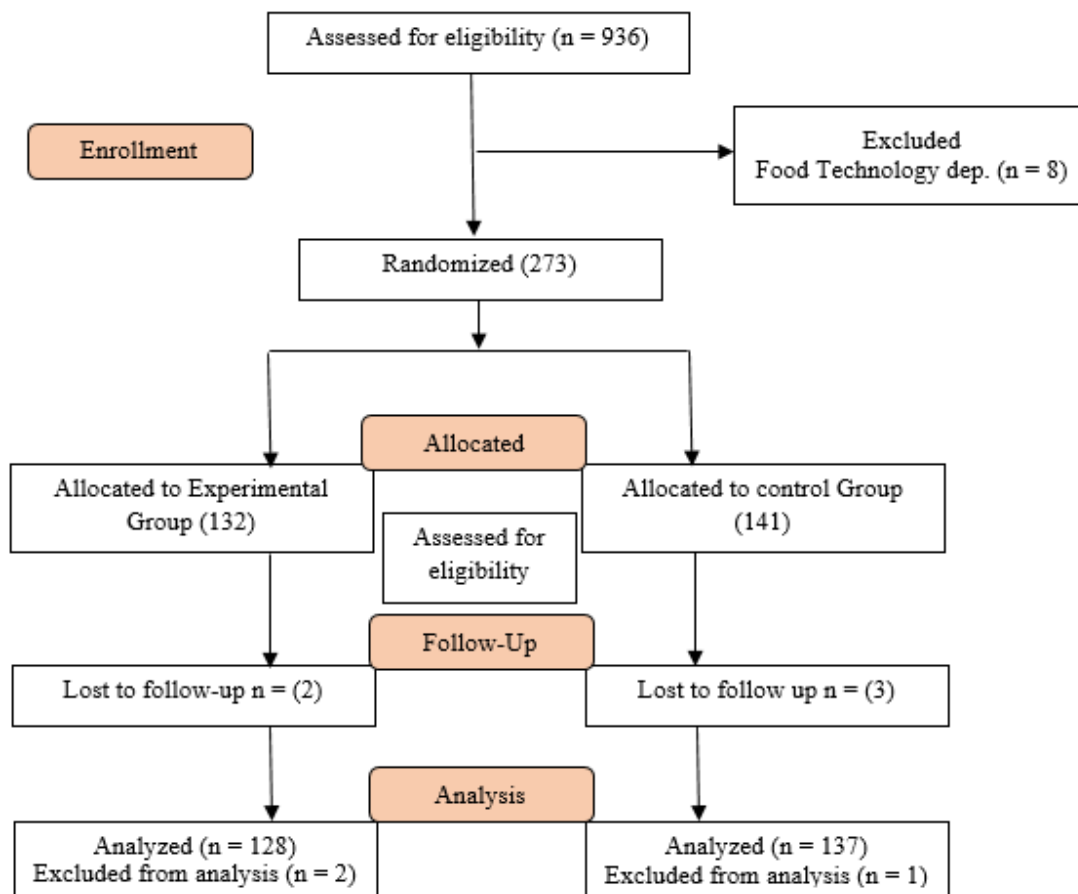


Figure 1: Flow Chart of the Study Participants

Data Collection Tools and Techniques Questionnaire

The initial draft of the questionnaire was prepared based on previous studies and some questions were added by the author according to the local needs [16]. The validity of the questionnaire was reviewed by five experts in the field of nutrition, research methodology and community medicine. Then, the most recent version consisted of two experts translating into Kurdish first and then translating back into English to check accuracy. The validity of the tool was evaluated by giving the questionnaire to 28 students in a non-study college as a pilot study; the demographics were similar to the target population and any mismatches were checked. The final version of the questionnaire was distributed to students to collect pretest data for both groups. The questionnaire consisted of two sections; the first included questions regarding sociodemographic characteristics (age, sex, place of residence, study year, family income, etc.). The second section consists of 5 categories of snacking patterns: first, healthy: fruits, vegetables and nuts; second, caffeinated drinks: tea and coffee, third, beverages: fresh juice, artificial juice, soft drinks and energy drinks, fourth section, dairy products: milk and regular yogurt and fifth section, unhealthy snacks high in sugar, fat and sodium: ice cream, cakes and chips). Frequency of intake per week was assessed with multiple-choice questions, including daily, 2-3 times a week, 1-2 times a week and never.

Intervention

An education program was developed to promote college students' healthy snack options based on the TPB. Each intervention class received three educational sessions, each

lasting approximately 55-60 minutes, over one month. Educational methods were a PowerPoint presentation, group discussion, question and answer and instructional images. All students in the intervention group received the same information in the sessions. The first session determined the attitudes of students and highlighted the health risks of processed and sugary snacks and their impacts on health. In addition, students were encouraged to choose healthy snacks; for this purpose, a flyer was created to help students distinguish between healthy and unhealthy options in university cafeterias Figure 2. In addition, a separate flyer was created encouraging healthy snacks from home for consumption during university classes, as shown in Figure 3. This flyer allowed students to make informed choices. The second session focused on subjective norms and discussed the influence of family and friends on snack choices, including how friends might encourage unhealthy options and how their encouragement of healthy options is significant. Furthermore, identifying barriers, encouraging and improving behavioral control and intention were addressed in the third session.

Body Mass Index (BMI)

Body weight and height were measured with minimal clothing and without shoes. A calibrated medical scale was used to measure weight and a tape measure was used to measure height to the nearest 0.2 cm. The body mass index was calculated by dividing the weight in kilograms by the height in meters squared. Male and female students' measurements were taken in separate classes in order to comfort them. A calibrated scale (electronic Uniscale Secca 874) was used without shoes and with light clothing.

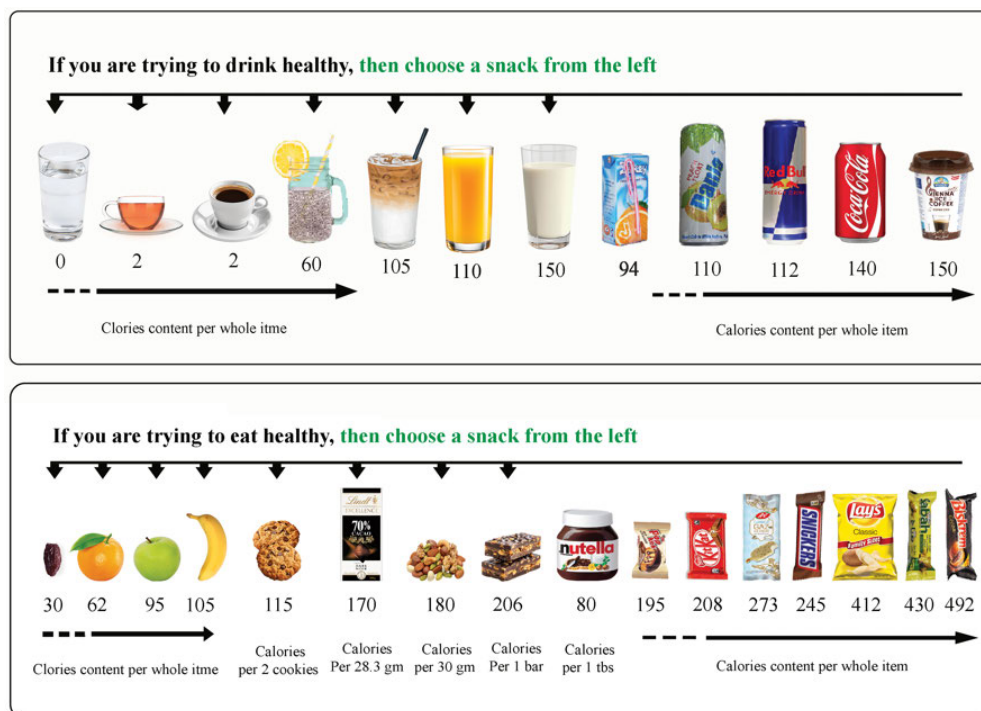


Figure 2: Healthy Versus Unhealthy Snack Options

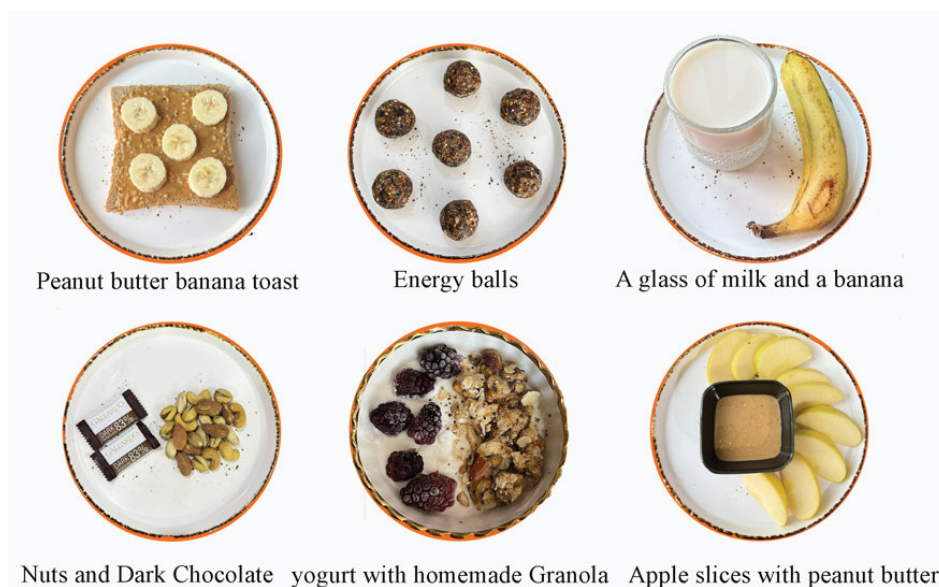


Figure 3: Homemade Healthy Snack Options

Sample Size

The sample size was calculated using a G-Power model 3.1.9.4 with the following assumptions: 0.5 effect size, 80% power and a significance level (α) of 0.05. Also, as a cluster sampling method was used, a design effect of 2 was considered. Finally, 10% of non-responses were added, yielding the final sample size of 273.

Statistical Analysis

SPSS statistical software (SPSS, Version 24.0, Armonk, NY: IBM Corp.) was used to analyze all statistics. Frequency was used for sociodemographic characteristics and the chi-square test was used for comparison. An independent sample t-test was used to compare the means. Additionally, a chi-square test was utilized to compare snacking patterns between the intervention and control groups and the McNemar test was used to compare baseline and endline within the group. The significance level was fixed at ≤ 0.05 .

RESULTS

This table compares the baseline characteristics of students in the intervention group (128 students) and the control group (137 students). The age distribution was well balanced between groups, with around 85.93% of students being aged 19-25 years in both groups and the difference was not significant ($p = 0.826$). Gender distribution is also comparable, although the control group includes slightly more females; this difference is not statistically significant ($p = 0.216$). Family income differed significantly between the two groups ($p = 0.016$). As well as residency and the father's education. However, no difference was seen between the two groups in terms of mother's education, cigarette smoking, narghile use and prevalence of chronic disease. BMI values were similar between the groups ($p = 0.582$) (Table 1).

This table describes snack consumption before the educational intervention. There were no statistical differences between the two groups in terms of fruits, vegetables, nuts, coffee, tea, fresh fruit juice, artificial juice, energy drinks and soft drinks. However, there was a difference between the two groups in milk consumption ($p = 0.005$). In addition, consumption of regular yogurt, ice cream, cakes and chips showed no major statistically significant differences between the intervention and control groups (Table 2).

Fruit and vegetable consumption improved significantly in the intervention group, with ($p = 0.002$) and ($p = 0.045$), respectively. A significant reduction in soft drink consumption was observed between the two groups ($p = 0.035$). Furthermore, students in the intervention group showed an increase in milk consumption compared to those in the control group ($p = 0.004$). While no significant association was observed between the two groups for fresh and artificial fruits, energy drinks, coffee, tea, ice cream, cakes, pastries, regular yogurt, chips and nuts (Table 3).

This table demonstrates within-group changes over time for both the intervention and control groups. In the intervention group, fruit and vegetable intake significantly increased after the intervention, with ($p = 0.006$) and ($p = 0.030$), respectively. In addition, a significant increase was observed regarding nut consumption ($p = 0.019$). Importantly, a significant decrease in energy drink and soft drink consumption was reported in the intervention group ($p = 0.013$), ($p = 0.001$), respectively. An improvement was observed in the consumption of milk ($p = 0.024$). While no significant association was seen between the two groups for fresh and artificial fruit juices, coffee, tea, ice cream, cakes, regular yogurt and chips (Table 4).

Table 1: Comparison of Demographic Characteristics between Intervention and Control Groups

Demographic characteristics		Study groups no (%)		p-value
		Intervention (n = 128)	Control (n = 137)	
Age	19-25	110 (85.94)	119 (86.86)	0.826
	26 years and older	18 (14.06)	18 (13.14)	
Sex	Male	62 (48.43)	56 (40.90)	0.216
	Female	66 (51.57)	81 (59.10)	
Family income	> 500,000 ID	12 (9.3)	29 (21.3)	0.016
	500,000 - 749,000 ID	28 (21.9)	38 (27.7)	
	750,000 - 999,000 ID	32 (25.0)	25 (18.2)	
	1,000,000 or above	56 (43.8)	45 (32.8)	
Mother education	Illiterate	43 (33.7)	51 (37.2)	0.626
	Primary and high school	65 (50.7)	67 (48.9)	
	2-years diploma	10 (7.8)	6 (4.4)	
	College and above	10 (7.8)	13 (9.5)	
Father education	Illiterate	20 (15.6)	18 (13.1)	0.002
	Primary and high school	51 (39.8)	85 (62.1)	
	2-years diploma	18 (14.1)	8 (5.8)	
	College and above	39 (30.5)	26 (19.0)	
Place of residency while studying	At home	88 (68.8)	113 (82.5)	0.015
	In dormitory	35 (27.3)	18 (13.1)	
	Other places	5 (3.9)	6 (4.4)	
Cigarette smoking	Never smoked	101 (78.9)	110 (80.3)	0.373
	Current smoker	18 (14.1)	13 (9.5)	
	Former smoker	9 (7.0)	14 (10.2)	
Narghile Smoking	Never smoked	95 (74.2)	113 (82.5)	0.234
	Current smoker	13 (10.2)	11 (8.0)	
	Former smoker	20 (15.6)	13 (9.5)	
Chronic disease	Yes	44 (34.4)	41 (29.9)	0.630
	None	84 (65.6)	96 (70.1)	
BMI	mean (SD)	24.20 (5.49)	23.88 (4.16)	0.582

P-value of the Relationship between Sociodemographic Characteristics Assessed by the Chi-Square Test

Table 2: Comparison of Snack Consumption between the Intervention and Control Group at Pre-Education

Items		Intervention (n = 128)	Control (n = 137)	p-value
		Pretest n (%)	Pretest n (%)	
Fruits	Daily	38 (29.7)	32 (23.4)	0.140
	3-4 times/week	35 (27.3)	56 (40.9)	
	1-2 times/week	45 (35.2)	41 (29.9)	
	Rarely	10 (7.8)	8 (5.8)	
Vegetables	Daily	44 (34.4)	44 (32.1)	0.121
	3-4 times/week	28 (21.9)	47 (34.3)	
	1-2 times/week	36 (28.1)	32 (23.4)	
	Rarely	20 (15.6)	14 (10.2)	
Nuts	Daily	9 (7.0)	12 (8.8)	0.424
	3-4 times/week	31 (24.2)	41 (29.9)	
	1-2 times/week	56 (43.8)	60 (43.8)	
	Rarely	32 (25.0)	24 (17.5)	
Coffee	Daily	25 (19.5)	27 (19.6)	0.942
	3-4 times/week	24 (18.8)	22 (16.1)	
	1-2 times/week	31 (24.2)	36 (26.3)	
	Rarely	48 (37.5)	52 (38.0)	
Tea	Daily	68 (53.1)	67 (48.9)	0.258
	3-4 times/week	17 (13.3)	17 (12.4)	
	1-2 times/week	19 (14.8)	14 (10.2)	
	Rarely	24 (18.8)	39 (28.5)	
Fresh Fruit juice	Daily	5 (3.9)	13 (9.5)	0.153
	3-4 times/week	21 (16.4)	27 (19.7)	
	1-2 times/week	48 (37.5)	53 (38.7)	
	Rarely	54 (42.2)	44 (32.1)	
Artificial fruit juices	Daily	10 (7.8)	6 (4.4)	0.616
	3-4 times/week	24 (18.8)	24 (17.5)	
	1-2 times/week	42 (32.8)	44 (32.1)	
	Rarely	52 (40.6)	63 (46.0)	
Energy drinks	Daily	9 (7.0)	8 (5.8)	0.861
	3-4 times/week	16 (12.5)	16 (11.7)	
	1-2 times/week	32 (25.0)	30 (21.9)	
	Rarely	71 (55.5)	83 (60.6)	
Soft drinks	Daily	20 (15.7)	16 (11.7)	0.746
	3-4 times/week	40 (31.2)	42 (30.7)	
	1-2 times/week	44 (34.3)	54 (39.4)	
	Rarely	24 (18.8)	25 (18.2)	

Table 2: Continue....

Milk	Daily 3-4 times/week 1-2 times/week Rarely	18 (14.1) 25 (19.5) 35 (27.3) 50 (39.1)	24 (17.5) 32 (23.4) 42 (30.6) 39 (28.5)	0.332
Regular Yogurt	Daily 3-4 times/week 1-2 times/week Rarely	25 (19.5) 32 (25.0) 42 (32.8) 29 (22.7)	36 (26.3) 44 (32.1) 26 (19.0) 31 (22.6)	0.060
Ice- cream	Daily 3-4 times/week 1-2 times/week Rarely	12 (9.4) 36 (28.1) 47 (36.7) 33 (25.8)	7 (5.1) 18 (13.1) 60 (43.8) 52 (38.0)	0.005
Cakes (e.g. Popkek, Biskrem)	Daily 3-4 times/week 1-2 times/week Rarely	21 (16.4) 48 (37.5) 39 (30.5) 20 (15.6)	17 (12.4) 57 (41.6) 48 (35.1) 15 (10.9)	0.469
Chips	Daily 3-4 times/week 1-2 times/week Rarely	23 (18.0) 33 (25.8) 51 (39.8) 21 (16.4)	23 (16.7) 40 (29.2) 52 (38.0) 22 (16.1)	0.940

P-value Assessed by Chi-Square Test

Table 3: Comparison of Snack Consumption between the Intervention and Control Groups after Education

Items		Intervention n = (128)	Control n = (137)	p value	RR (95% CI)
		Posttest n(%)	Posttest n(%)		
Fruits	Daily 3-4 times/week 1-2 times/week Rarely	36 (28.1) 60 (46.9) 22 (17.2) 10 (7.8)	21 (15.3) 56 (40.9) 51 (37.2) 9 (6.6)	0.002	1.11 (0.84 to 1.47) 0.99 (0.87 to 1.14) 0.80 (0.62 to 1.04) Ref.
Vegetables	Daily 3-4 times/week 1-2 times/week Rarely	47 (36.7) 44 (34.4) 29 (22.6) 8 (6.3)	32 (23.4) 45 (32.8) 47 (34.3) 13 (9.5)	0.045	1.20 (0.96 to 1.49) 1.09 (0.91 to 1.30) 1.00 (0.80 to 1.24) Ref.
Nuts	Daily 3-4 times/week 1-2 times/week Rarely	18 (14.1) 41 (32.0) 52 (40.6) 17 (13.3)	15 (10.9) 46 (33.6) 64 (46.7) 12 (8.8)	0.501	0.92 (0.58 to 1.47) 0.89 (0.72 to 1.10) 0.89 (0.75 to 1.05) Ref.
Coffee	Daily 3-4 times/week 1-2 times/week Rarely	32 (25.0) 20 (15.6) 27 (21.1) 49 (38.3)	22 (16.1) 34 (24.8) 37 (27.0) 44 (32.1)	0.071	1.18 (0.76 to 1.83) 0.66 (0.42 to 1.04) 0.77 (0.52 to 1.14) Ref.
Tea	Daily 3-4 times/week 1-2 times/week Rarely	72 (56.3) 20 (15.5) 13 (10.2) 23 (18.0)	68 (49.6) 24 (17.6) 15 (10.9) 30 (21.9)	0.743	1.09 (0.91 to 1.29) 0.87 (0.59 to 1.29) 1.08 (0.59 to 1.97) Ref.
Fresh Fruit juice	Daily 3-4 times/week 1-2 times/week Rarely	8 (6.3) 24 (18.8) 52 (40.6) 44 (34.4)	11 (8.0) 23 (16.8) 63 (46.0) 40 (29.2)	0.698	0.71 (0.31 to 1.62) 0.96 (0.61 to 1.52) 0.88 (0.69 to 1.12) Ref.
Artificial fruit juices	Daily 3-4 times/week 1-2 times/week Rarely	7 (5.5) 30 (23.4) 38 (29.7) 53 (41.4)	10 (7.3) 24 (17.5) 50 (36.5) 53 (38.7)	0.470	0.73 (0.29 to 1.80) 1.15 (0.74 to 1.79) 0.86 (0.62 to 1.17) Ref.
Energy drinks	Daily 3-4 times/week 1-2 times/week Rarely	8 (6.3) 14 (10.9) 25 (19.5) 81 (63.3)	5 (3.6) 14 (10.3) 28 (20.4) 90 (65.7)	0.794	1.70 (0.58 to 5.02) 1.09 (0.55 to 2.17) 0.99 (0.62 to 1.59) Ref.
Soft drinks	Daily 3-4 times/week 1-2 times/week Rarely	12 (9.4) 22 (17.2) 40 (31.2) 54 (42.2)	17 (12.4) 26 (18.9) 59 (43.1) 35 (25.6)	0.035	0.55 (0.29 to 1.05) 0.67 (0.43 to 1.07) 0.67 (0.51 to 0.89) Ref.
Milk	Daily 3-4 times/week 1-2 times/week Rarely	32 (25.0) 11 (8.6) 38 (29.7) 47 (36.7)	20 (14.6) 29 (21.2) 50 (36.5) 38 (27.7)	0.004	1.17 (0.75 to 1.83) 0.43 (0.24 to 0.79) 0.78 (0.58 to 1.06) Ref.
Regular Yogurt	Daily 3-4 times/week 1-2 times/week Rarely	30 (23.4) 33 (25.8) 32 (25.0) 33 (25.8)	35 (25.5) 46 (33.6) 27 (19.7) 29 (21.2)	0.407	0.87 (0.61 to 1.22) 0.81 (0.60 to 1.10) 1.02 (0.70 to 1.47) Ref.
Ice- cream	Daily 3-4 times/week 1-2 times/week Rarely	9 (7.0) 25 (19.5) 54 (42.2) 40 (31.3)	4 (2.9) 27 (19.7) 64 (46.7) 42 (30.7)	0.459	2.11 (0.69 to 6.38) 0.98 (0.64 to 1.50) 0.95 (0.75 to 1.20) Ref.
Cakes (e.g. Popkek, Biskrem)	Daily 3-4 times/week 1-2 times/week Rarely	20 (15.6) 46 (35.9) 43 (33.7) 19 (14.8)	26 (19.0) 47 (34.3) 46 (33.6) 18 (13.1)	0.893	0.86 (0.73 to 1.92) 0.97 (0.78 to 1.21) 0.96 (0.77 to 1.20) Ref.
Chips	Daily 3-4 times/week 1-2 times/week Rarely	26 (20.3) 32 (25.0) 46 (35.9) 24 (18.8)	32 (23.4) 32 (23.4) 56 (40.8) 17 (12.4)	0.476	0.79 (0.56 to 1.11) 0.87 (0.64 to 1.18) 0.85 (0.69 to 1.05) Ref.

p-value Assessed by Chi-Square Test

Table 4: Comparison of Snack Consumption between the Intervention and Control Groups at Pre- and Post-Education

Items		Intervention n = (128)			Control n = (137)		
		Pretest	Posttest	p-value	Pretest	Posttest	p-value
Fruits	Daily	38 (29.7)	36 (28.1)	0.006	32 (23.4)	21 (15.3)	0.124
	3-4 times/week	35 (27.3)	60 (46.9)		56 (40.9)	56 (40.9)	
	1-2 times/week	45 (35.2)	22 (17.7)		41 (29.9)	51 (37.2)	
	Rarely	10 (7.8)	10 (7.8)		8 (5.8)	9 (6.6)	
Vegetables	Daily	44 (34.4)	47 (36.7)	0.030	44 (32.1)	32 (23.4)	0.106
	1-2 times/week	28 (21.9)	44 (32.8)		47 (34.3)	45 (32.8)	
	3-4 times/week	36 (28.1)	29 (23.4)		32 (23.4)	48 (35.0)	
	Rarely	20 (15.6)	8 (7.1)		14 (10.2)	12 (8.8)	
Nuts	Daily	9 (7.0)	18 (14.1)	0.019	12 (8.8)	15 (10.9)	0.107
	1-2 times/week	31 (24.2)	41 (32.0)		41 (29.9)	46 (33.6)	
	3-4 times/week	56 (43.8)	52 (40.6)		60 (43.8)	64 (46.7)	
	Rarely	32 (25.0)	17 (13.3)		24 (17.5)	12 (8.8)	
Coffee	Daily	25 (19.5)	32 (25.0)	0.306	27 (19.7)	22 (16.1)	0.117
	1-2 times/week	24 (18.8)	20 (15.6)		22 (16.1)	34 (24.8)	
	3-4 times/week	31 (24.2)	27 (21.1)		36 (26.3)	37 (27.0)	
	Rarely	48 (37.5)	49 (38.3)		52 (38.0)	44 (32.1)	
Tea	Daily	68 (53.1)	72 (56.3)	0.718	67 (48.9)	68 (49.6)	0.064
	1-2 times/week	17 (13.3)	20 (15.5)		17 (12.4)	24 (17.5)	
	3-4 times/week	19 (14.8)	13 (10.2)		14 (10.2)	15 (10.9)	
	Rarely	24 (18.8)	23 (18.0)		39 (28.5)	30 (21.9)	
Fresh Fruit juice	Daily	5 (3.9)	8 (6.2)	0.355	13 (9.5)	11 (8.0)	0.221
	1-2 times/week	21 (16.4)	24 (18.8)		27 (19.7)	23 (16.8)	
	3-4 times/week	48 (37.5)	52 (40.6)		53 (38.7)	63 (46.0)	
	Rarely	54 (42.2)	44 (34.4)		44 (32.1)	40 (29.2)	
Artificial fruit juices	Daily	10 (7.8)	7 (5.5)	0.301	6 (4.4)	10 (7.3)	0.414
	1-2 times/week	24 (18.8)	30 (23.4)		24 (17.5)	24 (17.5)	
	3-4 times/week	42 (32.8)	38 (29.7)		44 (32.1)	50 (36.5)	
	Rarely	52 (40.6)	53 (41.4)		63 (46.0)	53 (38.7)	
Energy drinks	Daily	9 (7.0)	8 (6.3)	0.013	8 (5.8)	5 (3.6)	0.382
	1-2 times/week	16 (12.5)	14 (10.9)		16 (11.7)	14 (10.2)	
	3-4 times/week	32 (25.0)	25 (19.5)		30 (21.9)	28 (20.4)	
	Rarely	71 (55.5)	81 (63.3)		83 (60.6)	90 (65.7)	
Soft drinks	Daily	20 (15.7)	12 (9.4)	0.001	16 (11.7)	17 (12.4)	0.064
	1-2 times/week	40 (31.2)	22 (17.2)		42 (30.7)	26 (19.0)	
	3-4 times/week	44 (34.3)	40 (31.2)		54 (39.4)	59 (43.1)	
	Rarely	24 (18.8)	54 (42.2)		25 (18.2)	35 (25.5)	
Milk	Daily	18 (14.1)	32 (25.0)	0.024	24 (17.5)	20 (14.6)	0.341
	1-2 times/week	25 (19.5)	11 (8.6)		32 (23.4)	29 (21.2)	
	3-4 times/week	35 (27.3)	38 (29.7)		42 (30.7)	50 (36.5)	
	Rarely	50 (39.1)	47 (36.7)		39 (28.5)	38 (27.7)	
Regular Yogurt	Daily	25 (19.5)	30 (23.4)	0.555	36 (26.3)	35 (25.5)	0.461
	1-2 times/week	32 (25.0)	33 (25.8)		44 (32.1)	46 (33.6)	
	3-4 times/week	42 (32.8)	32 (25.0)		26 (19.0)	27 (19.7)	
	Rarely	29 (22.7)	33 (25.8)		31 (22.6)	29 (21.2)	
Ice cream	Daily	12 (9.4)	9 (7.0)	0.348	7 (5.1)	4 (2.9)	0.091
	1-2 times/week	36 (28.1)	25 (19.5)		18 (13.1)	27 (19.7)	
	3-4 times/week	47 (36.7)	54 (42.2)		60 (43.8)	64 (46.7)	
	Rarely	33 (25.8)	40 (31.3)		52 (38.0)	42 (30.7)	
Cakes (e.g. Popkek)	Daily	21 (16.5)	20 (15.6)	0.567	17 (12.5)	26 (19.0)	0.516
	1-2 times/week	48 (37.5)	46 (35.9)		57 (41.6)	47 (34.3)	
	3-4 times/week	39 (30.5)	43 (33.7)		48 (35.0)	46 (33.6)	
	Rarely	20 (15.6)	19 (14.8)		15 (10.9)	18 (13.1)	
Chips	Daily	23 (18.0)	26 (20.3)	0.619	23 (16.8)	32 (23.4)	0.370
	1-2 times/week	33 (25.8)	32 (25.0)		40 (29.2)	32 (23.4)	
	3-4 times/week	51 (39.8)	46 (35.9)		52 (38.0)	56 (40.9)	
	Rarely	21 (16.4)	24 (18.8)		22 (16.1)	17 (12.3)	

p-value Assessed by McNemar Test

DISCUSSION

Fostering adequate and balanced food consumption habits is the goal of nutrition education, including avoiding unhealthy foods by limiting poor dietary practices and utilizing food resources more appropriately and economically [17]. Studies about snacking patterns are limited in Iraq, including Kurdistan Region and experimental studies are nearly lacking.

Therefore, the results examined the impacts of nutrition education on snacking patterns among university students. In this study, notable initial similarity in family income, father's education and place of residence was observed between the groups. One possible explanation is that DPU colleges are public and everyone from different cultures, family income, or place of residence can attend the university. However, in

private universities, only those with high incomes and who mostly live with their family can apply to these universities. Also, such imbalances may occur by chance even in randomized studies [18]. However, these similarities might influence the outcome of interest; this is added as a limitation of the study.

In a cross-sectional study conducted at Al-Mustaqbal University in Babylon Province, Iraq, among 358 students, it was found that approximately 37.1% consumed regular snacks, including both healthy and unhealthy options [19]. A study conducted in Baghdad included 360 students aged between 12 and 15 years, showing that snacking patterns were associated with higher BMI [20]. A very recent study conducted among 200 female university students in Sulaymaniyah found that overall, participants had moderate eating habits, with just a small portion showing sufficient dietary patterns [21]. The current education resulted in an enhancement in the consumption of fruits, vegetables, milk and nuts among the intervention group following the program. In addition, this resulted in a significant decrease in energy drink and soft drink consumption. However, no changes were noted in other snacking patterns, such as intake of coffee, tea, chips, cakes and ice cream. On the other hand, no improvements were reported in the control group. Consistent with our findings, a campus-based nutrition intervention promoted healthier snack choices by encouraging the selection of healthier options available in campus vending machines [15]. Similarly, a quasi-experimental study conducted among teenagers in Indonesia found that nutrition education reduced unhealthy snacking choices [22]. As well as in Iran [23]. Additionally, educational nutrition messages were positively effective in consuming a larger percentage of healthy Vs unhealthy snacks in the USA [24]. As observed in Italy, students who received education consumed more fruit and vegetable intake and fewer sweets [25]. Students who received education showed an increase in the daily consumption of fruits and vegetables [26].

In addition, a study conducted in Turkey among first-year undergraduate students (n = 378) found that the intervention showed some improvement in students' nutrition knowledge and increased awareness of healthier snack choices; acquiring accurate knowledge is insufficient to implement healthy eating habits [27]. The unavailability of healthier options in university campuses in Kurdistan Region, Iraq, could be one of the main reasons why health education alone may not be sufficient in reducing unhealthy choices such as chips and cakes. As stated by the other study, the food environment on campus, particularly the availability of healthy meals and snack options at an affordable cost, is crucial in helping young adults adopt good eating habits, as students typically spend a significant amount of time in university [28]. According to a recent systematic review, the most available foods on college campuses were potato chips, chocolates and sugar-sweetened drinks [29]. Furthermore, reduced consumption of nutritious snacks such as fruits, vegetables, nuts and dairy products has been linked to the university setting [30].

Academic courses in higher education settings have been reported to be effective in changing food behavior [31]. However, the lack of educational resources (academic courses, peer learning and extracurricular activities) regarding nutrition in many universities in higher education settings in Kurdistan Region is another contributing factor for students to engage in unhealthy snacks.

CONCLUSION

A significant improvement was observed in the intervention group regarding the consumption of fruits, vegetables, milk and nuts. In addition, a significant decrease in the consumption of energy drinks and soft drinks was seen in the intervention group compared to the control group. These findings indicate that there is a need for nutrition education, especially in the first-year students who attend university, as they establish their long-term dietary habits. Cooperation of policymakers and the Ministry of Health is needed to incorporate healthy options in cafeterias, which is one of the public health priorities.

Limitations

There are some limitations in the current study. First, the limited number of sessions was due to a heavy academic load, as stated by a systematic review, nutrition education lasting for ≥ 5 months was more effective [32]. Second, the lack of healthy snack options on campus was a major barrier to students' successful adoption of healthy snacking practices. Furthermore, self-reported questionnaires were used, which may be susceptible to recall bias; the absence of objective dietary assessment methods may have affected the accuracy of the reported behaviors. Another important limitation was the imbalance in baseline characteristics between the two groups, which may introduce confounding despite randomization; however, statistical adjustment techniques to minimize baseline imbalances in future studies are recommended. Furthermore, although clustering was considered during sample size estimation, clustering-adjusted analyses were not performed.

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Ethical Statement

Permission was obtained from the president of DPU. The ethical approval was obtained from the University Committee and the General Directorate of Health-Duhok, with a reference number 29052024-4-16. Verbal consent was obtained from each student.

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