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Impact of project-based learning on the eating behaviors of nursing students on meeting the sustainable development goals

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ABSTRACT

Introduction: The Sustainable Development Goals promote quality education and healthy eating, and nursing is a fundamental profession for their fulfilment due to its educational role. Project-based learning is an innovative methodology for acquiring competencies; however, its impact on nursing students needs further study.

Aim: This study evaluates whether project-based learning effectively modifies nursing students' nutritional behaviours to align with the Sustainable Development Goals.

Materials and methods: A longitudinal quasi-experimental study with a pretest-posttest design was conducted. 50 first-year nursing students participated, completing an online questionnaire at four stages: program start, pre-implementation, six weeks post-implementation, and one year later. The questionnaire assessed eating habits, food consumption frequency, choices, beliefs and preferences.

Results: Project-based learning was associated with small short-term improvements in some eating habits and indicators of long-term adherence to the Mediterranean Diet, although effects were not consistent across time points.

Conclusions: Project-based learning appears to be a promising pedagogical strategy in nursing education, enhancing nutrition knowledge application in real-life situations, leading to sustainable improvements in eating habits and supporting the simulation of quality education and health promotion.

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KEYWORDS

Educational intervention; Mediterranean diet; Behavioural change; Repeated measures; Health education; University students; Dietary habits; Longitudinal analysis; Health promotion.

ABBREVIATIONS

SDGs: Sustainable Development Goals.

CBL: Competency-based learning.

PBL: Project-based learning.

AMD: Adherence to the Mediterranean Diet.

IB: Irrational Believes.

INTRODUCTION

Nursing is recognized as an inherent profession for the achievement of the Sustainable Development Goals (SDGs), which were formulated in 2015 by world leaders to eradicate poverty, protect the planet, and ensure prosperity for all people[1].

One of the SDGs (SDG 4) seeks to ensure equitable, quality education and increase youth and adult skills for employment[2], it becomes clear that continuous efforts are needed to address persistent challenges in education, to make education accessible, adequate and efficient, including university education in this condition[3]. Nowadays, universities have developed competency-based learning (CBL), to establish essential skills[4]. CBL is characterized by its focus on learners and active learning[5]. In the health sector, authors such as Levett-Jones *et al*. assert that nursing students often lack the necessary `*practice readiness*´ for clinical practice[6]. To improve this aspect CBL should be taught

using methodologies that streamline and systematize the monitoring and learning process[7].

Strategies such as project-based learning (PBL) are employed to achieve that teaching which can promote the acquisition of professional competencies[8,9] by encouraging students to engage with learning simulation scenarios, formulate hypotheses, and critically evaluate them against existing literature. This method enhances creative and collaborative skills while utilizing communication technologies. Even simple projects help students connect content with practical application, focusing on problem-solving within the CBL framework. Once qualified, learners can apply these methods to patient care[9].

Moreover, the SDG 3 aims to "*ensure healthy lives and promote well-being for all at all ages*" emphasizing a holistic approach to health[10]. In this goal, nursing staff can have a major responsibility[11], however, there is a lack of studies on effective pedagogical approaches to nutrition education in nursing[12], with most relying on traditional lectures and lacking detailed descriptions of interventions and outcomes[13].

Given their role in patient nutrition education[14], it is crucial for nurses to gain nutritional knowledge through CBL. Nurses are expected to provide personalized care, which should reflect their educational training[15], and it would be expected variations in students' nutrition and habits corresponding to the knowledge acquired during their degree. However, the impact of CBL and innovative teaching methodologies like PBL on modifying these factors among nursing students remains unexplored.

The aim of this study is to assess whether PBL serves as an effective tool for modifying the nutritional behaviours of nursing students in a more responsible and sustainable way.

MATERIAL AND METHODS

Study design and participants

A quasi-experimental, longitudinal study with an intra-subject pretest-posttest design was carried out, with measurements taken one year after the posttest assessment[16]. All students enrolled in the first year of the bachelor's degree in nursing at the Faculty of Medicine and Nursing during the 2019-2020 academic year were invited to participate. The inclusion criteria comprised enrolment on the course, attainment of legal age, and the provision of voluntary informed consent to participate. Questionnaires were excluded from the analysis where they were incomplete, as such deficiencies precluded the reliable assessment of the principal variables under investigation. The study was approved by the Human Research Ethics Committee of the university (CEISH, M10_2019_175).

Intervention details and implementation

In the first year, the subject 'Structure and Function of the Human Body II'. This module provided 6 ECTS spread over 15 weeks. The nutrition part was taught along the last 6 weeks, through a typical lecture-based learning teaching (11 hours), practical classes (4 hours), and applying an active teaching methodology (PBL in 9 hours). This methodology is characterized by involving students in complex projects, based on real situations (such as a dietary evaluation), where they must research, design, plan, and execute tasks that result in a final product or conclusion[17]. The expected outcome was for nursing students to develop the ability to evaluate their dietary patterns and design a balanced diet according to the Mediterranean Diet Foundation standards[18]. Five consecutive and linked sub-projects were designed, and specific surveys were conducted to assess their effectiveness and impact on skill acquisition (Table 1).

Data collection

Participants completed an online questionnaire on four occasions: at the beginning of the university career (T0), pre-implementation of PBL (T1), six weeks later (right after PBL or T2) and 1 year later or T3. The questionnaire consisted of questions to assess food consumption frequency, food choices, food beliefs and preferences, and included anthropometric data.

Preferences and aversions were assessed by a questionnaire[19] with a 3-point Likert scale, using the statements '*List from 1 to 3 the foods you like the most*' and '*Choose the foods you like the least*'. They chose from 13 food groups: meat, sausages, fish, eggs, dairy products, cereals, fruits, vegetables, pulses, pastries, soft drinks, alcohol and snacks.

To analyse diet quality, a 48-item questionnaire[20] was used for the calculation of the Mediterranean Diet Score[21]. This tool consists of 11 food groups, which are assigned a score from 0 to 5 according to food consumption frequency. The final score ranges from 0 to 55 points, meaning that the higher the score, the higher the Adherence to the Mediterranean Diet (AMD).

For analysed food choices, an *ad hoc* dish choice questionnaire was used, consisting of 12 items with three possible answers: one healthy, one less healthy and one unhealthy dish, assessed by a panel of 8 nutritionists. The choice of healthy dishes was counted by calculating the median, with a high choice >4 and a low choice ≤4. Median-based cut-off points were used due to the exploratory nature of the study and the relatively small sample size, as this approach allows for a balanced classification of participants without assuming normal distribution of the variables, as recommended in similar exploratory analyses[22]. The questionnaires were evaluated through confirmatory factor analysis using the robust weighted least squares estimation method on a polychoric correlation matrix, which is appropriate for ordinal data. Convergent validity with the food consumption frequency questionnaire[20] was assessed using Spearman's correlations.

Table 1. Description of the subprojects implemented in the Nutrition course by nursing students and the evaluation process used to assess the impact of PBL on student learning

SUBPROJECT	OBJECTIVE	TIME IN CLASS	HOW IT`S DONE	EVALUATION PROCESS
1. What do I eat?	To demystify false dietary beliefs	2 hours	The students, in groups, and according to their dietary beliefs, classified certain foods according to their carbohydrate, protein and fat content.	Once the project was completed, another group of students evaluated the classification. Afterwards, it was discussed in class as a group, working on their food beliefs about healthy foods.Evaluation tool: Food beliefs questionnaire.
2. How do I eat?	To integrate dietary recommendations into their own dietary intake.	3 hours	With no prior knowledge, they were asked to complete a food record for 3 days. They took photographs, noted the grams per serving and their nutritional value using the DIAL nutritional assessment software[34]	Each student calculated their basal and total calorie expenditure in order to compare it with their daily intake and perform a nutritional assessment[18]. Evaluation tool: Frequency of food consumption.
3. What is a healthy menu?	To understand the importance of food variety in achieving a healthy diet.	1 hour	In groups, they designed a healthy menu for one day, using the food groups[18].	The designed menus were presented to the rest of the class so that they could observe the errors and suggest improvements to the menu designs.Evaluation tool: Food choices questionnaire.
4. What is a healthy diet?	To know the students' concept of Healthy Eating.	1 hour	On the first day of class, each student created a one-day menu of foods and drinks they considered healthy	At the final program, they evaluated their menu quantitatively and qualitatively, checking its adequacy to a healthy diet. Afterwards, they designed new menus following the recommended portions[18]. Evaluation tool: food preference/aversion questionnaire
5. Oral presentation of the final project	To design targeted nutritional care systems, assessing the individual's physiological state beforehand to promote healthy lifestyles.	2 hours	In groups, they select a dietary assessment of a member and evaluate it as a patient. They present the consumption details, assess the diet quantitatively and qualitatively, recall dietary recommendations, and propose improvements	Transversal competencies in oral communication and critical thinking are assessed. The rest of the students participate by pointing out the strengths and weaknesses of each presentation. The instructor corrects errors and asks questions to reinforce the concepts.

Reliability was evaluated in terms of internal consistency using ordinal alpha coefficients, and temporal stability using test–retest analysis based on polychoric correlations. The association between these questionnaires and the food consumption frequency questionnaire was moderate (r = 0.38), while reliability was high (α = 0.84), supporting the adequacy of the instruments.

The "*Irrational Food Beliefs Scale*" was used[23], which has two subscales: rational and irrational believes (IB). This questionnaire is composed of 57 statements to be rated with a score from 1 to 4, with 1=strongly disagree and 4=strongly agree. The IB subscale is composed of 41 items, where a higher score denotes the presence of a higher amount of IB. High or low IB was counted as the median, with the median being at T0 ≤ 72, at T1 ≤ 65 and at T2 ≤77.

Data analysis

Once the responses were obtained, the description of categorical variables was expressed as frequencies and percentages, and quantitative variables as median and interquartile range or mean and standard deviation. McNemar's statistical test was used to establish the differences between food preferences and food choices; and the Wilcoxon test was used to analyse the changes produced in the frequency of general

consumption, IB and AMD, with a significance level of $p < 0.05$ for all variables

Handling of missing data

Prior to analysis, we examined the proportion and distribution of missing responses for all variables across the four assessment points (T0–T3). Missing data ranged from 0% to 8%, mostly due to isolated unanswered items within the questionnaires. Because missingness was low and showed no systematic pattern when compared across sociodemographic or outcome variables, a complete-case analysis was conducted for all statistical comparisons. This approach is recommended in small-sample quasi-experimental studies when the amount of missing data is minimal[24]. Multiple imputation was not implemented because the percentage of missing data was below common thresholds (5–10 %) and was unlikely to introduce bias in the results. The exact number of respondents per analysis is reported in each table.

RESULTS

Characteristics of participants

A total of 50 students (47 females and three males), aged between 18 and 20 years (at the beginning of the degree) and with a BMI between 17.96 and 28.73 kg/m^2, completed the questionnaire all three times.

Effect of the intervention on the participants

Minor variations in sample size across tables reflect missing responses to isolated questionnaire items rather than participant dropout; all 50 students remained enrolled and completed all scheduled assessment points.

Table 2 shows a descriptive analysis of the results of the food choice and food beliefs questionnaires. PBL implementation did not influence food choices but did influence food beliefs. A significant decrease ($p = 0.001$) in IB after the application of PBL and an increase in rational beliefs were observed (T1-T2). Items showing significant improvement at T1 were '*Food is a substitute for pleasure*' and '*A good way to reduce stress is to eat*' ($p < 0.05$). Subsequently, at maintenance (T2-T3), IB were maintained and rational beliefs decreased significantly ($p < 0.05$).

Table 3 shows the food preferences of the nursing students at the four time points of the study. After the training in Nutrition and the PBL (T1-T2), the preference for fish decreased ($p < 0.05$) and for cereals increased ($p < 0.05$). One year later (T2-T3), preference for dairy products, fruit and nuts and snacks increased ($p < 0.05$).

Table 4 shows the weekly food consumption frequency of first-year nursing students. After the PBL (T1-T2), there was a significant decrease in the consumption of sausages ($p < 0.001$) and dairy products ($p < 0.05$). After one year, the significant decrease in the consumption of sausages was maintained ($p < 0.001$), while the consumption of meat, cereals, fruits and nuts, vegetables, legumes, non-alcoholic beverages, and alcoholic beverages increased ($p < 0.05$).

Finally, Table 5 expands the information on the AMD by disaggregating the values of the food groups used for its calculation. In the first year of the course, after the implementation of the PBL (T1-T2), there was no significant change in the AMD, although the score for red meat increases ($p = 0.01$) due to a decrease in the food consumption frequency. After one year, there was a significant increase in the AMD ($p < 0.001$) mainly due to an increase in the score for unrefined or wholegrain cereals, potatoes, vegetables, pulses, and olive oil ($p > 0.05$).

DISCUSSION

The findings of this study highlight the potential of project-based learning (PBL) as an effective teaching strategy to influence the nutritional habits of nursing students. However, given the large number of statistical tests conducted and the absence of a control group, these results should be interpreted as exploratory and not confirmatory. Importantly, the effects of PBL were not uniform across all outcomes, and no consistent or immediate effects were observed for several variables, particularly food choice behaviours. By engaging in PBL activities, students not only acquire competences related to nutritional education but also experience shifts in their irrational beliefs (IBs), preferences, and eating habits in the short term. Moreover, the sustained impact on adherence to the Mediterranean Diet (AMD) underscores the long-term benefits of PBL in promoting healthier dietary practices among nursing students. This approach aligns with Sustainable Development Goals (SDGs), contributing to holistic educational outcomes that extend beyond traditional classroom learning.

Aligning with SDG3, challenging IBs and promoting rational thinking about food and nutrition can enable individuals to adopt sustainable dietary habits that support health. Cognitive-behavioural approaches target these erroneous beliefs to promote long-term weight maintenance[25]. In nursing students, addressing irrational eating beliefs could reduce misconceptions about food. While food choices may not change significantly, interventions like the nutrition subject and PBL enhance both irrational and rational beliefs over time. This improvement reflects a positive shift in critical thinking, enabling students to transform ideas into knowledge that influences their decisions.

IBs significantly influence food preferences by distorting perceptions. For example, IBs may lead to favouring high-calorie or high-fat foods as coping mechanisms for stress[26,27]. Our study found that changes in food preferences didn't always match changes in consumption frequency. This lack of

Table 2. Choice, beliefs and irrational beliefs subscale (most significant items) of nursing students segmented in control, before and after receiving teaching in Nutrition (first year) and one year later (second year) (T0-T1-T2-T3)

		T0		T1		T2		T3		T0-T1	T1-T2	T2-T3
		CONTROL		PRE		POST		+ 1 YEAR		CONTROL	IMPLEMENTATION	MAINTENANCE
		n	%	n	%	n	%	n	%	p[a]	p[a]	p[a]
Food choice	↓	16	32	20	40	23	46	24	48	1.000	0.267	1.000
	↑	30	60	25	50	22	54	26	52			
		n	M (IQR)	n	M (IQR)	n	M (IQR)	n	M (IQR)	p[b]	p[b]	p[b]
Irrational beliefs		48	72 (18)	43	72 (17)	44	66 (16)	44	68 (16)	0.327	**0.001**	0.184
Rational beliefs		48	49 (5)	43	49 (4)	44	50 (5)	44	49 (6)	0.458	**0.025**	**0.044**
		n	%	n	%	n	%	n	%	p[a]	p[a]	p[a]
1:	Food is a substitute for pleasure.	26	52	26	52	17	39	23	52	1.000	**0.022**	0.210
2:	Some foods can relax you.	32	64	30	60	26	59	32	73	0.774	0.424	0.180
4:	I couldn't possibly live without my favourite food.	18	36	21	42	15	34	19	43	0.581	0.146	0.454
6:	My greatest pleasure in life is eating.	15	30	15	30	9	20	9	20	1.000	0.070	1.000
7:	Eating is a good way to overcome boredom.	14	28	16	32	12	27	10	23	0.754	0.289	0.754
11:	Social gatherings are not as much fun without food.	18	36	24	48	16	36	20	45	0.210	0.077	0.481
16:	A good way to reduce stress is to eat.	10	20	12	24	4	9	6	14	0.727	**0.021**	0.727
18:	Some foods are irresistible.	27	54	27	54	20	45	28	64	1.000	0.118	0.057
26:	There are some foods that I can't control what I eat.	23	46	18	36	22	50	20	45	0.302	0.424	0.581
27:	I can't live without sweets.	17	34	11	22	11	25	15	34	0.146	1.000	0.454
31:	Some foods are addictive.	38	76	36	72	29	66	35	80	0.687	0.118	0.180
40:	There are times when I 'need' certain foods.	37	74	27	54	26	59	29	66	**0.021**	1.000	0.648
44:	Happiness can be achieved with food.	13	26	13	26	8	18	9	20	1.000	0.180	1.000

Food choice: ↓=low healthy food choices and ↑=high healthy food choices, M: median, IQR: Interquartile range.
pa: McNemar test, pb: Wilcoxon test.
Irrational Beliefs in green (< 40%); in yellow (40% - 60%); in red (> 60%).
n=50, the sum may not reach the total value of the sample due to lost values.

Table 3. Food preferences of nursing students segmented in control, before and after being taught Nutrition (in first year) and one year later (T0-T1-T2-T3)

Food Preferences		T0		T1		T2		T3		T0-T1	T1-T2	T2-T3
		CONTROL		PRE		POST		+ 1 YEAR		CONTROL	IMPLEMENTATION	MAINTENANCE
		n	%	n	%	n	%	n	%	P	P	P
Meat	NO	18	36	27	54	26	57	25	50	0.727	0.754	0.454
	YES	22	64	23	46	20	43	25	50			
Sausages	NO	45	90	43	86	43	93	41	82	0.500	0.625	0.070
	YES	5	10	7	14	3	7	9	18			
Fishes	NO	32	64	30	60	32	70	20	40	0.453	**0.016**	0.238
	YES	18	36	20	40	14	30	30	60			
Eggs	NO	39	78	37	74	32	70	28	56	0.375	0.687	0.065
	YES	11	22	13	26	14	30	22	44			
Diary	NO	42	84	42	84	38	83	30	60	1.000	1.000	**0.004**
	YES	8	16	8	16	8	17	20	20			
Cereals	NO	46	92	45	90	30	65	38	76	1.000	**0.001**	0.503
	YES	4	8	5	10	16	35	12	24			
Fruits and nuts	NO	35	70	40	80	30	65	24	48	0.125	0.146	**0.013**
	YES	15	30	10	20	16	35	26	52			
Vegetables	NO	35	70	28	56	26	57	30	60	0.065	0.549	1.000
	YES	15	30	22	44	20	43	20	40			
Legumes	NO	43	86	42	86	38	83	36	72	1.000	1.000	0.146
	YES	7	14	8	14	8	17	14	28			
Baking	NO	36	72	36	72	38	83	35	70	0.727	0.125	0.109
	YES	14	28	14	28	8	17	15	30			
Soft drinks	NO	49	98	50	100	45	98	43	86	1.000	1.000	0.070
	YES	1	2	0	0	1	2	7	14			
Snacks	NO	40	80	37	74	46	100	42	84	0.453	0.125	**0.001**
	YES	10	20	13	26	0	0	8	16			

YES: the food is among their favourites, NO: the food is not among their favourites.
p: McNemar test.
n=50, the sum may not reach the total value of the sample due to lost values.

Table 4. Weekly food consumption by Nursing students in control, before and after receiving the Nutrition course and one year later (T0-T1-T2-T3)

Consumption (servings/ week)	T0		T1		T2		T3		T0-T1	T1-T2	T2-T3
	CONTROL		PRE		POST		+ 1 YEAR		CONTROL	IMPLEMENTATION	MAINTENANCE
	n	mean±SD	n	mean±SD	n	mean±SD	n	mean±SD	p	p	p
Meats	50	4.9 ± 3.8	50	4.1 ± 2.6	50	3.3 ± 2.0	50	4.5 ± 2.1	**0.027**	0.099	**<0.001**
Sausages	50	3.8 ± 2.5	50	2.0 ± 2.4	50	1.8 ± 2.0	50	0.9 ± 1.0	**0.005**	**<0.001**	**<0.001**
Fishes	50	4.2 ± 6.3	50	3.1 ± 2.7	50	2.8 ± 1.9	50	3.5 ± 2.0	0.441	0.934	0.106
Eggs	50	3.0 ± 3.0	50	2.8 ± 1.6	50	2.9 ± 2.0	50	2.1 ± 1.4	0.267	0.497	0.181
Diary	50	14.0 ± 7.6	50	14.3 ± 8.5	50	12.1 ± 7.3	50	12.9 ± 7.9	0.921	**0.028**	0.974
Cereals	50	14.1 ± 10.6	50	14.0 ± 8.9	50	13.6 ± 9.4	50	17.7 ± 10.9	0.564	0.735	**0.018**
Fruits and nuts	50	14.7 ± 11.0	50	14.4 ± 11.8	50	13.1 ± 11.1	50	18.4 ± 10.7	0.468	0.225	**0.001**
Vegetables	50	10.8 ± 7.3	50	9.0 ± 6.4	50	8.3 ± 5.3	50	16.0 ± 8.3	**0.001**	0.824	**<0.001**
Legumes	50	2.1 ± 1.2	50	1.8 ± 1.2	50	1.8 ± 1.1	50	2.5 ± 1.0	0.187	0.923	**<0.001**
Bakery	50	4.2 ± 6.5	50	2.6 ± 4.0	50	2.2 ± 3.1	50	4.0 ± 6.5	0.06	0.825	**0.007**
Non-alcoholic beverages	50	2.2 ± 2.7	50	1.7 ± 2.8	50	1.9 ± 3.5	50	2.8 ± 3.5	**0.031**	0.104	**0.022**
Appetizers	50	4.8 ± 5.0	50	3.7 ± 3.3	50	3.5 ± 3.3	50	5.2 ± 6.3	**0.023**	0.586	0.062
Alcoholic beverages	50	1.6 ± 2.6	50	1.4 ± 1.6	50	1.1 ± 1.1	50	2.6 ± 3.4	0.827	0.208	**<0.001**
Oils	50	24.4 ± 19.5	50	31.2 ± 22.1	50	29.3 ± 18.9	50	37.7 ± 31.3	**0.006**	0.681	0.066

p: Wilcoxon test. SD: Standard Deviation.
n=50, the sum may not reach the total value of the sample due to lost values.

concordance reflects the absence of a direct and consistent effect of the intervention on food choice behaviours, suggesting that short-term educational strategies may be insufficient to modify complex dietary decisions. After PBL, a preference for fish decreased, but consumption remained stable, while soft drink and snack consumption increased, possibly due to vending machines on campus offering low-nutritional foods[28]. This accessibility, combined with conflicting information from social media, complicates discerning valid nutritional advice. Our study suggests that active methodologies like PBL can help nurses develop a balanced diet, despite barriers like unhealthy food availability[14].

Although the campus food environment can influence students' dietary habits, our study revealed that the PBL teaching strategy significantly enhanced long-term ADM. The Mediterranean Diet is globally recognized as the most studied dietary pattern and plays a critical role in promoting health and preventing chronic diseases[21,29]. Its implementation aligns with SDGs 3 and 4, aiming to reduce premature mortality from non-communicable diseases[1]. Interestingly, sophomores demonstrated higher AMD scores compared to freshmen, contrary to findings by Green *et al.,* suggesting varied nutritional habits among student cohorts[30]. Thus, our nutrition course via PBL did not immediately impact consumption habits; rather, sustained benefits emerged over time, paralleling skill acquisition during the initial two years of the program.

Research suggests that PBL durations ranging from nine to eighteen weeks optimize instructional effectiveness, facilitating deeper learning compared to shorter durations like ours (one to eight weeks)[8]. Longer-term studies, such as those spanning nine months, have demonstrated significant improvements in learning outcomes and academic performance related to nutrition education[31]. Choi *et al.*, similarly, noted

Table 5. Adherence to the Mediterranean Diet and differences in its component values of segmented nursing students in control, before and after Project-Based Learning (in first year) and one year later (T0-T1-T2-T3)

	T0		T1		T2		T3		T0-T1	T1-T2	T2-T3
	CONTROL		PRE		POST		+ 1 YEAR		CONTROL	IMPLEMENTATION	MAINTENANCE
	n	mean±SD	n	mean±SD	n	mean±SD	n	mean±SD	p	p	p
Adherence to the Mediterranean Diet	46	32.7 ± 5.7	48	32.4 ± 5.7	44	33.5 ± 5.8	44	43.1 ± 7.6	0.927	0.053	**<0.001**
Unrefined cereals	46	2.1 ± 5.7	48	1.8 ± 2.2	44	1.6 ± 2.2	44	2.3 ± 2.2	0.606	0.306	**0.025**
Potatoes	46	2.1 ± 1.6	48	1.7 ± 1.0	44	1.9 ± 1.2	44	2.7 ± 1.2	**0.046**	0.323	**<0.001**
Fruits	46	4.8 ± 0.9	48	4.6 ± 0.9	44	4.6 ± 0.8	44	4.8 ± 0.8	0.142	0.658	0.142
Vegetables	46	4.6 ± 0.9	48	4.2 ± 1.3	44	4.2 ± 1.3	44	4.7 ± 0.7	**0.009**	0.791	**0.002**
Legumes	46	2.0 ± 1.2	48	1.8 ± 1.0	44	1.8 ± 1.1	44	2.5 ± 1.1	0.158	0.532	**<0.001**
Fish	46	3.0 ± 1.5	48	3.0 ± 1.5	44	2.9 ± 1.3	44	3.1 ± 1.4	0.86	0.628	0.355
Red meat and meat products	46	0.9 ± 1.7	48	1.2 ± 1.5	44	1.7 ± 1.8	44	2.0 ± 1.8	0.274	**0.01**	0.305
Poultry	46	2.7 ± 1.5	48	3.2 ± 1.2	44	3.3 ± 1.0	44	2.9 ± 1.3	**0.01**	0.378	0.11
Whole milk products	46	1.5 ± 2.0	48	1.7 ± 1.9	44	2.0 ± 2.0	44	1.7 ± 1.8	0.191	0.143	0.143
Olive oil	46	4.1 ± 0.9	48	4.4 ± 0.7	44	4.4 ± 1.0	44	5.0 ± 0.0	0.102	0.572	**<0.001**
Alcohol	46	5.0 ± 1.5	48	5.0 ± 0.0	44	5.0 ± 0.0	44	4.9 ± 0.5	0.317	1.000	0.317

p: Wilcoxon test. SD: Standard Deviation.
n=50, the sum may not reach the total value of the sample due to lost values.

the importance of extended instructional periods for enhancing critical thinking and problem-solving skills in students[32]. However, methodological challenges across dietary intervention studies in university settings have limited conclusive findings and hindered widespread dissemination efforts[33].

In higher education, the integration of new technologies across university domains, including management, research, and teaching, supports pedagogical innovation. This innovation leverages technology for didactic and pedagogical purposes, creating new virtual spaces that foster student autonomy and enhance interaction and educational creation[4]. An example of innovative assessment and competency acquisition is the use of simulation training[5]. Specifically, within the field of nutrition education, tools like food diaries have proven effective in engaging university nursing students[12]; in our study, students maintained a food record over three days. Such tasks aid nursing students in integrating acquired knowledge into their personal lives and contribute to meeting SDGs promoting equal access to quality technical and vocational training[3] thus addressing societal needs.

In summary, in higher education, the creation of knowledge and active learning are intertwined, requiring active participation and collaboration between students and educators to achieve SDGs[3]. PBL exemplifies active learning by focusing on student-centred methodologies that go beyond mere transmission of information, thus playing a pivotal role in modern educational practices[4]. Taken together, the findings indicate that project-based learning may contribute to gradual and indirect improvements in dietary patterns rather than producing immediate, direct changes in food choices.

LIMITATIONS

Despite the strengths of the study, several methodological limitations should be acknowledged. Firstly, it was conducted exclusively with students from a single nursing school. Expanding the study to include students from various healthcare disciplines would provide a more comprehensive understanding of how innovative teaching methodologies influence nutritional habits and their alignment with the SDGs. In ad-

dition, future studies should incorporate a control group or consider methods such as propensity score matching to improve internal validity and strengthen causal inference. In addition, the analyses involved multiple statistical comparisons without adjustment, increasing the risk of Type I error. Therefore, some significant findings may reflect chance and should be interpreted with caution. Secondly, the duration of the study was constrained by the course's teaching period. Longer intervention periods would be more advisable to help bring about effective changes in eating behaviours. Additionally, although missing data were minimal and random, the use of complete-case analysis may still introduce some degree of bias, and future studies with larger samples should employ multiple imputation strategies to strengthen analytical robustness. Finally, no formal a priori power analysis was conducted. The sample size was determined by cohort availability within a compulsory first-year nursing course, which limits the ability to detect small effect sizes. Therefore, these limitations restrict both the internal and external validity of the findings and should be considered when interpreting the results.

CONCLUSIONS

Project-based learning (PBL) is a useful tool in the education of nursing students, helping them to address real-world challenges and providing a richer and more meaningful educational experience simulating real projects. This teaching methodology presents itself as a dynamic and active approach that has been key for the application of nutritional knowledge acquired by nursing students and can lead to sustainable improvements in their eating habits and irrational beliefs, despite the great challenge it poses, especially given the usual availability of unhealthy food options in the university environment. To achieve more robust and sustainable results in nutrition education through PBL, longer studies are required, as changes in nutritional habits need more time to consolidate to meet the Sustainable Development Goals.

DECLARATION OF GENERATIVE AI USE

During the preparation of this work the authors used OpenAI's ChatGPT-5 to improve English language. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

REFERENCES

1. United Nations. United Nations Sustainable Development [Internet]. 2015 [cited 2025 Dec 14]. Sustainable Development Goals. Available from: https://www.un.org/sustainabledevelopment/
2. Ydo Y. Reaching SDG 4: Our shared responsibility and renewed commitment to action. Prospects (Paris). 2022;52(3–4):223–9. doi:10.1007/s11125-022-09628-3 PubMed PMID: 36531532; PubMed Central PMCID: PMC9744361.
3. Carroll C, Fitzgibbon I, Caulfield M. Community and university partnerships: Integrating Sustainable Development Goals 3, 4, 10, 11, and 17. Int J Speech Lang Pathol. 2023 Feb;25(1):102–6. doi:10.1080/17549507.2022.2154081 PubMed PMID: 36537999.
4. Villa AV, Poblete M. Aprendizaje basado en competencias: una propuesta para la evaluación de las competencias genéricas. Universidad de Deusto; 2007. 333 p.
5. Lavoie P, Michaud C, Bélisle M, Boyer L, Gosselin É, Grondin M, et al. Learning theories and tools for the assessment of core nursing competencies in simulation: A theoretical review. J Adv Nurs. 2018 Feb;74(2):239–50. doi:10.1111/jan.13416 PubMed PMID: 28815750.
6. Levett-Jones T, Pitt V, Courtney-Pratt H, Harbrow G, Rossiter R. What are the primary concerns of nursing students as they prepare for and contemplate their first clinical placement experience? Nurse Education in Practice. 2015 Jul 1;15(4):304–9. doi:10.1016/j.nepr.2015.03.012
7. Blas EGC, González JS, Roche MEM, Martínez E, Perea CM, Embarba BÁ. Metodologías de enseñanza-aprendizaje en enfermería: ¿Es el portafolio una metodología acorde con el Espacio Europeo de Educación Superior? Enfermería Docente. 2017;enero-junio(108):24–8.
8. Marnewick C. Student experiences of project-based learning in agile project management education. Project Leadership and Society. 2023 Dec 1;4:100096. doi:10.1016/j.plas.2023.100096
9. Boston University. Project-Based Learning | Center for Teaching & Learning. Institute for Excellence in Teaching & Learning. [Internet]. 2024 [cited 2025 Dec 14]. Available from: https://www.bu.edu/excellence/
10. Seidman G. Does SDG 3 have an adequate theory of change for improving health systems performance? J Glob Health. 2017 Jun;7(1):010302. doi:10.7189/jogh.07.010302 PubMed PMID: 28567275; PubMed Central PMCID: PMC5441444.
11. Iriarte-Roteta A, Lopez-Dicastillo O, Mujika A, Ruiz-Zaldibar C, Hernantes N, Bermejo-Martins E, et al. Nurses' role in health promotion and prevention: A critical interpretive synthesis. J Clin Nurs. 2020 Nov;29(21–22):3937–49. doi:10.1111/jocn.15441 PubMed PMID: 32757432.
12. Holmberg C, Klingberg S, Brembeck P. The food diary as a pedagogical strategy in undergraduate nursing nutrition education: A student evaluation. Nurse Educ Today. 2021 Mar;98:104737. doi:10.1016/j.nedt.2020.104737 PubMed PMID: 33453558.
13. Dang TM, Maggio LA. Supporting the Call to Action: A Review of Nutrition Educational Interventions in the Health Professions Literature and MedEdPORTAL. Acad Med. 2017 Mar;92(3):403–16. doi:10.1097/ACM.0000000000001532 PubMed PMID: 28225733.
14. Reed D. Healthy Eating for Healthy Nurses: Nutrition Basics to Promote Health for Nurses and Patients. Online J Issues Nurs. 2014 Sep 30;19(3):7. PubMed PMID: 26824155.
15. Comisión de Trabajos Intercentros. Competencias transversales del Grado de Enfermería. 2018. 27 p.

16. Arnau J, Bono R. Estudios longitudinales de medidas repetidas: Modelos de diseño y análisis. Escritos de Psicología (Internet). 2008 Dec;2(1):32–41.

17. Kim KJ. Project-based learning approach to increase medical student empathy. Med Educ Online. 2020 Dec;25(1):1742965. doi:10.1080/10872981.2020.1742965 PubMed PMID: 32197574; PubMed Central PMCID: PMC7170272.

18. Fundación Dieta Mediterránea. ¿QUÉ ES LA DIETA MEDITERRÁNEA? [Internet]. 2023 [cited 2025 Dec 14]. Available from: https://dietamediterranea.com/nutricion-saludable-ejercicio-fisico/

19. Martínez JA, Portillo M del PP. Fundamentos de Nutrición y Dietética. Bases metodológicas y aplicaciones. Editorial Médica Panamericana; 2011. 458 p.

20. Rodríguez IT, Ballart JF, Pastor GC, Jordà EB, Val VA. Validation of a short questionnaire on frequency of dietary intake: reproducibility and validity. Nutr Hosp. 2008;23(3):242–52. PubMed PMID: 18560701.

21. Panagiotakos DB, Pitsavos C, Stefanadis C. Dietary patterns: a Mediterranean diet score and its relation to clinical and biological markers of cardiovascular disease risk. Nutr Metab Cardiovasc Dis. 2006 Dec;16(8):559–68. doi:10.1016/j.numecd.2005.08.006 PubMed PMID: 17126772.

22. MacCallum RC, Zhang S, Preacher KJ, Rucker DD. On the practice of dichotomization of quantitative variables. Psychol Methods. 2002 Mar;7(1):19–40. doi:10.1037/1082-989x.7.1.19 PubMed PMID: 11928888.

23. Jáuregui Lobera I, Bolaños, P. Spanish version os the Irrational food belifs scale. Nutricion Hospitalaria. 2010 Jun 1;25(5):852–9. doi:10.3305/nh.2010.25.5.4712

24. Jakobsen JC, Gluud C, Wetterslev J, Winkel P. When and how should multiple imputation be used for handling missing data in randomised clinical trials – a practical guide with flowcharts. BMC Med Res Methodol. 2017 Dec 6;17:162. doi:10.1186/s12874-017-0442-1 PubMed PMID: 29207961; PubMed Central PMCID: PMC5717805.

25. Osberg TM, Poland D, Aguayo G, MacDougall S. The Irrational Food Beliefs Scale: development and validation. Eat Behav. 2008 Jan;9(1):25–40. doi:10.1016/j.eatbeh.2007.02.001 PubMed PMID: 18167321.

26. Capellà, A. Alimentación como prevención: La relevancia de las preferencias alimentarias. Universitat de les Illes Balears; 2016.

27. López Nieves G, Sosa Cordobés E, Garrido Fernández A, Travé González G, García Padilla FM. Hábitos, preferencias y habilidades culinarias de estudiantes de primer curso de la universidad de Huelva. Enfermería Global. 2019;18(55):127–56. doi:10.6018/eglobal.18.3.332791

28. Martínez-González MA, Fernández-Jarne E, Serrano-Martínez M, Wright M, Gomez-Gracia E. Development of a short dietary intake questionnaire for the quantitative estimation of adherence to a cardioprotective Mediterranean diet. Eur J Clin Nutr. 2004 Nov;58(11):1550–2. doi:10.1038/sj.ejcn.1602004 PubMed PMID: 15162136.

29. Markellos C, Ourailidou ME, Gavriatopoulou M, Halvatsiotis P, Sergentanis TN, Psaltopoulou T. Olive oil intake and cancer risk: A systematic review and meta-analysis. PLoS One. 2022;17(1):e0261649. doi:10.1371/journal.pone.0261649 PubMed PMID: 35015763; PubMed Central PMCID: PMC8751986.

30. Green G. Nursing Students' Eating Habits, Subjective, and Mediterranean Nutrition Knowledge During the COVID-19 Pandemic. SAGE Open Nurs. 2021 Sep 14;7:23779608211038209. doi:10.1177/23779608211038209 PubMed PMID: 34782863; PubMed Central PMCID: PMC8590384.

31. Rezaee R, Haveshki F, Barati-Boldaji R, Mehrabi M. The effect of case-based e-learning on academic performance and problem-solving ability in nursing students: A pre- and post-test study. J Educ Health Promot. 2022;11:302. doi:10.4103/jehp.jehp_1613_21 PubMed PMID: 36438997; PubMed Central PMCID: PMC9683439.

32. Choi S, Nah S, Kim S, Seong EO, Kim SH, Han S. A validation of newly developed weight estimating tape for Korean pediatric patients. PLoS One. 2022 Jul 7;17(7):e0271109. doi:10.1371/journal.pone.0271109 PubMed PMID: 35797338; PubMed Central PMCID: PMC9262219.

33. Kelly NR, Mazzeo SE, Bean MK. Systematic review of dietary interventions with college students: directions for future research and practice. J Nutr Educ Behav. 2013;45(4):304–13. doi:10.1016/j.jneb.2012.10.012 PubMed PMID: 23433967.

34. Ortega, RM, López-Sobaler AM, Andrés, P, Requejo, AM, Aparicio, A, Molinero, LM. Programa DIAL para valoración de dietas y cálculos de alimentación (para Windows, versión 3.15) [Internet]. Departamento de Nutrición y Ciencia de los Alimentos (UCM) y Alceingeniería, S.A. Madrid, España; 2021 [cited 2025 Dec 14]. Available from: https://www.ucm.es/idinutricion/programa-dial