frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 15 July 2024
DOI 10.3389/fsufs.2024.1364085

OPEN ACCESS

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RECEIVED 01 January 2024
ACCEPTED 27 June 2024
PUBLISHED 15 July 2024

CITATION
AlTarrah D, Malik A and Nur A (2024) Knowledge and attitudes toward food sustainability among Kuwait University students.
Front. Sustain. Food Syst. 8:1364085.
doi: 10.3389/fsufs.2024.1364085

Knowledge and attitudes toward food sustainability among Kuwait University students

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Transitioning toward sustainable food systems and sustainable diets is critical in reducing environmental impact and achieving the Sustainable Development Goals established by the United Nations General Assembly. This transition requires collaborative efforts across multiple stakeholders, including the general public's knowledge and attitudes. To assess the knowledge and attitudes toward food sustainability, we carried out a cross-sectional study among Kuwait University students with a total of 278 participants aged ≥18 years (78% women and 22% men). A validated questionnaire was used for this study. Most respondents (>70%) recognized the concept of "local food" and "environmental impact." The concept "green water-blue water" was least recognized among respondents (75%). Participants perceived that a sustainable diet was rich in vegetables, included plenty of fresh products, and was affordable. Participants (>66%) perceived a positive impact of meat and its derivatives toward sustainability, a misconception most common among men. Overall, participants with more knowledge about environmental concepts showed favorable attitudes toward a sustainable diet. Women showed more interest in changing their current dietary habits toward food sustainability. In conclusion, despite participants' positive attitude toward food sustainability, lack of understanding persists, necessitating public health interventions aimed at educating consumers about sustainable diets and their impact on the environment.

KEYWORDS

food sustainability, knowledge, attitudes, sustainable diet, sustainable consumption

1 Introduction

According to the latest Intergovernmental Panel on Climate Change (IPCC) report to control global warming within safe levels by 2030, countries worldwide should drastically change their approach to land use (Lee et al., 2023). Human behaviors have been suggested to be the main drivers of climate change, which in turn negatively impacts health and the environment and disrupts the food chain. The aforementioned report also emphasizes the need for a global strategy prioritizing sustainability to tackle climate change. According to data released by the National Aeronautics and Space Administration (NASA), the "Earth's global average surface temperature in 2020 was statistically tied with 2016 as the hottest year on record, implicating a long-term warming trend due to human activities" (Jia et al., 2023). Kuwait is susceptible to the negative health effects of climate change. Considering its high greenhouse gas (GHG) emissions, the mean annual temperature is projected to rise by approximately 6.2°C on average from 1990–2100 (Alkandari, 2024). Moreover, in line with

the Sustainable Development Goals that focus on numerous critical global issues, several are closely related to food sustainability and are recognized targets in Kuwait, particularly related to food security, sustainable agriculture, consumption and production, climate change, and sustainable food systems (Allen et al., 2019).

More recently, there has been a focus on the ecological footprint, which compares the rate of resource consumption and waste generation to the rate at which nature can absorb and generate new resources (Network, 2020). Considering these methods, it would be ideal for countries to better understand their ecological footprint impact to improve long-term sustainability.

In Africa, the Middle East, and Central Asia regions, the total ecological footprint *per capita* was found to be increasing more rapidly than in other regions (Lin et al., 2018). In particular, the carbon footprint, which is the total amount of greenhouse gas emissions (GHG), including carbon dioxide and methane, was found to account for 60% of the world's total ecological footprint and is considered the main cause of human-induced climate change (Lin et al., 2018). Food security in Kuwait is another great challenge due to its growing population, arid dry soil, limited natural water resources, and climate change. As such, the most recent "Our World in Data" report found that GHG emissions in Kuwait ranked second highest among the GCC countries, wherein in 2018, 21.62 tonnes *per capita* GHG emissions were recorded (AlRukaibi and AlSalem, 2022). In response, Kuwait has pledged to reduce its GHG emissions, equivalent to 7.4% of its total emissions by 2035, with unconditional national efforts (Billich et al., 2022).

Global food systems, including production, processing, distribution, and consumption, account for 26% of global GHG (Ritchie and Roser, 2022). "Globally, enough food is wasted every year to feed nearly 2 billion people a 2,100 kcal/day diet" (Conrad et al., 2018), and approximately one-third of the wasted food is responsible for nearly 6% of total GHG emissions (Ritchie and Roser, 2022). The Food Waste Index Report in 2021 by the United Nations Environment Program (UNEP) showed that Kuwait wastes 397,000 tons of food yearly, with 95 kg *per capita* on average (Forbes, 2021). Food waste poses a negative environmental impact on agriculture and increases resource shortage (Conrad et al., 2018); therefore, it is empirical that efforts focus on the reduction of food waste through sustainable consumption and production and transition toward a low-carbon and green economy (ESCAP U, 2016).

Sustainable diets promote the intake of foods low in water and carbon footprints and the use of food biodiversity comprising local and traditional foods (Burlingame and Dernini, 2010). The Food and Agricultural Organization (FAO) defines sustainable diets as "those diets with low environmental impacts, are protective of biodiversity and ecosystems, culturally acceptable, accessible, economically fair, affordable, nutritionally adequate, safe, and healthy while optimizing natural and human resources" (Burlingame and Dernini, 2010).

The FAO recognizes the Mediterranean diet as a healthy dietary pattern for humans with a low environmental impact and has been selected as a model to help achieve the Sustainable Development Goals (García-González et al., 2020). The Mediterranean diet, a diverse diet rich in plant-based foods such as cereals, fruits, vegetables, and legumes and healthy fats such as olive oil with moderate amounts of fish and red meat, has shown to have numerous health benefits and a low environmental footprint (Dernini and Berry, 2015). Previously, plant-based foods and dietary patterns were shaped by cultural beliefs, personal preferences, and socioeconomic factors; however, currently, there is a growing interest in diets that are predominantly plant-based (Fresán and Sabaté, 2019; Hu, 2024; Wiśniewska et al., 2024). While preexisting plant-based diets are found to vary widely, depending on their flexibility (flexitarian, lacto-ovo-vegetarian, and pesco-vegetarian) or strictness (vegetarian and vegan diets), these diets are found to align with health benefits observed with the Mediterranean diet (Neuenschwander et al., 2023; Wang et al., 2024). Nevertheless, the health benefits of plant-based diets remain a topic of debate with limited consistent conclusions (Magkos et al., 2020; Gibbs and Cappuccio, 2022). While some research found no significant association or clear benefits of vegetarian diets for weight management, other studies have indicated that predominantly plant-based or vegan diets can lead to physiological changes and reductions in body weight. More recently, research has shifted to better understanding dietary factors that may influence the risk of non-communicable diseases, particularly focused on the impact of green/plant-based diets on longevity and healthy aging (Van Soest et al., 2023; McEvoy and McClure, 2024). The adoption of a plant-based diet has been suggested to contribute significantly to healthy aging by mitigating the risk of chronic diseases (hypertension, diabetes, and heart diseases) and by promoting overall wellbeing in the aging population (Dominguez et al., 2024; Hu, 2024; van Soest et al., 2024). However, more research is needed to determine the benefits of such diets in the long term (Magkos et al., 2020). Moreover, in line with one of the key messages of the EAT-*Lancet* Commission on healthy diets from sustainable food systems states: "Transformation to healthy diets by 2050 will require substantial dietary shifts, including a greater than 50% reduction in global consumption of foods, such as red meat and sugar, and a greater than 100% increase in consumption of healthy foods, such as nuts, fruits, vegetables, and legumes" (Barthelmie, 2022). These recommendations similarly highlight that plant-based diets have been linked to efforts to save the planet and promote environmental causes. Shifting to plant-based diets can drastically diminish environmental impacts, cutting diet-related land use by 76%, greenhouse emissions by 49%, and green and blue water use by 21% and 14,%, respectively. In consideration of their notable health benefits related to increased consumption of plant-based foods, it would be ideal that sustainable food systems are embraced to lessen the environmental damage and concurrently address the rising prevalence of obesity and related non-communicable diseases (Gibbs and Cappuccio, 2022).

Individual food consumption behaviors can have a significant impact on GHG mitigation (García-González et al., 2020). Despite the Mediterranean diet's recognized health and environmental benefits, several studies have shown a global shift toward a "western-style dietary pattern," characterized by excessive intake of calories, animal-based products, and processed foods such as refined carbohydrates, added sugars, salt, and saturated fat. This type of "western diet" is concurrently presenting challenges for population health and environmental sustainability (Conrad et al., 2018).

Kuwait and neighboring countries have experienced a similar shift in dietary patterns due to urbanization, economic development, food globalization, and lifestyle changes. The Kuwait Nutrition Profile prepared by the FAO highlighted that the food habits and dietary patterns have shifted from a traditional dietary pattern rich in grains, fish, camel milk, fruits, and vegetables to one that is high in fat and sugar. Several studies in Kuwait have reported a high prevalence of

meat and fast-food consumption among adolescents (Shaban and Alkazemi, 2019; Almansour et al., 2020).

Food sustainability is thus an important topic. A shift toward a more healthy and sustainable food system requires individuals to be more aware of their dietary consumption patterns and understand that their food choices can directly impact the environment. In Kuwait, various initiatives and projects have been implemented to address environmental issues and the impact of climate change, such as the Beatona initiative, established by the Environment Public Authority (EPA), which aims to increase public awareness through sharing real-time environmental news and information. Kuwait's agricultural efforts to mitigate climate change in 2012 were undertaken by the Kuwait Institute for Scientific Research (KISR) to develop crops that can adapt to high temperatures and different spans of seasons and crops resistant to salinity and drought. More than 50 types of trees for greenery and landscape that can reduce climate change effects were introduced under the Agriculture Master Plan by (KISR) and the Public Authority for Agricultural Affairs and Fish Resources (PAAFR). As a part of Kuwait Vision 2035, Kuwait plans to develop a completely carbon-free green city named XZERO.

Nevertheless, it is important to explore the public's understanding and attitudes toward food sustainability and related environmental impact concepts. By identifying the level of knowledge and awareness, effective public health interventions and awareness campaigns can be tailored and developed to improve food sustainability in Kuwait and aid in the control of the related environmental impacts. There are no studies that investigated the knowledge and attitudes toward food sustainability among the population in Kuwait. Therefore, this research was aimed at investigating the knowledge of food sustainability and its related attitudes among Kuwait University (KU) students.

2 Materials and methods

2.1 Sample and study design

The study design was cross-sectional, and the study population was students at Kuwait University in Kuwait. Data were collected through convenience sampling using a self-administered questionnaire developed from a previous study carried out in Spain, which was adapted for use in the present study (García-González et al., 2020). The English language questionnaire was developed and validated by the authors of the study, translated to Arabic, and back-translated to English, after which pilot testing was conducted in both languages. The survey was reviewed by experts in the field to ensure questions were clear, easy to understand, and matched the research objectives.

The questionnaire was disseminated online via email and a QR code with a link where participants filled out the questionnaire in either English or Arabic language. The purpose of the study was described at the start of the survey. Data were collected between February 2023 and March 2023. Composed of 30 questions, the questionnaire was divided into 4 sections (Supplementary material), where section 1 collected student background information. Section 2 collected sociodemographic data, subjective physical activity measures, and self-reported weight (kgs) and height (cm) to calculate body mass index (BMI) to categorize students into an obese group (BMI > 30 kg/m^2) and non-obese group (BMI < 30 kg/m^2) according to World Health Organization cutoffs. Section 3 comprised questions related to food sustainability and environmental impact concepts in which participants were asked about their knowledge of sustainability concepts (yes/no) and to rate attributes that contribute to a sustainable diet on a scale of 1–5, where 1 represented "Not important at all" and 5 represented "Very important." A list of food groups was provided and participants were asked to choose whether each group had a positive or a negative impact on the sustainability of the planet. A question on the perceived impact of water use in food production was asked on a scale from 1 to 5 (1 = totally disagree; 5 = totally agree). A 5-point Likert scale rating system was used in section 4 of the questionnaire to measure participants' attitudes toward sustainable diets. Participants had to rate the significance of buying sustainable foods, their willingness to pay extra for food that is produced sustainably, and their willingness to change their current dietary habits toward more sustainability. Participants also rated their willingness to purchase a food or drink that is labeled with a low carbon and water footprint, as well as their willingness to reduce consumption of a particular food or drink after knowing its environmental impact.

This study involved a total of 278 participants who were recruited using a convenience sampling method. With a 95% confidence interval and a 5% margin of error, the minimum sample size required was 221. Considering non-responders, the sample size was increased by 20%, and thus, the required sample size for this study was 265.

2.2 Statistical analyses

All data were analyzed using SPSS v.26.0. Descriptive analysis was carried out to identify sociodemographic characteristics of the population, level of knowledge, and attitudes. The results for categorical data were reported using frequencies and percentages. For results pertaining to knowledge of sustainability concepts and the effects of various food groups toward sustainability, differences among groups were assessed using a chi-square test. A binary logistic regression was performed to determine the significant predictors for attitudes toward food sustainability among KU students. Statistical significance was set at $p < 0.05$.

3 Results

Out of the 278 participants who completed the questionnaire, 78% were women, 22% were men, and most of them were between 18 and 22 years of age, while 18% of them were above 22 years. Most of the participants (94%) were undergraduates and non-medical students (82%). By employment status, 12% were employed in the government sector, while 89% of the participants did not work. By health status, 66% of participants were of normal weight, whereas 34% were obese. Table 1 shows the student background and sociodemographic characteristics of the sample population.

3.1 Level of knowledge on food sustainability concepts

As illustrated in Figure 1, over 50% of participants recognized only half of the concepts related to food sustainability. "Local food" and "environmental impact" were the most known concepts, whereas "green water-blue water" and "food sustainability" were the least known concepts.

TABLE 1 Socio-demographic characteristics of Kuwait University students.

Categories	Total	
	n	%
Gender		
Female	217	78.1
Male	61	21.9
Age range (years)		
<20	133	47.8
20-22	95	34.2
>22	50	18.0
Type of Degree		
Bachelor's degree	261	93.9
Master's degree	17	6.1
Mode of study		
Full-time	161	57.9
Part-time	117	42.1
Year of study		
<3rd year	197	70.9
=>3rd year	81	29.1
Nationality		
Kuwaiti	237	85.3
Non-Kuwaiti	41	14.7
Faculty		
Medical	51	18.3
Non-medical	227	81.7
Marital status		
Single	243	87.4
Married	31	11.2
Divorced	4	1.4
Children		
No	255	91.7
Yes	23	8.3
Governorate		
Al-Ahmadi	50	18
Capital	50	18
Farwaniya	67	24.1
Hawali	42	15.1
Jahra	29	10.4
Mubarak Al-Kabeer	34	12.2
Not reported	6	2.2
Employment status		
No	246	88.5
Yes	32	11.5
Length of Employment		
None	234	84.2
<=5 years	29	10.4
>5 years	15	5.4
Employment sector		
Govt Sector	25	9
Private Sector	8	2.9
Other	245	88.1
Income		
None of the above	117	42.1
<500 KD	126	45.3
>=500 KD	35	12.6
BMI		
Non-Obese	182	65.5
Obese	94	33.8
Physically active		
No	100	36
Yes	178	64
Physical activity - hrs/week		
<3 hrs/week	98	35.3
3-5 hrs/week	118	42.4
>5 hrs/week	62	22.3

Most of the terms related to food sustainability were recognized by women more than men. When participants were asked if they knew the concept of "environmental impact," a statistical difference ($p \leq 0.05$) was observed in which more female (77%) than male participants (61%) indicated awareness of this concept. In addition, the concept "ecological footprint" was least known by men (59% vs. 43% of women).

Interestingly, students' knowledge of each concept increases with age, as illustrated in Table 2. The highest percentage is found among students over 22 years old, followed by those aged 22–20 years, and the lowest percentage is among students under 20 years old. The term "green water/blue water" was the least known among all participants, regardless of age or gender. In addition, statistical differences were observed ($p < 0.05$) between percentages of students who knew the terms "ecological footprint" and "biodiversity" in each age group.

Participants were given a list of aspects that contribute toward a sustainable diet (Table 3) and were asked to rate them accordingly from 1 to 5, 1 representing "not important at all" and 5 "very important." Overall, participants perceived a sustainable diet comprised mainly of a "diet rich in vegetables" (3.58 ± 1.733), "plenty of fresh products" (3.53 ± 1.806), and "affordable" (3.53 ± 1.826). In contrast, participants perceived "few ingredients" (1.72 ± 1.744), "no additives" (1.78 ± 1.903), and interestingly "low processing" (1.98 ± 1.947) as aspects that contribute the least toward a sustainable diet. The scores given by women were higher than those given by men for all aspects except for "low processing" and "locally produced." When asked whether sustainable and healthy diet terms mean the same thing, 50% of the participants believed that both terms did not mean the same, with no statistical difference in gender and age.

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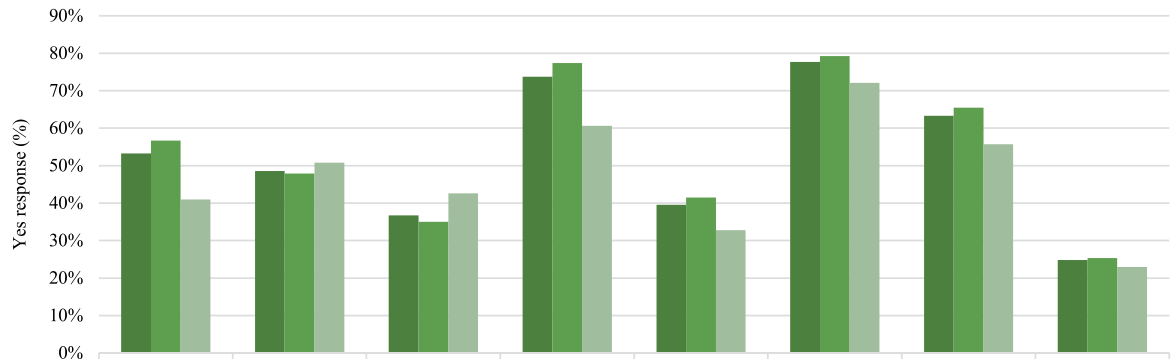

	Ecological footprint	Carbon footprint	Food sustainability	Environmental impact	Biodiversity	Local food	Greenhouse gas emissions	Green water–Blue water
Total	53.2	48.6	36.7	73.7	39.6	77.7	63.3	24.8
Female	56.7	47.9	35.0	77.4	41.5	79.3	65.4	25.3
Male	41.0	50.8	42.6	60.7	32.8	72.1	55.7	23.0

FIGURE 1
Bar graph presenting the percentage of students that responded "yes" to knowing the terms related to food sustainability by gender.

TABLE 2 Percentage of Kuwait University students that responded "yes" to knowing the terms related to food sustainability by age groups.

Food sustainability related term	Age groups (in years)			Total	*p*-value
	<20	20–22	>22		
	n = 133	*n* = 95	*n* = 50		
Ecological footprint	44.4	57.9	68.0	53.2	0.046
Carbon footprint	42.1	53.7	56.0	48.6	0.295
Food sustainability	30.1	42.1	44.0	36.7	0.079
Environmental impact	69.2	74.7	84.0	73.7	0.277
Biodiversity	33.1	44.2	48.0	39.6	0.006
Local food	72.9	81.1	84.0	77.7	0.454
Greenhouse gas emissions	58.6	68.4	66.0	63.3	0.605
Green water–Blue water	26.3	20.0	30.0	24.8	0.546

Chi-square test with a significant value $p < 0.05$.

TABLE 3 Perceived aspects that contribute to a sustainable diet.

Attribute	Mean	SD
Low environmental impact	2.62	1.934
Respectful of biodiversity	2.47	1.928
No additives	1.78	1.903
Low processing	1.98	1.947
Few ingredients	1.72	1.744
Organic/ecologic products	2.88	1.884
Plenty of fresh products	3.53	1.806
Diet rich in vegetables	3.58	1.733
Diet typical from own culture	2.39	1.801
Locally produced	2.79	1.757
Affordable	3.53	1.826
Easy to follow	3.16	1.916

Data presented, Mean and Standard Deviation (SD). Perceived aspects scored on a scale of 1–5 (1 = not important at all to 5 = very important).

Tables 4, 5 illustrate how participants viewed the impact of food groups on sustainability by gender and age group. Vegetables are a top indicator for perceived impact on sustainability in which over half of the participants (86%) stated that vegetables have a positive impact on food sustainability. Similarly, 74% of students think that eggs have a positive effect on food sustainability, whereas 71% consider the same for fish and its derivatives and 69% attribute a positive impact to dairy products as well as meat. The perception that meat contributes positively toward food sustainability is more common among men than women in which a statistical difference ($p < 0.05$) was also observed. On the other hand, participants believe that carbonated and processed drinks (78%) and processed food (73%) have a negative impact on food sustainability. More women (81%) than men (67%) think that carbonated and processed drinks contribute negatively to food sustainability, in which a statistical difference was found ($p < 0.05$).

Statistical differences were also found (Table 5) among the three age groups for processed food and carbonated and processed drinks. The percentage tended to increase with age, attributing a negative impact by both food groups on food sustainability.

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TABLE 4 Perceived impact of food groups on sustainability among Kuwait University students by gender.

Food type	Gender	I do not know	Negative impact	Positive impact	*p*-value
Vegetables	Female	13%	2%	85%	0.658
	Male	10%	3%	87%	
Meat and its derivatives	Female	22%	15%	63%	0.032
	Male	10%	10%	80%	
Fish, shellfish, and its derivatives	Female	21%	11%	68%	0.131
	Male	10%	11%	79%	
Milk and dairy	Female	17%	17%	66%	0.252
	Male	13%	10%	77%	
Eggs	Female	21%	8%	71%	0.082
	Male	15%	2%	84%	
Processed food	Female	16%	76%	8%	0.133
	Male	26%	64%	10%	
Carbonated and processed drinks	Female	13%	81%	6%	0.01
	Male	15%	67%	18%	

Significance set at $p < 0.05$.

TABLE 5 Perceived impact of food groups on sustainability among Kuwait University students by age group.

Food type	Age group (years)	Do not know	Negative impact	Positive impact	*p*-value
Vegetables	<20	17.30%	0.80%	82.00%	0.084
	20–22	7.40%	3.20%	89.50%	
	>22	8.00%	4.00%	88.00%	
Meat and its derivatives	<20	24.10%	9.00%	66.90%	0.052
	20–22	16.80%	15.80%	67.40%	
	>22	12.00%	24.00%	64.00%	
Fish, shellfish, and its derivatives	<20	22.60%	12.80%	64.70%	0.169
	20–22	16.80%	6.30%	76.80%	
	>22	12.00%	14.00%	74.00%	
Milk and dairy	<20	21.10%	15.00%	63.90%	0.167
	20–22	10.50%	13.70%	75.80%	
	>22	12.00%	20.00%	68.00%	
Eggs	<20	23.30%	6.00%	70.70%	0.293
	20–22	15.80%	5.30%	78.90%	
	>22	16.00%	12.00%	72.00%	
Processed food	<20	25.60%	67.70%	6.80%	0.027
	20–22	11.60%	76.80%	11.60%	
	>22	10.00%	82.00%	8.00%	
Carbonated and processed drinks	<20	20.30%	69.90%	9.80%	0.016
	20–22	6.30%	85.30%	8.40%	
	>22	8.00%	86.00%	6.00%	

Significance set at $p < 0.05$.

Table 6 shows the study population's understanding of the significance of water usage in food production, and our findings indicate that more water resources were required in the production of plant-based foods than for meat-based production. In addition, one-third of the participants either "do not know" or "do not agree" while 56% of participants "mostly agree" to "completely agree" with the perception that "enough water for the planet is granted by the natural cycle of water."

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TABLE 6 Importance of water usage in food production, on a scale of 1–5 (1 - totally disagree, 5 - totally agree), total and by gender.

Response	1. Enough water for the planet is granted by the natural cycle of water			2. Production of meat-based foods require more input of water resources			3. Production of plant-based foods require more input of water resources		
	Gender		Total	Gender		Total	Gender		Total
	Female	Male		Female	Male		Female	Male	
I do not know	23%	20%	22%	30%	34%	31%	25%	33%	27%
Do not agree	9%	3%	8%	13%	15%	13%	5%	5%	5%
Agree a little	15%	13%	14%	13%	10%	13%	11%	7%	10%
Mostly agree	21%	18%	20%	19%	18%	19%	16%	11%	15%
Agree	21%	30%	23%	18%	11%	17%	24%	26%	24%
Completely agree	12%	16%	13%	6%	11%	8%	19%	18%	19%

TABLE 7 Responses of attitudes toward a sustainable diet on a 5-point Likert scale.

Response	To what extent are you willing to pay more money for food and drink products that are produced in a sustainable way?	To what extent are you willing to change your current dietary habits toward more sustainability?
Not sure/do not know	20.9%	19.4%
Not at all	4.0%	4.3%
Unwilling	10.1%	10.1%
Moderately willing	36.7%	25.9%
Quite willing	16.9%	21.9%
Willing	11.5%	18.3%
	To what extent are you willing to purchase food or drink that is labeled with a low carbon and water footprint?	To what extent are you willing to reduce consumption of a particular food or drink after knowing that it is producing more environmental impact?
Not sure/do not know	30.6%	22.3%
Not at all	3.6%	3.6%
Unwilling	13.3%	10.4%
Moderately willing	21.2%	25.2%
Quite willing	12.2%	15.8%
Willing	19.1%	22.7%

3.2 Attitudes toward sustainable diets

The study participants were inquired about their willingness to pay more for a food item that was sustainable on a scale from 1 to 5, with 1 corresponding to "not at all" and 5 to "willing." The majority of them (37%) were moderately willing to pay more for a sustainable diet, while 21% were unsure. Men were more likely to pay more for food and beverage that was sustainable. When asked to rate their willingness to change their current dietary habits toward a more sustainable one, the majority of the participants were moderately willing to quite willing to do so. More women than men were willing to change their dietary habits toward sustainability (Table 7).

One-third of participants (30%) were unsure whether they would purchase any food or drink labeled with a low carbon and water footprint, while the majority of them (25%) were "moderately willing" to reduce consumption of certain foods after knowing that it was producing a negative impact toward the environment.

A bivariate analysis using the chi-square test was performed, as shown in Table 8, to identify the relationship between independent variables and dependent variables (Attitude: negative/positive). Higher knowledge of environmental concepts and food sustainability was significantly associated with a positive attitude toward sustainable diets. Participants who had more knowledge about environmental concepts and food sustainability showed a positive attitude toward sustainable diets, whereas those with less knowledge had a more negative attitude, with a significant statistical difference ($p < 0.001$). Statistical differences ($p < 0.05$) were observed between faculty type, age groups, governorate, nd monthly income, and attitudes toward food sustainability.

A binary logistic regression analysis was performed with backward elimination to further analyze the significance of the relationship between independent variables and dependent variables with a 95% CI, as shown in Table 9. It was found that respondents with no income were 47% less likely to have a positive attitude toward sustainable diets when compared to respondents with a monthly income ($p < 0.05$). It

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TABLE 8 Association between attitude and investigated variables.

Variable	Category	Attitude		Pearson chi-square value	*p*-value
		Negative (*n*)	Positive (*n*)		
Faculty type	Medical	10	41	7.551	0.006
	Non-medical	91	136		
Degree level	Bachelor	95	166	0.008	0.927
	Master	6	11		
Knowledge	Poor	40	73	65.78	<0.001
	Good	137	28		
Year of study	<3rd year	78	119	3.112	0.078
	≥3rd year	23	58		
Mode of study	Full-time	53	108	1.925	0.165
	Part-time	48	69		
University accommodation	No	101	175	1.15	0.284
	Yes	0	2		
Gender	Female	78	139	0.064	0.801
	Male	23	38		
Age	<20 years old	58	75	6.462	0.04
	20–22 years old	26	69		
	>22 years old	17	33		
Nationality	Kuwaiti	88	149	0.444	0.505
	Non-Kuwaiti	13	28		
Governorate	Capital	33	59	8.113	0.017
	Al-Ahmadi	40	44		
	Al-Farwaniya	28	74		
Marital status	Single	88	155	0.334	0.846
	Married	11	20		
	Divorced	2	2		
Children	No	92	163	0.085	0.771
	Yes	9	14		
Employment status	Unemployed	92	154	1.053	0.305
	Employed	9	23		
	None	87	147		
Length of Employment	≤5 years	7	22	2.629	0.269
	>5 years	7	8		
Employment sector	Government sector	7	18	1.352	0.509
	Private sector	2	6		
	Other	92	153		
Monthly income	None	54	63	8.524	0.014
	<500 KD	36	90		
	≥500 KD	11	24		
BMI	Non-Obese	61	121	2.182	0.14
	Obese	40	54		
Physically active	No	39	61	0.481	0.488
	Yes	62	116		
Physical activity—h/week	<3 h/week	37	61	0.249	0.883
	3–5 h/week	43	75		
	>5 h/week	21	41		

TABLE 9 Logistic regression analysis to assess the relationship between variables and positive attitudes toward food sustainability.

Independent variable	*B*	*p*-value	OR	95% C.I.	
				Lower	Upper
Constant	0.511	0.057	1.666		
Income = None of the above (1)	−0.638	0.019	0.528	0.310	0.900
BMI=Non-obese (1)	0.645	0.022	1.906	1.099	3.307
Governorate = Al-Ahmadi (1)	−0.786	0.005	0.456	0.263	0.790
Type_College = Medical (1)	0.959	0.016	2.608	1.194	5.698

Significant set at $p < 0.05$; Adjusted R2 = 0.21, OR = Odds Ratio.

is worth noting that although no statistical significance was observed between BMI and attitude in the bi-variate analysis, there seems to be a correlation between BMI and other variables, as shown in the binary logistic regression model. Respondents with a normal BMI were 1.9 times more likely to have a positive attitude toward sustainable diets compared to the obese group. When comparing respondents' area of residence, the analysis suggests that respondents living in the Al-Ahmadi area were 54% less likely to have a positive attitude toward a sustainable diet than others. When comparing medical to non-medical students, the analysis shows that respondents from medical college were 2.6 times more likely to have a positive attitude toward a sustainable diet.

4 Discussion

4.1 Knowledge of environmental concepts and food sustainability

The aim of this study was to assess the knowledge and attitudes toward food sustainability among Kuwait University students. This is the first study in Kuwait that evaluates the level of knowledge of food sustainability and its related attitudes toward food sustainability of a small sample size of Kuwait University students. Overall, the results present a positive attitude of Kuwait University students toward a sustainable diet. Yet, the results also indicate some misconceptions and lack of knowledge among participants about sustainability concepts and food groups that have a major impact toward sustainability and the environment. However, considering that the majority of the study population was of non-medical/health science background, these misconceptions may be due to their limited knowledge of concepts and terminology related to nutrition and health. A better knowledge of environmental concepts and food sustainability has a significant positive impact on attitude toward sustainable diets, which in turn correlates with the willingness to buy sustainable products, change dietary habits toward sustainability, and reduce consumption of products that negatively impact the environment. Most of the study population was still unfamiliar with many environmental concepts and aspects that contribute to a sustainable diet, indicating a need for greater efforts to increase knowledge of food sustainability and the importance of sustainability concepts when making food choices. Research shows that only a small number of consumers have a good understanding of the attributes of sustainable food products (García-González et al., 2020). Although participants acknowledged that they heard the term or know the concepts in relation to food sustainability, the level of knowledge was lower for certain concepts such as "green water/blue water" and interestingly "food sustainability." This is in parallel with a study carried out by Gonzalez et al., in which its Spanish population had the least knowledge of the term "green water/blue water" (García-González et al., 2020). Interestingly, they also identified that the best-known concepts among their study population were "local food" and "environmental impact" which was similar to our findings. Furthermore, our analysis revealed that the level of knowledge increased with each age group, which is in accordance with a study by Gaspar et al., who identified that the level of knowledge of topics related to sustainability depended mainly on the level of formal education and therefore related with the age of the participants (Vanhonacker et al., 2013; Gaspar et al., 2022).

When evaluating the importance of different aspects of a sustainable diet, the study population emphasized that such a diet must be rich in vegetables, include plenty of fresh products, and be affordable. In a similar way, the Eurobarometer, on perceptions of food sustainability, reported that "Europeans prioritize taste, food safety and cost over sustainability concerns when making their food purchases" (European Commission, 2020). Furthermore, the results from our study also reflect some of the elements stated in the FAO's description of sustainable diets with "low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources" (Burlingame and Dernini, 2010). In this study, although the participants associated the importance of a sustainable diet with its affordability and taste, the average scores for all other aspects of the environmental dimension of food sustainability were less than 3. One of the aspects "few ingredients" scored the lowest, similar to the study by Irazusta-Garmendia et al., in which "presence of few ingredients" was given the lowest score (Irazusta-Garmendia et al., 2023).

Many sustainability aspects in this study were evaluated either as "not sure/do not know" or "of little importance," indicating the need to incorporate education programs to promote food sustainability concepts mainly to address its environmental dimensions. The EAT-Lancet project report indicates an increase in unhealthy food consumption, while the global average consumption of healthy foods is significantly lower than the recommended guidelines (Willett et al., 2019). A sustainable diet may help reduce the consumption of high-calorie, processed, and packaged foods by emphasizing a lower intake of animal-derived foods and a higher consumption of plant-based foods. "Transitioning toward more plant-based diets that are in line with global dietary guidelines could reduce global mortality by 6–10%

and food-related greenhouse gas emissions by 29–70% compared with a reference scenario in 2050" (Springmann et al., 2016).

The results of this study demonstrate the study population's understanding that vegetables positively contribute toward the sustainability of the planet and that carbonated and sugar-sweetened beverages and processed foods are detrimental to sustainability. However, when evaluating the impact of other food groups on environmental sustainability, there seemed to be few misconceptions. Approximately 66% of participants believe that meat and its byproducts yield a positive impact toward sustainability, and close to 70% think similar to dairy products. Diets high in dairy products and meat, however, are generally correlated with the highest ecological footprint (Ruini et al., 2015). A study found that reducing meat consumption could significantly decrease food-related greenhouse gas emissions by nearly 50% (Barthelmie, 2022). Reducing meat consumption and transitioning toward more plant-based diets would be the most effective way to reduce dietary footprint and mitigate climate change (Springmann et al., 2021). The lack of knowledge of the adverse effects of meat on sustainability has been reported in other studies. Macdiarmid et al. explored public awareness of the environmental impact of food and their willingness to reduce meat consumption and observed that its participants lacked awareness of the association between meat consumption and climate change (Macdiarmid et al., 2016). Similarly, in another study by Gonzalez et al., half of the participants thought that meat and its byproducts have a positive effect on food sustainability, and 70% thought the same for dairy products (García-González et al., 2020).

Global *per capita* meat intake is currently above healthy levels, and dangerous climate change cannot be avoided unless food consumption trends change (Wellesley et al., 2015). Almansour et al. found a high-frequency consumption of meat and fast food per day among Kuwait University students (Almansour et al., 2020). The idea that meat and its derivatives have a favorable influence on food sustainability is more common among men than women, consistent with the study findings of Gonzalez et al. in which meat intake and its products in Spain are higher among men than women (García-González et al., 2020). In consideration of the transitioning diets in Kuwait, whereby most of the food consumed is imported and westernized, more research is needed to better understand current local dietary patterns and how they may be tailored to become more sustainable while still being nutritionally adequate (Zaghloul et al., 2013).

Most participants (71%) associated fish and its derivatives with having a positive impact on a sustainable diet. Seafood, in general, is known to have a much lower carbon footprint than any other type of animal protein, and fish-eaters, who consume no meat, have a similar emissions profile to strict vegetarians, who are the least impactful eaters (Koehn et al., 2022). The concern, however, lies in issues such as "biodiversity loss" that need to be considered while examining the effects of fish on food sustainability. A dietary survey carried out by Laird et al. in more than 2,000 households reported a high intake of fish and shellfish among the Kuwaiti population (Laird et al., 2017). Global intake of seafood has more than doubled in the last 50 years (Guillen et al., 2019). The shift toward sustainable food habits also requires a better understanding of the implications of the loss of biodiversity among the population of Kuwait.

All animal products have a water footprint; in general, more water is needed to produce meat than plant-based foods such as grains or beans (Birke, 2021). The last question in this section asked participants about the significance of water usage in the production of food. According to our findings, most participants perceive that vegetable food production requires more water resources than meat-based foods, indicating a lack of knowledge in this regard. When asked about the notion that "enough water for the planet is granted by the natural cycle of water," most participants "moderately agree," demonstrating the need to create more awareness surrounding this topic.

4.2 Attitudes to sustainable diets

One of the objectives of this study was to investigate the correlation between sociodemographic factors, knowledge, and related attitudes among KU students contributing to food sustainability. A significantly positive association was found between the level of knowledge of environmental concepts and food sustainability and attitudes toward sustainable diets. It was observed that participants who had greater knowledge about environmental concepts and food sustainability showed a positive attitude toward a sustainable diet, whereas those with poor knowledge exhibited a negative attitude. This is in accordance with another study by Irazusta-Garmendia et al., in which a positive association between greater knowledge and positive attitudes toward food sustainability was found among their sample population of students and faculty professors (Irazusta-Garmendia et al., 2023).

Our results indicate that respondents with no income were less likely to have a positive attitude toward sustainable diets when compared to respondents with a monthly income, which is similar to a study by Sánchez-Bravo et al., in which consumers' views and attitudes were assessed around food sustainability based on sociodemographic factors. They identified that in some cases, income level was associated with environmental concerns in which rising income leads to an increase in sustainability concerns (Sánchez-Bravo et al., 2020). Respondents' BMI, in this study, was also found to be associated with positive attitudes toward sustainable diets compared to the obese group. When comparing medical to non-medical students, the analysis shows that respondents from medical college were 2.6 times more likely to have a positive attitude toward a sustainable diet. In contrast, in another study by Syed Azhar et al., in assessing students' attitudes and perceptions toward sustainability, no significant difference was found among science students and non-science students of University Sains Malaysia (Syed Azhar et al., 2022). This could be due to the Malaysian higher education institutions' emphasis on sustainability issues. In contrast, a study by Afroz and Ilham, in which their aim was to assess the knowledge, attitude, and practice of university students toward SDGs, found that science students possessed greater knowledge (science 85.8%, non-science 81.9%) and positive attitude (science 78.29%, non-science 68.84%) toward SDGs than non-science students (Nusrat and Zul, 2020). This is in line with our findings, which show that medical students were more likely to have a positive attitude toward sustainability than non-medical students. This could be because medical students receive more exposure and education on sustainability concepts than non-medical students.

Participants were asked four questions on their inclination to pay extra for sustainable food and change current dietary habits to

purchase and reduce the consumption of products that would positively impact sustainable diets and the environment. Most of the participants were "moderately willing" to pay more for a sustainable diet, which could be tied to the fact that affordability or price was one of the main barriers toward sustainability. Similarly, a Kuwaiti public perception survey revealed that consumers are willing to spend more on organic produce, particularly if it is locally grown and reasonably priced (Elmi et al., 2019). Our findings could further reinstate that respondents with no income were less likely to have a positive attitude toward sustainable diets.

In our study, men were more likely to spend extra for sustainable food and beverages than women despite their relatively small percentage in the sample population. When asked to rate their willingness to change their current dietary habits toward a more sustainable one, the majority of the participants were moderately willing to quite willing to do so. Our results indicate that women showed more interest in changing their dietary habits toward sustainability than men. This is consistent with another study by Tobler et al., in which they found that women were more inclined toward adopting ecological food consumption patterns (Tobler et al., 2011). In addition, a systematic review by Sánchez et al. found that women had higher levels of sustainable food consumption behaviors (Syed Azhar et al., 2022).

Most participants (30%) were unsure whether they would purchase any food or drink labeled with a low carbon and water footprint, followed by "moderately willing." The response reflects a lack of understanding about the sustainable concepts among participants, as half of the study population did not know the concepts, as shown in our analysis. This finding is quite similar to the study by Gonzalez et al., where "carbon footprint" was one of the least familiar terms among participants (García-González et al., 2020).

The responses to our study's last question indicate our study population's interest in learning about the aspects of a sustainable diet, and thus, are open to changing certain behaviors that may positively impact the environment. Most participants were "moderately willing" to "willing" to reduce consumption of certain foods after learning about their negative impact on the environment. This suggests that the population's willingness to adopt environmentally friendly behaviors is greatly influenced by their level of knowledge about sustainability and related concepts.

5 Study limitations

In consideration of the study findings, it is important to note several limitations. First, the cross-sectional design of the study limits the ability to observe change over time and thus cannot confer causation. Ideally, longitudinal studies would be needed to track changes in knowledge and attitudes over time and help determine causal relationships. Second, the study relies heavily on self-reported data such as weight and height as well as students' attitudes and knowledge levels. This reliance on self-reported data increases the risk of response bias, and participants may provide socially desirable responses or may not accurately recall their attitudes and knowledge toward food sustainability, leading to potential inaccuracies while interpreting the findings. Third, the use of a non-probability sampling method (convenience sampling) may have introduced sampling and participation bias. Students may have been more motivated and willing to participate, which could limit the diversity of opinions and experiences captured in the study, resulting in poor external validity. Additionally, the sample was predominantly women and skewed toward non-medical disciplines, making it difficult to generalize the findings to a wider population of students. This gender imbalance may further skew the findings, hindering a comprehensive understanding of students' knowledge and attitudes toward food sustainability. Future studies should aim to include a more diverse and representative sample of students across Kuwait to better understand the knowledge and attitudes toward food sustainability and consider other factors, such as students' current dietary habits and whether the university setting facilitates sustainable food choices.

6 Conclusion

In conclusion, this is the first study that assesses the knowledge and attitudes toward food sustainability in Kuwait. This study is relevant since food sustainability and climate change are a global concern. Nevertheless, further research is needed with a larger sample size to ensure the generalizability of findings. The results of this study suggest that the study population shows a positive attitude toward sustainable diets; however, more evidence-based knowledge is needed for people to fully understand food sustainability concepts and their environmental implications. The public health sector of Kuwait should contribute by creating awareness and empowering people to make sustainable choices. Campaigns and policies should be directed toward educating the public on how food consumption affects our planet and future generations. The shift into a more sustainable future requires disseminating the right information and encouraging the population to make the right diet choices. This study has addressed some important environmental concepts and identified related attitudes over establishing preliminary evidence that can be used in planning a more advanced and thorough study.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Institutional Review Board of Ministry of Health, Kuwait (protocol code 2142/2022 and approval date: 19-01-2023). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

DA: Methodology, Validation, Writing – review & editing, Conceptualization, Supervision. AM: Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing, Validation,

Writing – original draft. AN: Methodology, Supervision, Writing – review & editing, Data curation, Formal analysis, Investigation, Software.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1364085/full#supplementary-material

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