

Effectiveness of Nutrition Education in Improving All Five Food Groups Consumption among Selected School Students of Lahore of 9-15 Years of Age- A Pre-Post Interventional Study

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Abstract

This pre-post interventional study aimed to evaluate the effectiveness of nutrition education in improving the consumption of all five food groups among selected school students aged 9-15 years in Lahore. Recognizing the critical role of balanced nutrition in growth and health, the study implemented a structured nutrition education program based on established behavior change models to enhance students' knowledge and dietary practices. Baseline data on dietary intake and nutritional knowledge were collected before the intervention. The educational sessions utilized interactive methods, including audiovisual aids and worksheets, to engage students in

understanding the importance of incorporating fruits, vegetables, grains, protein, and dairy into their daily diets. Post-intervention assessments indicated a significant improvement in students' knowledge and a measurable increase in the consumption frequency of all five food groups. The findings suggest that targeted nutrition education programs can effectively promote healthier eating habits among school-aged children, thereby contributing to improved nutritional status and potentially reducing the risk of diet-related diseases. The study underscores the necessity of integrating regular nutrition education into school curricula to sustain healthy dietary behaviors in this vulnerable age group.

INTRODUCTION

Proper nutrition during childhood is crucial, particularly for children aged 9 to 15 years, who are in a key developmental stage. A balanced diet is essential to support their physical, mental, and emotional growth. However, unhealthy dietary patterns, characterized by low intake of fruits and vegetables (FV) and increased consumption of processed foods, are prevalent among school-aged children globally. This highlights the urgent need for effective nutrition education programs that focus on the five major food groups: fruits, vegetables, grains, protein, and dairy. Schools represent an ideal setting for such interventions, as they can reach children during this critical period of development (1,2).

Research has shown that school-based nutrition education programs can significantly improve dietary habits among students. Various studies indicate that these interventions can increase FV intake while reducing the consumption of high-caloric processed foods. A comprehensive analysis of international studies concluded that nutrition education enhances awareness and attitudes toward a balanced diet. However, the effectiveness of these programs can vary across different age groups and regions due to differences in cultural determinants and program strategies. The pre-post

interventional research approach is commonly employed to evaluate the impact of these initiatives by comparing dietary patterns before and after the intervention (3,4).

In Pakistan, the prevalence of malnutrition among school-aged children remains alarmingly high, with significant rates of underweight and obesity. Despite the pressing need for nutrition education, it is not officially included in the academic syllabus in most regions. Limited research indicates that both students and their parents often lack knowledge about balanced diets. This study aims to address this gap by assessing the effectiveness of a pre-post interventional nutrition education program on school students, focusing on knowledge and practices related to healthy eating. By exploring this under-researched area, the study seeks to provide evidence-based recommendations for incorporating nutrition education into school curricula nationwide (5,6).

Numerous studies have demonstrated the effectiveness of school-based nutritional interventions in promoting healthier lifestyles among students. For instance, a study focused on the impact of a structured school-based education program led by a pediatrician showed significant changes in weight and body mass index (BMI) among obese adolescent girls compared to those attending regular nutrition classes. The success of these interventions is often linked to the integration of cultural elements, behavior-focused curricula, and supportive school policies that encourage healthier eating environments. Schools play a vital role in obesity prevention by providing access to nutritious meals and promoting higher intake of fruits and vegetables alongside physical activity (7,8).

Despite the positive outcomes associated with some school-based interventions, systematic reviews have revealed challenges in translating knowledge and behavioral

changes into measurable reductions in BMI. Most research on adolescent obesity has been conducted in Western countries, with limited studies focusing on Eastern nations. For example, a study in Thailand aimed to develop a school-based childhood obesity prevention program but found no significant changes in students' weight or BMI. This highlights the need for further evaluation of the quality of food available in school cafeterias and the effectiveness of nutrition education programs in diverse cultural contexts (9).

This study not only aims to improve dietary habits among school students but also seeks to enhance their overall health and well-being. By promoting knowledge about the five food groups, the program can empower students to make informed food choices, which can lead to long-term health benefits and a reduction in the prevalence of diet-related diseases. Additionally, the involvement of parents and the community in the nutrition education process can foster a supportive environment for healthy eating, reinforcing the lessons learned in school (10).

Furthermore, the study aligns with the Sustainable Development Goals (SDGs), particularly in promoting good health and well-being, quality education, and responsible consumption. By addressing malnutrition and encouraging healthier eating habits, the research contributes to the broader goal of improving public health outcomes and fostering a culture of wellness among future generations (11).

In conclusion, this study addresses a significant research gap in assessing the impact of nutrition education programs targeted at school students in Pakistan. By evaluating the effectiveness of a pre-post interventional nutrition education program, the research aims to provide valuable insights into how education about the five major food groups can influence dietary behaviors among 9 to 15-year-old students. The

findings will not only contribute to the existing body of knowledge but also offer evidence-based recommendations for integrating nutrition education into school curricula, ultimately promoting healthier lifestyles and improving the nutritional status of children in Pakistan (12).

METHODOLOGY

RESEARCH DESIGN: Pre- Post Interventional Study

STUDY SETTINGS: Private schools of Lahore, Pakistan

SAMPLE SIZE: 206 students

SAMPLING TECHNIQUE: Simple random sampling (13)

DURATION OF STUDY: 3 months

SELECTION CRITERIA

INCLUSION CRITERIA

- students who gave Consent
- students who attended at least 3 sessions

EXCLUSION CRITERIA

- students who did not gave consent (14)
- students who did not attended at least 3 sessions

DATA COLLECTION PROCEDURE

Data was collected from students aged 9-15 years in various schools in Lahore, Pakistan, using a questionnaire divided into eight sections covering demographics, medical information, knowledge of food groups, attitudes towards nutrition, eating behaviors, impact of nutrition education, barriers to healthy eating, and lifestyle and physical activity. The questionnaire included a total of 26 questions designed to assess the effectiveness of nutrition education among the students.

DATA ANALYSIS

Data was analyzed using SPSS version 20 through three stages: univariate analysis for demographic characteristics, bivariate analysis with the chi-square test to assess associations between variables, and paired sample t-tests to compare pre-test and post-test scores for statistical significance after the intervention. A p-value of less than 0.05 was considered statistically significant (15).

RESULTS

This section deals with the results. In this, we explained our results (Table 1), (Table 2), (Table 3). The descriptive statistics shows that the mean age of the students was 12.3204 and the standard deviation was 1.45645. The standard deviation of class was 1.19597. The mean weight and height of the classes were 149.4089 and 43.0728 respectively. The mean BMI was 19.133 and the standard deviation of BMI was 4.2206. (Table 1) Out of the total father’s education, the frequency and percentage of intermediate was 33 and 16 respectively. The percentage of graduation was 23.8. And out of the total mother’s education, the frequency of matric was 81 and the percentage of intermediate was 14.1. Out of all the father’s occupation, the frequency of employed father’s was 190. And the percentage of the occupation of mother’s, who were housewife was 84.5.

TABLE 1: UNIVARIATE ANALYSIS OF DEMOGRAPHIC VARIABLE (DESCRIPTIVE STATISTICS) (N=412)

Variable	Mean	Standard Deviation (S.D.)
Age	12.3204	1.45645
Class	6.0243	1.19597
Weight	149.4089	12.84885
Height	43.0728	11.93272

BMI	19.133	4.2206
	Frequency	Percentage
Father's Education		
Illiterate	26	12.6
Matric	63	30.6
Intermediate	33	16
Graduation	49	23.8
Post-Graduation	35	17
Mother's Education		
Illiterate	31	15
Matric	81	39.3
Intermediate	29	14.1
Graduation	42	20.4
Post-Graduation	23	11.2
Father's Occupation		
Employed	190	92.2
Unemployed	16	7.8
Mother's Occupation		
Employed	32	15.5
Housewife	174	84.5

The study demonstrated significant improvements in students' knowledge, attitudes, and eating behaviors regarding nutrition after the intervention. Knowledge of food groups increased notably, with awareness of grains providing energy rising from 6.7% to 70.4% ($p=0.000$), and understanding the importance of dairy for strong bones increasing

from 4 students to 86.4% ($p=0.013$). Attitudes towards nutrition also improved, as the number of students who strongly agreed on the importance of eating a variety of foods rose from 1 to 100, and those consuming 3-4 portions of fruits daily increased from 0% to 45.6% ($p=0.000$). Eating behaviors showed a similar trend, with vegetable consumption increasing from 2.1% to 45.6% ($p=0.000$) and daily protein intake rising significantly. The impact of nutrition education was evident, with 89.3% of students recognizing the importance of including all five food groups in meals post-intervention ($p=0.000$). Barriers to healthy eating shifted, with taste preference becoming a more common reason for difficulties, and the perception of inadequate healthy food options in schools increased from 65 students to 90.3% ($p=0.000$). Additionally, participation in physical activity improved, with those engaging in it four or more times a week rising to 11.7% and those spending 30 minutes to an hour on physical activity increasing to 40.8% ($p=0.000$).

TABLE 2: BIVARIATE ANALYSIS OF VARIABLES BEFORE AND AFTER THE INTERVENTION (CHI-SQUARE) (N=412)

Variable	Frequency and Percentage		p-value
	(n & %)		
	Pre- Intervention	Post- Intervention	
Knowledge of Food Group			
Can you name five food groups?			
Yes	77 (92.7%)	198 (96.5%)	0.263
No	121 (94.5%)	8 (3.4%)	
Which food group provides you energy?			

Fruits	10 (1.5%)	19 (2.2%)	
Vegetables	2 (8.7%)	73 (7.4%)	0.000
Grains	8 (6.7%)	146 (70.4%)	
Dairy	2 (1.5%)	9 (4.4%)	
Protein	4 (5.9%)	25 (12.1%)	
Which food group is important for strong bones and teeth?			
Grains	0 (0.0%)	6 (2.9%)	
Dairy	4 (3.9%)	178 (86.4%)	
Protein	12 (2.2%)	16 (7.8%)	0.013
Vegetables	0 (0.0%)	4 (1.9%)	
Fruits	1 (3.8%)	2 (1.0%)	
Which of the following food is a good source of protein?			
Chicken	95 (90.5%)	173 (84.0%)	
Bread	10 (66.7%)	2 (1.0%)	
Apple	9 (60.0%)	2 (1.0%)	0.011
Butter	17 (85.0%)	6 (2.7%)	
Fruits	42 (82.4%)	18 (8.7%)	
How many portions of fruits and vegetables should you eat daily?			
1 – 2	29 (30.2%)	48 (23.3%)	
3 – 4	15 (15.5%)	111 (53.9%)	
5 – 6	6 (24.0%)	36 (17.5%)	0.000
6 or more	1 (16.7%)	7 (3.4%)	
Not sure	3 (14.3%)	4 (1.9%)	

Attitudes towards Nutrition

Do you think eating variety of foods is important?			
Strongly disagree	2 (33.3%)	10 (4.9%)	
Disagree	1 (50.0%)	1 (0.5%)	
Neutral	1 (4.2%)	16 (7.8%)	0.000
Agree	5 (4.5%)	79 (38.3%)	
Strongly agree	1 (1.1%)	100 (48.5%)	
Do you think you should include all five food groups in your meal every day?			
Yes	70 (84.3%)	169 (89.2%)	
No	25 (83.3%)	15 (7.3%)	0.678
Not sure	74 (79.6%)	22 (10.7%)	
How often do you think about the nutritional value of the foods you eat?			
Never	3 (6.7%)	17 (8.3%)	
Rarely	2 (21.7%)	13 (6.3%)	
Sometimes	9 (20.0%)	14 (6.7%)	0.000
Often	6 (13.3%)	18 (8.8%)	
Always	0 (0.0%)	27 (13.1%)	
Do you enjoy learning about health, eating and nutrition?			
Never	1 (1.1%)	3 (1.5%)	
Rarely	0 (0.0%)	12 (5.8%)	
Sometimes	2 (3.4%)	62 (31.5%)	0.023
Often	6 (4.5%)	77 (39.4%)	
Always	0 (0.0%)	37 (18.9%)	
How often do you eat fruits each day?			
Never	0 (0.0%)	2 (1.0%)	

1–2 times	2 (1.4%)	136 (66.6%)	0.000
3–4 times	0 (0.0%)	56 (27.2%)	
5 or more times	0 (0.0%)	12 (5.6%)	

Eating Behaviors

How often do you eat vegetables each day?

Never	1 (1.1%)	4 (1.9%)	
1–2 times	3 (2.1%)	101 (49.0%)	0.000
3–4 times	0 (0.0%)	94 (45.6%)	
5 or more times	0 (0.0%)	7 (3.4%)	

How many servings of grains (bread, rice, cereal) do you eat daily?

1–2	46 (45.1%)	67 (32.5%)	
3–4	18 (20.9%)	110 (53.4%)	0.000
5–6	1 (3.3%)	29 (13.6%)	
More than 7	2 (33.3%)	10 (5.7%)	

How often do you eat dairy products (milk, yogurt, cheese)?

Never	0 (0.0%)	4 (1.9%)	
1–2 times/week	3 (6.4%)	8 (7.3%)	0.000
3–4 times/week	0 (0.0%)	51 (25.0%)	
Daily	1 (1.1%)	95 (46.1%)	

How often do you eat foods high in protein (meat, eggs, beans)?

Never	4 (28.6%)	7 (3.4%)	
1–2 times/week	2 (2.4%)	61 (29.6%)	0.000
3–4 times/week	0 (0.0%)	53 (25.7%)	
Daily	1 (1.1%)	85 (41.3%)	

Impact of Nutrition Education

Do you understand the importance of including all five food groups in meals?

Yes	115 (94.3%)	184 (89.3%)	0.006
No	6 (5.7%)	22 (10.7%)	

Have you made any changes in your eating behavior since previous year?

Yes	152 (91.0%)	195 (89.8%)	0.182
No	15 (9.0%)	21 (10.2%)	

Barriers to healthy eating

What makes it difficult for you to eat healthy food?

Lack of time	19 (35.2%)	50 (24.3%)	0.001
Lack of availability	12 (36.4%)	21 (10.2%)	
Taste preference	4 (6.5%)	136 (66.0%)	
Cost	3 (5.3%)	7 (3.4%)	

Does your school provide healthy food options?

Yes	65 (50.0%)	20 (9.7%)	0.000
No	65 (50.0%)	186 (90.3%)	

Lifestyle and Physical Activity

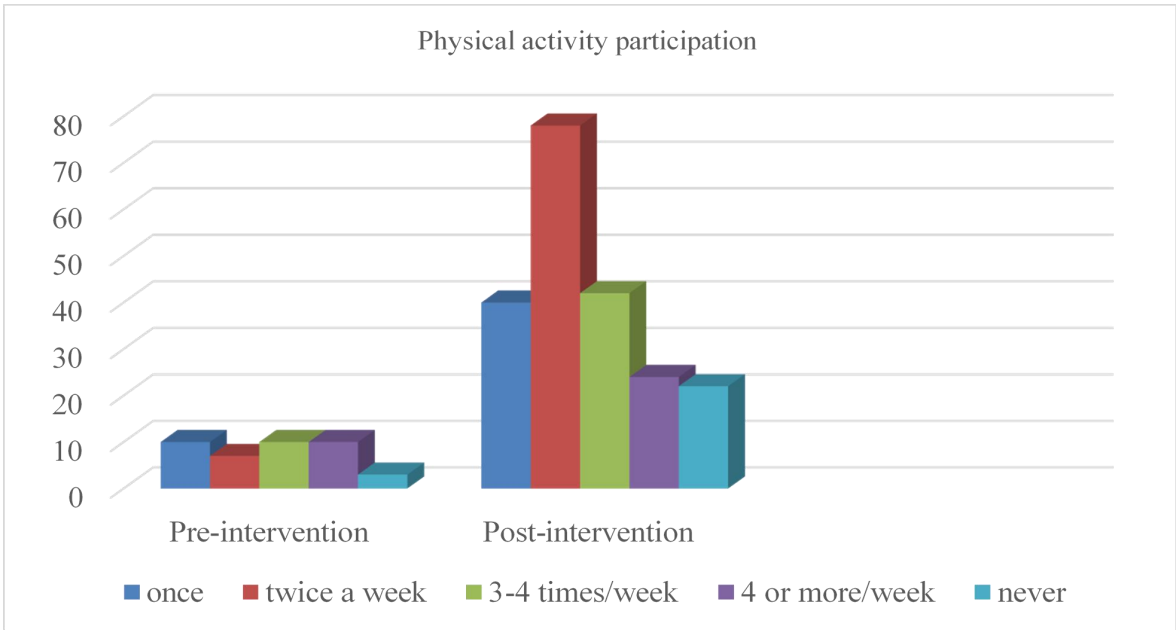
How often you participate in physical activity?

Once	10 (37.0%)	40 (9.4%)	0.000
Twice a week	7 (14.9%)	78 (39.9%)	
3 – 4 times a week	10 (17.9%)	42 (20.4%)	
4 times or more	10 (17.9%)	24 (11.7%)	
Never	3 (15.0%)	22 (10.7%)	

How much time do you spend on physical activity in school day?

Less than 30 min	41 (43.6%)	68 (30.9%)	0.000
30 min – 1 hour	9 (18.4%)	84 (40.8%)	
1 – 2 hours	2 (15.4%)	19 (9.2%)	
More than 2 hours	2 (50.0%)	10 (4.9%)	
None	14 (30.4%)	25 (12.1%)	
How often do you feel tired during school hours?			
Never	2 (8.7%)	5 (2.4%)	0.117
Rarely	0 (0.0%)	29 (14.1%)	
Sometimes	1 (1.3%)	96 (46.6%)	
Often	1 (6.3%)	23 (11.2%)	
Always	1 (1.8%)	53 (25.7%)	

FIGURE 1: PHYSICAL ACTIVITY PARTICIPATION BEFORE AND AFTER INTERVENTION



The comparison of mean scores for the effectiveness of nutrition education before and after the intervention revealed significant improvements across various domains. In

terms of knowledge of food groups, the mean score for understanding that food groups provide energy increased from 2.563 ± 1.533 to 3.068 ± 0.965 , with statistically significant results ($p=0.000$). Attitudes towards nutrition also showed positive changes, with the mean score for the importance of eating a variety of foods rising from 4.087 ± 0.850 to 4.252 ± 0.979 ($p=0.030$), and awareness of the nutritional value of foods increasing from 2.791 ± 1.233 to 3.179 ± 1.107 ($p=0.000$). Additionally, eating behaviors improved, as the mean score for daily servings of grains increased from 1.621 ± 0.727 to 1.821 ± 0.671 ($p=0.002$), and consumption of protein-rich foods showed a significant increase ($p=0.003$). Overall, these findings indicate that the nutrition education intervention effectively enhanced students' knowledge, attitudes, and eating behaviors related to nutrition.

FIGURE 2: CONSUMPTION OF FIVE FOOD GROUPS PRE AND POST INTERVENTION

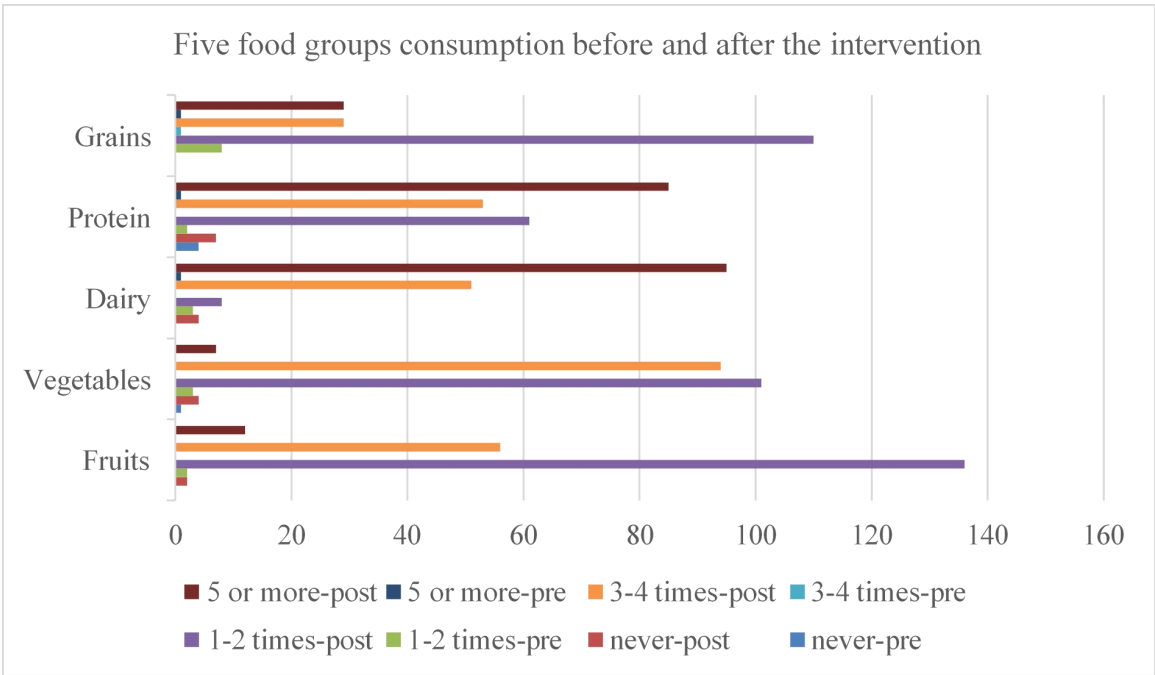


TABLE 3: COMPARISON OF MEAN SCORE OF EFFECTIVENESS OF NUTRITION EDUCATION BEFORE AND AFTER THE INTERVENTION (PAIRED SAMPLE T-TEST) (N=412)

Variable	Before	After	Confidence interval		p-value
	intervention	intervention	Lower	Upper	
	Mean ± SD	Mean ± SD			
Knowledge of Food Groups					
Can you name the five main food groups?	1.621 ± 0.486	1.038 ± 0.193	0.513	0.651	0.000
Which food group provides energy for daily activities?	2.563 ± 1.553	3.068 ± 0.965	-0.728	-0.281	0.000
Which food group is important for strong bones and teeth?	2.699 ± 1.137	2.116 ± 0.509	0.423	0.741	0.000
Which of the following foods is a good source of protein?	2.500 ± 1.721	1.514 ± 1.244	0.709	1.261	0.000
How many portions of fruits and vegetables should you eat daily?	2.019 ± 1.276	2.068 ±0.846	-0.239	0.142	0.617
Attitudes towards Nutrition					
Do you think eating variety of foods is?	4.087 ± 0.850	4.252 ± 0.979	-0.313	-0.016	0.030

important?					
Do you think you	2.048 ± 0.925	1.286 ± 0.648	0.612	0.911	0.000
should include all					
five?					
food groups in your					
meals every day?					
How often do you	2.791 ± 1.233	3.179 ± 1.017	-0.590	-0.185	0.000
think about the					
nutritional value of the					
foods you?					
eat?					
Do you enjoy learning	3.830 ± 1.215	3.888 ± 1.027	-0.257	0.141	0.565
about healthy eating					
and?					
nutrition?					
Eating Behaviors					
How often do you eat	2.310 ± 0.670	2.378 ± 0.610	-0.169	0.033	0.187
fruits each day?					
How often do you eat	2.286 ± 0.640	2.504 ± 0.598	-0.321	-0.115	0.000
vegetables each day?					
How many servings of	1.621 ± 0.727	1.820 ± 0.671	-0.321	-0.076	0.002
grains (bread, rice?					
cereals) do you eat daily?					

How often do you eat dairy products (milk? yogurt, cheese)?	3.034 ± 0.959	3.150 ± 0.889	-0.263	0.030	0.120
How often do you eat foods high in protein? (Meat, eggs, beans)?	2.791 ± 0.977	3.048 ± 0.920	-0.423	-0.091	0.003
Impact of Nutrition Education					
Do you understand the importance of including all five food groups in meals?	1.407 ± 0.492	1.106 ± 0.309	0.228	0.373	0.000
Have you made any changes in your eating habits since previous years?	1.189 ± 0.392	1.101 ± 0.303	0.022	0.152	0.009

DISCUSSION

This study highlights the significant impact of nutrition education on students' understanding and consumption of the five food groups, aligning with findings from previous research. Prior to the intervention, knowledge about the importance of these food groups was low, similar to results from Pollard et al. in Western Australia, indicating a lack of awareness among the population. Our findings showed substantial post-intervention improvements, with awareness of all five food groups rising from 5.7% to 89.3% (p=0.000), and increased consumption of vegetables, grains, dairy, and protein.

Comparatively, studies from the USA and Croatia also reported significant gains in nutritional knowledge and dietary behaviors following structured interventions (16,17).

The effectiveness of our educational sessions is further supported by studies demonstrating similar outcomes in various contexts, such as in Ghana and Mumbai, where nutrition education led to improved dietary habits and physical activity levels. Our results showed that students engaging in physical activity increased from 10 to 11.7%, and those active for 30 minutes to an hour rose from 18.4% to 40.8% ($p=0.000$), reinforcing the positive influence of targeted interventions on lifestyle changes (18,19).

Despite the improvements, barriers to healthy eating persisted, with taste preference becoming a significant obstacle post-intervention (20). This aligns with findings from other studies indicating that structural and environmental challenges, such as limited healthy food options in schools, continue to hinder dietary improvements. Overall, our research underscores the importance of integrating nutrition education into school curricula to foster healthier eating habits and physical activity among children, supporting the notion that comprehensive programs involving both education and environmental changes are essential for promoting long-term health benefits (21,22).

The study also revealed critical insights into dietary behavior changes post-intervention (23). While students showed marked improvements in consumption of various food groups - with vegetable intake increasing from 2.1% to 45.6% and protein consumption rising significantly - persistent barriers like taste preferences (reported by 136 students) and limited healthy school food options (noted by 90.3%) emerged as key challenges. These findings mirror research from Sri Lanka and Indonesia, emphasizing that while nutrition education effectively enhances knowledge and attitudes, structural and environmental factors must be simultaneously addressed to sustain dietary

improvements. The disconnect between increased nutritional awareness and actual behavioral change points to the need for more holistic interventions that combine education with policy changes in school food environments (24,25).

Comparative analysis with international studies demonstrated notable parallels in intervention outcomes. Similar to research conducted in Spain, Japan, and Brazil, our findings confirmed that structured educational programs significantly impact children's health metrics, including physical activity levels and dietary habits. The consistency of results across diverse cultural contexts - from the 75.5% knowledge improvement in Croatia's study to Malaysia's School Nutrition Program benefits - suggests the universal value of school-based nutrition education. However, cultural adaptations appear crucial, as evidenced by varying success rates in different regions, highlighting the need for locally-tailored approaches while maintaining evidence-based core principles (26,27).

This research underscores the dual benefit of nutrition education in simultaneously addressing malnutrition and obesity - two pressing public health challenges in Pakistan (28). The dramatic increase in students' awareness of dairy's role in bone health (from 4 to 86.4%) and understanding of appropriate fruit/vegetable portions (rising to 53.9%) demonstrates education's power to correct prevalent nutritional misconceptions. Moving forward, scaling such interventions will require addressing implementation barriers identified in this and other studies, including teacher training limitations, curriculum constraints, and parental engagement challenges. Future programs should incorporate multi-component strategies combining classroom education, school environment modifications, family involvement, and policy support to create sustainable improvements in children's nutritional status and overall well-being (29,30).

CONCLUSION

Nutrition education significantly improved knowledge and consumption of all five food groups among school students. The program enhanced awareness about the importance of a balanced diet, emphasizing the inclusion of fruits, vegetables, grains, proteins, and dairy. These results highlight the need to integrate structured nutrition education into school curricula to promote healthier eating habits during key developmental years. Such interventions can enhance nutritional status, support growth, and prevent diet-related health issues. Future studies should focus on maintaining these positive outcomes and evaluating their long-term effects on health.

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