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Research Article

Keywords: Food systems, sustainable diets, knowledge, perception, undergraduates, Nigeria

Posted Date: November 9th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11250775/v1

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Additional Declarations: No competing interests reported.

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ABSTRACT

Background: Food systems and dietary choices have important implications for human health and environmental sustainability. Undergraduate is a critical period for establishing lifelong dietary habits and shaping environmental attitudes. The complex and often opaque nature of modern food systems can challenge undergraduate understanding of their food choices' impact on their health and the environment.

Objective: This study assessed knowledge and perception of food systems and sustainable diets, as well as attitudes towards sustainable diets, among undergraduate students of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Methods: A cross-sectional study was conducted among 307 undergraduate students selected through multistage sampling from six colleges of the university. Data were collected using a structured and validated interviewer-administered questionnaire covering socio-demographic characteristics, knowledge of food systems and sustainable diets, perceptions, and attitudes towards sustainable dietary practices. Knowledge was assessed using graded scores, while

perceptions and attitudes were assessed using Likert-type scales. Data were analysed using SPSS version 20 with descriptive statistics, including frequencies, percentages, means and standard deviations.

Results: Among 307 respondents, 67.1% demonstrated knowledge of food and sustainable diet concepts, while 82.4% had heard of sustainable diets. Most respondents (72.6%) recognized key components of sustainable diets, including affordability, cultural acceptability, locally produced foods and biodegradable packaging. Positive perceptions were also observed, with 57.0% considering sustainable diet practices extremely important. Sustainable food behaviours were most commonly reflected in purchasing organic fruits and vegetables (60.9%) and local foods (57.7%). However, reducing meat and dairy consumption was less frequently practiced, with 69.7% never eating smaller meat portions and 68.7% never reducing dairy consumption. Overall, the findings suggest that relatively good knowledge and positive perceptions did not consistently translate into sustainable food practices.

Conclusion: Undergraduate students demonstrated generally good knowledge and favourable perceptions and attitudes towards food systems and sustainable diets, although some knowledge gaps remained. Incorporating food-system and sustainable-diet education into university curricula and health-promotion activities could strengthen students' understanding and encourage sustainable dietary practices.

Keywords: Food systems; sustainable diets; knowledge; perception; undergraduates; Nigeria.

INTRODUCTION

The food system is responsible for more than one-third of global GHG (Greenhouse gases) emissions, accounting for 28.34% of emissions overall which needs to be changed (Crippa *et al.*, 2021). Not only must we take into account what is consumed, as food waste is also an important factor. It is estimated that one-third of all food produced each year is wasted in consumer and retail settings (Conrad *et al.,* 2018). There is sufficient evidence demonstrating that the consumption of meat and animal products in general, are the most important generators of GHGs in the food system, which is detrimental to the health of the population (Tilman and Clark, 2014). On the contrary, plant-based foods (e.g., fruits, vegetables, grains, and legumes) are not only healthy but generate much lower GHG (Greenhouse gases) emissions (Gibbs and Cappuccio, 2022). Food systems involve people and factors that initiate or inhibit change in the system, as well as the social, political, economic and technological environment in which food systems-related activities take place (FAO, 2013). This includes children and adolescents themselves, as well as their caregivers and others they interact with in their food environments. A food systems framework that explicitly focuses on how children and adolescents respond to and engage with activities, inputs, and outputs across the food system (including those related to food production, processing, marketing, consumption and disposal (FAO, 2013), can better illuminate gaps and opportunities to address their dietary needs. Food systems are critical to addressing the multiple burdens of malnutrition that children and adolescents face, as food is a key determinant for healthy diets and good nutrition throughout the entire life.

The recommendations of the report included a minimum 50% reduction in the overall consumption of unhealthy foods, such as red meat and sugar, and a more than 100% increase

in the consumption of healthy foods, such as fruits, vegetables, and pulses (Willett *et al*, 2019). Most studies of knowledge and perception towards sustainable diets support the need for initiatives aimed at educating consumers about sustainable dietary patterns. A study in a representative sample of the Spanish population revealed an interest in sustainable food, although only 40% of the population rated sustainable diets are healthy. However, knowledge on the subject remains cursory. The study reported that more than 50% of the population was unaware of the environmental impact of meat, and this figure increased to 70% regarding the impact of fish and dairy products (García-González *et al.,* 2020).

Despite extensive research on the need to adopt sustainable diets, there is limited research on what knowledge and perception are towards sustainable diets in the health sector. The role of healthcare professionals is fundamental in promoting health, and a healthy diet is essential to prevent diet-related risk factors, such as overweight and obesity and associated with non-communicable diseases (Bach-Faig *et al.*, 2022). Furthermore, it is essential for healthcare professionals to have deeper knowledge of sustainable diets and to act in accordance with their knowledge and perception, since they are responsible for disseminating this information to patients and the general population. Furthermore, higher education has great potential to aid in achieving the SDGs and to formally and informally transfer knowledge of food sustainability to students. For this reason, individuals responsible for disseminating this information must be aware of the importance of including food sustainability in their efforts and be able to implement these initiatives in communities. Knowledge and perceptions of food and environmental sustainability in university populations have been previously explored (Busquets *et al.*, 2021; Gaspar *et al.,* 2022) in Spain, although with greater focus on environmental issues sustainable development goals (SDGs), and related concepts. Research assessing the knowledge of actual sustainable food habits and attitudes toward dietary customs is scarcer.

According to National Population Commission (NPC), (2019), Nigeria is also witnessing a significant rise in the incidence of diet-related non-communicable diseases (NCDs): the prevalence of overweight/obesity, and type II diabetes in adults was 33.3 percent and 7.9 percent respectively. Diet-related NCDs are increasingly becoming the leading causes of morbidity and mortality worldwide. They encompass a cluster of illnesses which include diabetes mellitus, cancers, chronic respiratory diseases, cardiovascular disease, and musculoskeletal disorders. The impact of NCDs is great on the poor countries of sub-Saharan Africa, among which Nigeria occupies a significant position. Non communicable disease in Nigeria accounted for an estimated 28 percent of all mortality in 2008. It is estimated that 30% of Nigerians are affected by non-communicable disease (NCD) with prevalence of cardiovascular disease 11%, cancer 4%, diabetes 1%, chronic respiratory disease 2% and other non-communicable disease 12% (WHO 2018). The number of people with type II diabetes in Nigeria is forecast to double from 3.1 million to 6.1 million between 2011 and 2030 (Development Initiatives, 2017).

To combat these challenges, engaging in environmentally sustainable and healthy dietary behaviors is of high importance, and is required to meet the Sustainable Development Goals set by the United Nations for a sustainable future (Food and Agriculture Organization, 2016 and Willett *et al.*, 2019). Sustainable and healthy dietary behaviors should be adopted from a young age, since dietary patterns developed in youth both impact current dietary behaviors and lay foundations for individual's future dietary behaviors (Appannah *et al.*, 2021; Reilly and Kelly, 2011; Simmonds *et al.*, 2016; Singh *et al.*, 2008). Current consumption patterns contribute to proven diet-related environmental damage, such as increased greenhouse-gas

emissions, biodiversity loss, and water scarcity (Swinburn *et al.*, 2019; Willett *et al.,* 2019). In addition, factors related to individual's knowledge, perception, peers and families can influence what adolescents eat (Neufeld *et al.*, 2022). While individual behavior matters, systemic changes across food systems are essential. These changes include reducing reliance on animal-based foods (especially red meat) and promoting whole plant-based foods. Our current food systems prioritize profit over health and sustainability. Encouraging diverse plant-based diets and minimizing reliance on animal foods and ultra-processed products is crucial for their growth and development (Kenny *et al*., 2023). There is, therefore, an urgent need to appraise the diet, food environment, and food supply systems and create recommendations for improvement and the study aim to assess knowledge and perception among under graduates in South Eastern Nigeria about food system and sustainable diets.

MATERIALS AND METHODS

Study design

A cross sectional study design was used in this study among undergraduates in Michael Okpara University of Agriculture, Umudike, and Abia State University Extension, Abia State, Nigeria.

Study population

The study population consists of all the students both males and females in Michael Okpara University of Agriculture, Umudike, Abia State and Abia State University Extension.

Sampling and sampling technique

Sample size determination

The sample size was calculated using the Finite population correction (FPC) formula for sample size estimation.

$$n = \frac{N \times P \times (1-P)}{e^2(N-1)+P(1-P)}$$

A multi-stage sampling technique was used to select the study sample. In the first stage, Michael Okpara University Umudike, and Abia State University Extension, Abia state was purposively selected as the study area. Then six (6) colleges were randomly selected out of the thirteen (13) that make up the study area. In the second stage, a simple random sampling technique by balloting without replacement was used in the selection of three (3) departments from each of the selected six (6) colleges. In the third stage, thirty-three (33) students were randomly selected from each of the selected departments which made up a total of 307 respondents for the study.

Ethical declarations

Informed Consent/ Ethical Approval

Ethical approval to conduct the research was given from the Ethics Committee, of Federal Medical Center Umuahia with ethical number: FMC/QEH/G.596/Vol.10822. The study was conducted in accordance with the relevant guidelines and regulations of the approving ethics committee and the principles of the Declaration of Helsinki. All procedures involving human participants were conducted in accordance with the approved protocol.

A written informed consent was obtained from all participants before participation in the study. Participants were informed about the purpose and procedures of the study, and participation was voluntary.

Data collection

Data was collected using structured and validated interviewer administered questionnaires. The total number of 307 Questionnaire was distributed to the selected respondent.
Which contained sections:
Socio-Demographic data included information on age, sex, religion, department, current level, marital status, economic status, monthly allowance and location of residence.
Fifteen Knowledge of Food System questions was adapted from (Culliford, 2020) and used to assess students' knowledge on food system. Each correct question had a score of 2 marks making a maximum score of 30. The scores were graded into Poor knowledge (0-10), Average knowledge (11-20) and Good knowledge (20-30).
In the assessment of knowledge of sustainable diets nine Knowledge question on sustainable diet were adapted from (García-González *et al*., 2020 and Culliford, 2020). Each correct question was scored 2 marks and the section had a total score of 18 marks. Knowledge sustainable diets were graded into poor knowledge (0-5), average knowledge (6-10) and good knowledge (11-18)
Perception of the food system was determined using a five likert scale questions ranging from: Not important = 0, Slightly important = 1, Moderately important = 2, Very important = 3, Extremely important = 4. Perception on food available in the environment, varieties, cost, and unhealthy and healthy food was adapted from (Gaspar *et al.,* 2022). While perception questions on sustainable diets was adapted from as adapted from Gaspar *et al.,* 2022, and Culliford, 2020.

Data collection on the sustainable diet behavior was assessed using the frequency of sustainable food-consumption behaviours among the respondents. The responses categories were coded as Always = 1, Frequently = 2, Occasionally = 3 and Never = 4, lower mean scores indicate more frequent practice of the behaviour, whereas higher mean scores indicate less frequent practice.

Data/ Statistical analysis
Data was analysed using the Statistical Package for Social Science 20. Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize the data.

RESULTS

Table 1 shows the socio-demographic characteristics of undergraduate students who participated in Michael Okpara University Umudike, and Abia State University Extension, Abia state. The total number of respondents used for this study is 307. However, among the respondents the result shows that males were (34.8%), while (65.2%) were females.
Ethnicity of the participates shows that majority (84.1%) are from Igbo while (9.7%) were from other tribes. With regards to ethnicity which shows more (44.6%) of the respondents are from a particular tribe where the study is being carried out. On the religion of the respondents, the results shows that majority (90.8%) are Christians. Hence, more than of the respondents (84.7%) are single. On the education level, results showed that almost half (25.7) are in there first years in the institution.

The result revealed that 83.7%, 13.1% and 3.3% of undergraduate students has 1-3, 4-6 and <7 as their family size respectively. Below half 11.4% of undergraduate student earned less than 10,000 naira per month, 18.6% earned 11,000 to 20,000 naira, 20.2% earned 31,000 to 40,000, 18.3% earned 41, 000 – 50,000 and 14.9% earned <60,000. The result revealed that majority earned less than minimum wage per month. This was expected because most undergraduate

student do not actively run their business because of the attention they give to their education. The result revealed majority of the respondents (41.4%) resides off campus.

Table 1 Demographic/Socio-Economic Data of respondents (n = 307)

Variable	Frequency (n)	Percentage (%)	Mean
Sex			
Male	107	34.8	
Female	200	65.2	
Total	**307**	**100.0**	
Age			
19 – 24	128	41.6	
25 – 29	117	38.1	
30<	62	20.2	
Total	**307**	**100.0**	**23.5±4.3 Years**
Ethnicity			
Igbo	258	84.1	
Hausa	9	2.9	
Yourba	10	3.3	
Others	30	9.7	
Total	**307**	**100.0**	
Religion			
Christian	279	90.8	
Muslim	16	5.2	
Traditional	3	0.9	
Others	9	2.9	
Total	**307**	**100.0**	
Marital status			
Single	260	84.7	
Married	40	13.1	
Divorced/Separated	6	1.9	
Widowed	1	0.3	
Total	**307**	**100.0**	
Education Level			
1st year	79	25.7	
2nd year	61	19.8	
3rd year	42	13.7	
4th year	59	19.2	
5th year	66	21.3	
Total	**307**	**100.0**	
Family Size			
1 – 3	257	83.7	
4 – 6	40	13.1	
≥7	10	3.3	
Total	**307**	**100.0**	

Monthly Income		
N10, 000	35	11.4
N11,000 – N20, 000	57	18.6
N21, 000 – N30, 000	62	20.2
N31, 000 – N40, 000	51	16.6
N41, 000 – N50, 000	56	18.3
<N60, 000	46	14.9
Total:	**307**	**100.0**
Location of Residence		
Old school hostel	73	23.7
New school hostel	50	16.3
NDDC female hostel	57	18.6
Off Campus	127	41.4
Total	**307**	**100.0**

Table 2 present results on undergraduate student's knowledge on food system. Result showed that majority (90.2%) of the respondents knows that everything they consume using natural resources available on earth, 67.2% of the respondents knows that some of their food have negative impact on their environment, 62.2% indicated that students are concern about environment protection by controlling what they consume. Findings also revealed that mor than half (69.2%) of the respondents know the alternative pattern to avoid negative environmental impact of what they consume, 64.1% of the respondents know foods to avoid because they are environmentally harmful for consumption, more than half (57.9%) of the respondents know that farming generates some toxic gases to the environment. Thus, majority (81.2%) of respondents know that farming significantly influences global warming, more than half (64.8%) of respondents knows that meat production has negative impact on carbon footprint, 64.1% of respondents know that farming practice has influence on climate change, while majority (89.2%) of the respondents knows that burning of charcoal/ gas during cooking at home might have negative impact on the environment. The results also indicated that 68.4% of the respondents knows plastic/polithine are not good for the environment, majority (71.6%) of the respondents know that packages of food items might be harmful to the environment. 68.4% of the respondents knows that food waste at home have serious environmental problem to the environment, while 64.5% of respondents knows that burning of waste create some toxic gases and 63.5% of the respondents knows that the environmental importance of sorting your waste before dumping.

Table 2 Students Knowledge on Food System (n=307)

S/N	Variables	Yes n (%)	No n (%)
1	I know everything I consume is using some of the natural resources available on earth (e.g., fuel, electricity, food).	277 (90.2)	30 (9.8)
2	I know some foods have a negative impact on the environment.	174 (56.7)	133 (43.3)
3	I am always concerned with environmental protection by controlling what I consume.	191 (62.2)	116 (37.8)
4	I know alternative ways to avoid the negative environmental impact of what I consume.	217 (70.7)	90 (29.3)
5	I know foods to avoid because they are environmentally harmful for consumption.	192 (62.5)	115 (37.5)
6	I know that farming generates some toxic gases to the environment (greenhouse gases).	188 (61.2)	119 (38.8)
7	I know farming significantly influences global warming.	221 (72.0)	86 (28.0)
8	I know meat production has a negative impact on carbon footprint.	199 (64.8)	108 (35.2)
9	I know farming practices have an influence on climate change.	192 (62.5)	115 (37.5)
10	I know burning charcoal/gas during cooking at home might have a negative impact on the environment.	219 (71.3)	88 (28.7)
11	I know plastic/polythene is not good for the environment.	172 (56.0)	135 (44.0)
12	I know packages of food items might be harmful to the environment.	188 (61.2)	119 (38.8)
13	I know food waste at your house has serious environmental problems.	210 (68.4)	97 (31.6)
14	I know burning waste creates some toxic gases.	198 (64.5)	109 (35.5)
15	I know the environmental importance of sorting your waste before dumping.	195 (63.5)	112 (36.5)

Figure 1 presents respondents knowledge score on food system. Results revealed that more than half (58.4%) of respondents had good knowledge of food system, while 29.3% has average knowledge and very few (12.3%) of respondents has poor knowledge regarding food system.

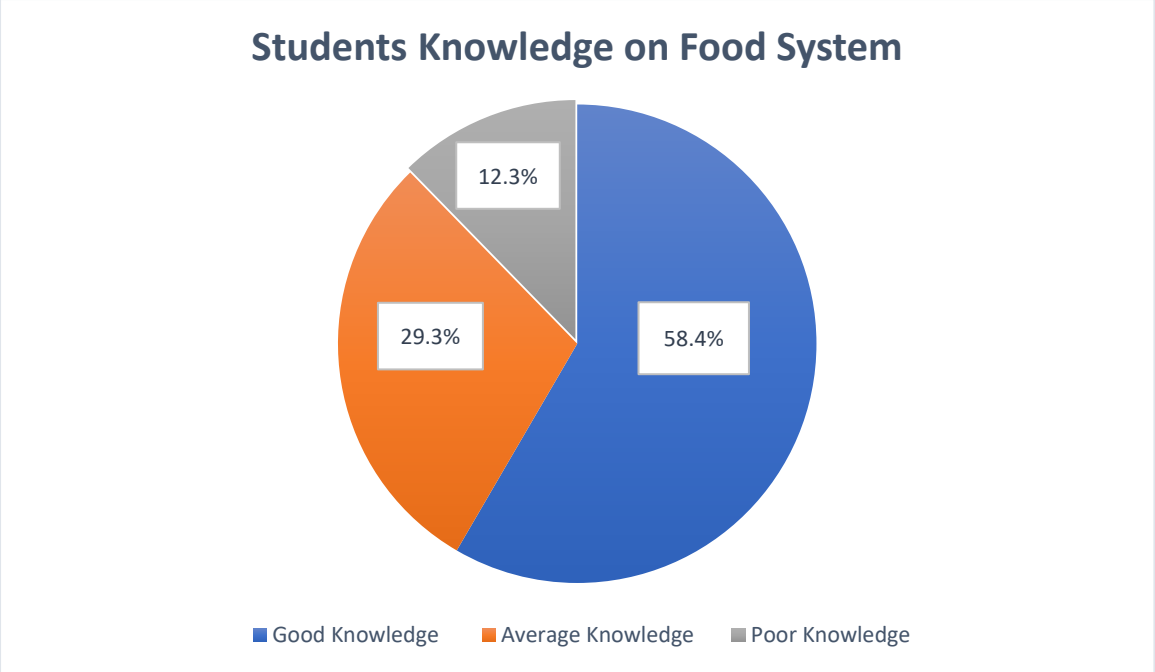


Fig 1: Students' Knowledge level of Food System

Table 3 present respondents' knowledge on sustainable diet. Result revealed that more than half 67.1% knew that food is any substance, natural or processed that provides nutrient to ensure the maintenance and growth of tissues and the continuity of vital function, food is life and the driving force of our body, generating physical, mental and emotional health, when you consume food, you are feeding on symbols, myths and values and that to be considered as food, a natural product must have meaning in a complex system of communication, situations, images and behaviours.

The results also showed that 69.1% of the respondents believed or knew that healthy diet and sustainable diet are the same, while majority 72.6% indicated that sustainable diets include all aspect of sustainable food that could be affordable, cultural acceptable, rich, locally produced and biodegradable. The result shows that majority (82.4%) of the respondents knew the concept of sustainable diets. Majority (77.5%) of the students knows the impediment to a sustainable diet. Also, majority (76.6%) of respondents knows the food groups as part of a sustainable diets, while, 80.5% of the respondents were familiar with the word's organic foods and organic agriculture. Majority (89.6%) of respondents knows the impact of organic food on human health and finally, 78.8% of the respondents knew that traditional foods are identified as healthy/ sustainable diets.

Table 3 Students Knowledge on Sustainable Diet (n=307)

S/N	QUESTIONS	Yes (%)	No (%)
1.	**The word I know that are associated with food?**		
	(i) Food is any substance, natural or processed that provides nutrient to ensure the maintenance and growth of tissues and the continuity of vital function.	64	30
	(ii) Food is life and the driving force of our body, generating physical, mental and emotional health.	57	20
	(iii) When you consume food, you are feeding on symbols, myths and values	36	31
	(iv) To be considered as food, a natural product must have meaning in a complex system of communication, situations, images and behaviours.	49	20
	Total	**206 (67.1%)**	**101 (32.9)**
2.	**I believe that healthy diets and sustainable diets mean the same**.		
	Ecological footprint	40	10
	Carbon footprint	27	13
	Food sustainability	35	7
	Environmental impact	22	11
	Biodiversity	30	12
	Local food	25	17
	Green house emission	31	25
	Total	**212 (69.1%)**	**95 (30.9)**
3.	**A sustainable diet could include all the aspects are related with sustainable food.**		
	Affordable	64	16
	Cultural acceptable (Organic)	35	16
	Rich in plant-based foods (vegetarian or vegan)	37	18
	With locally produced, seasonal products.	49	12
	With biodegradable, compostable packing	38	14
	Total	**223 (72.6%)**	**84 (27.4)**
4.	I have heard of the concept sustainable diets.	253 (82.4%)	54 (17.6%)
5.	**To what extent are the following aspects an impediment to a sustainable diet?**		
	Cost	38	13
	Lack of knowledge	36	7
	Food preferences and taste	19	9
	Lack of knowledge	39	4
	Lack of time	37	7
	Food custom and tradition	32	2
	Ease of purchase	45	-

	Total	272 (77.5)	35 (22.5)
6.	**To what extent do you know the food groups as part of a sustainable diets?**		
	Fruit and vegetable eg. Apple, banana Nuts and seed eg. Walnut, almonds Grains eg. Oats, barley, brown rice Legume eg. Beans, peas	232 (75.6%)	75 (24.4%)
7.	Are you familiar with the words organic foods and organic agriculture?	247 (80.5%)	60 (19.5%)
8.	Do you know the overall impact of organic foods on human health?	272 (89.6)	35 (10.4)
9.	Do you know that traditional foods are identified as healthy/ sustainable diets?	242(78.8%)	65(21.2)

Source: Field Survey, 2024

Figure 2 shows the knowledge score of sustainable diet of respondents. Results shows that more than half (62.8%) of had positive knowledge about sustainable diet, 24.3% has negative average knowledge and very few (12.9%) of the respondents has poor knowledge of sustainable diet.

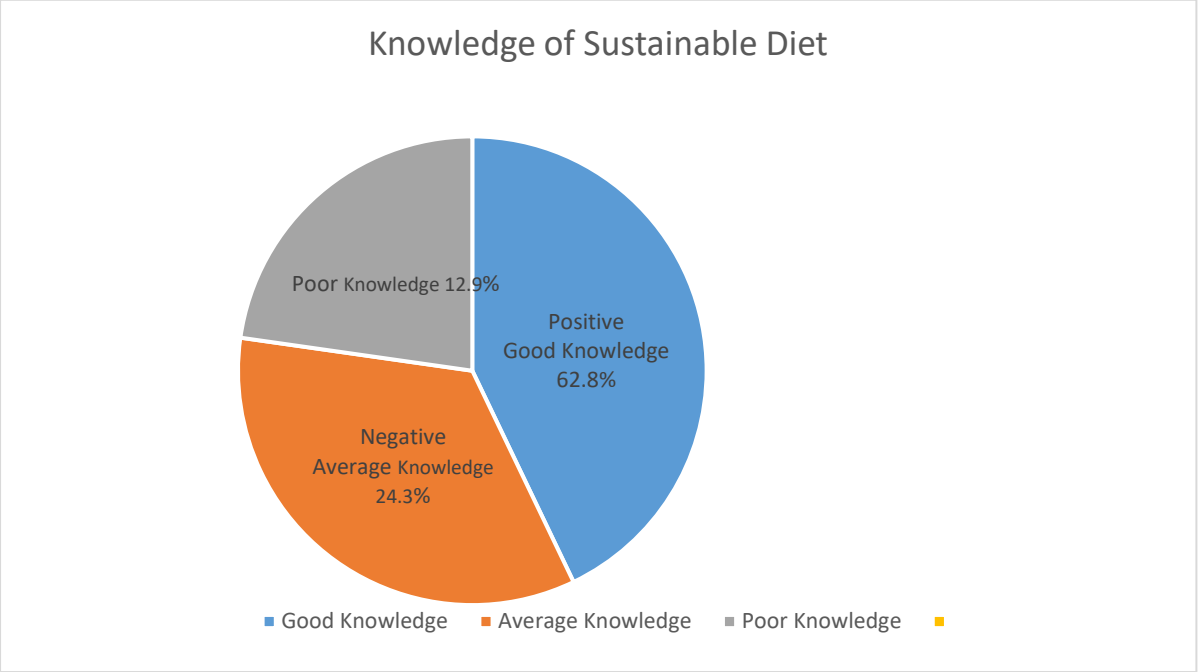


Fig. 2 Knowledge level of Sustainable Diet

Table 4 and figure 3 present results on students' perception of sustainable diets. Result showed that almost half (46.1%) of the respondents believes that the list sustainable food diets are extremely important to sustainable diets. Moreso, the results of the study also showed that more than half (58.4%) of the respondents agreed that food is first and foremost for sustainable diets. 62.8% of the respondents have confident that the items on Table 4 are quality foods.

Table 4 Students Perception on Sustainable Diets (n=307)

QUESTIONS		NI F(%)	SI F(%)	MI F(%)	VI F(%)	EI F(%)	Mean
1.	**Extent students consider that each of the following contributes to a sustainable diet**						
	Low environmental impact	1	-	3	3	14	
	Respectful of biodiversity	2	-	2	4	16	
	No additives	-	1	1	4	17	
	Fewer ingredients	-	-	1	3	28	
	Organic food production	1	-	-	3	12	
	Diet with plenty of fresh products	2	1	4	4	13	
	Diet rich in vegetables and fruits	1	3	1	3	4	
	Diet with traditional foods from own culture	-	1	-	4	6	
	Locally grown products	-	1	2	2	2	
	Affordable foods	1	-	-	4	4	
	Easy-to-follow diet	2	-	2	3	4	
	Choosing foods with less packaging	-	2	6	4	8	
	Reducing consumption of red meat (e.g., beef, lamb, mutton) and processed meat (e.g., sausages, hot dogs, nuggets)	-	1	1	4	10	
	Increasing consumption of plant proteins (e.g., beans, nuts, tofu, chickpeas, lentils)	3	1	4	2	13	
	Consuming fish produced by aquaponics	-	1	-	4	5	
	Reducing consumption of packaged water	1	-	4	4	4	
	Reducing food waste	-	1	1	4	6	
	Total	**15 (8.2)**	**13 (6.7)**	**32 (41.0)**	**61 (29.5)**	**162 (46.1)**	**3.02**
2.	**Extent students agreed that food is first and foremost**	6 (3.3)	8 (4.2)	174 (58.4)	38 (11.4)	17 (6.3)	4.21
3.	**Extent the items below make students confident about the quality of foods**						
	Brand	-	3	4	8	18	
	Origin	2	4	5	9	39	
	Type of packing	-	2	4	12	17	
	Place of purchase	3	4	5	11	23	
	Quality label	2	-	12	15	34	
	Price	1	3	6	13	44	
	Total	**8 (2.3)**	**15 (3.1)**	**27 (6.8)**	**68 (24.3)**	**183 (62.8)**	**3.42**

Source: Field Survey, 2024

Not Important (NI=0), Slightly Important (SI=1), Moderately Important (MI=2), Very Important (VI=3) and Extremely Important (EI=4).

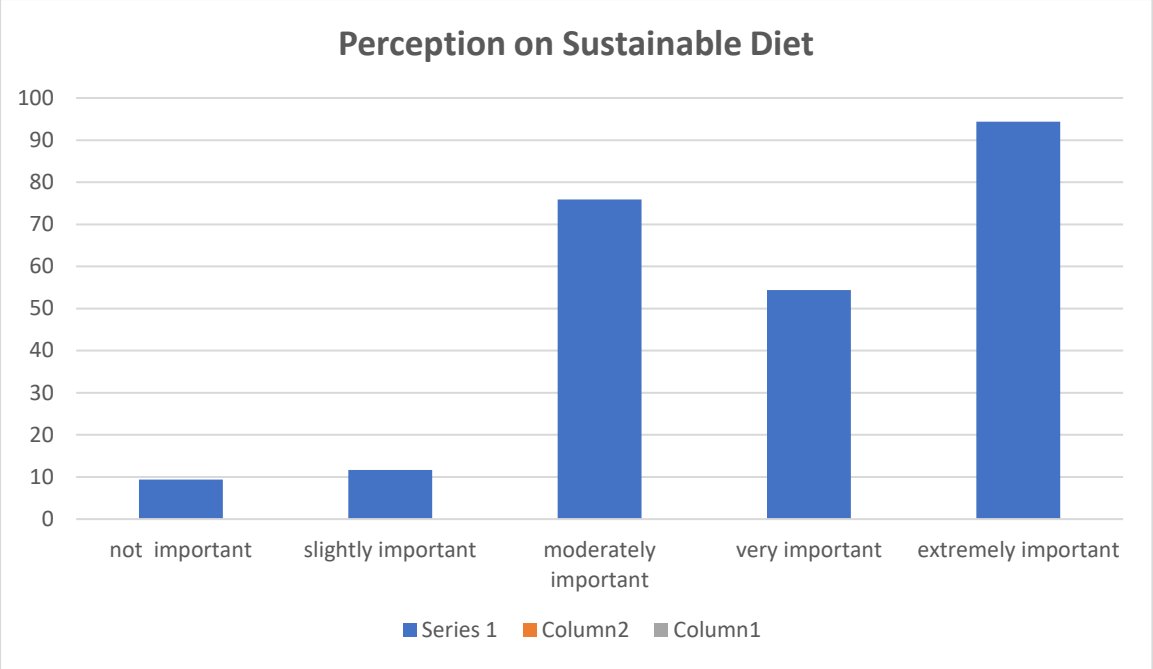


Fig. 3 Perception on Sustainable Diet

Table 5 shows the sustainable diet consumption pattern. The most frequently practiced behaviours were purchasing organic foods such as fruits and vegetables (mean = 1.75) and purchasing local foods (mean = 1.85). In particular, 60.9% of respondents reported always purchasing organic fruits and vegetables, while 57.7% reported always purchasing local foods. In contrast, behaviours related to reducing consumption of animal-source foods and environmentally intensive food products were less frequently practiced. Eating smaller portions of meat had a mean score of 3.55, with 69.7% of respondents reporting that they never practiced this behaviour. Similarly, eating less dairy had a mean of 3.54, while 68.7% reported never doing so. Eating meat at most once a week or only a small quantity had a mean of 3.39, with 59.0% reporting that they never practiced this behaviour.

The respondents also reported low frequency of avoiding products with excessive packaging (mean = 3.49), eating less ultra-processed foods (mean = 3.42), avoiding food products imported by air or ship (mean = 3.32), and eating only seasonal foods and vegetables (mean = 3.32). Notably, 66.4% of respondents reported never eating less ultra-processed foods, while 60.9% reported never avoiding products with excessive packaging. Purchasing organic meat was comparatively more frequent, with a mean score of 2.07, although the interpretation of this finding should consider the possibility that respondents may have used their own understanding of the term "organic." The purchase of free-range meat (mean = 3.09) and products carrying sustainability labels (mean = 3.11) was less frequent. Having one meat-free day per week had a mean score of 3.04, suggesting some adoption of meat-reduction practices, although not all respondents consistently practised this behaviour.

Table 5 Students' Response on sustainable consumption diets among undergraduate (n=307)

S/N	Food consumption question	Always A (%)	F (%)	O (%)	N (%)	Mean

1	I buy organic foods e.g. fruits and vegetables	187 (60.9)	28 (9.1)	75 (24.4)	17 (5.5)	1.75
2	I buy local foods	177 (57.7)	21 (6.8)	88 (28.7)	21 (6.8)	1.85
3	I avoid products with excessive packaging	12 (3.9)	14 (4.6)	94 (30.6)	187 (60.9)	3.49
4	I eat only seasonal foods and vegetables	12 (3.9%)	30 (9.8%)	114 (37.1%)	151 (49.2%)	3.32
5	I eat meat at most once a week or a little at a time	18 (5.9%)	26 (8.5%)	82 (26.7%)	181 (59.0%)	3.39
6	I avoid food products that were imported by airplane or ships e.g. green peas, can foods	22 (7.2%)	59 (19.2%)	25 (8.1%)	201 (65.5%)	3.32
7	I buy organic meat e.g. pork, beef	38 (12.4%)	219 (71.3%)	41 (13.4%)	9 (2.9%)	2.07
8	I buy organic dairy e.g. yoghurt, cheese	9 (2.9)	32 (10.4%)	79 (25.7)	187 (60.9)	3.45
9	I buy free-range meat e.g. chicken, egg	15 (4.9)	52 (16.9)	129 (42.0)	111 (36.2)	3.09
10	I buy products with sustainability label	29 (9.4)	26 (8.5)	134 (43.6)	118 (38.4)	3.11
11	I eat smaller portions of meat	12 (3.9)	22 (7.2)	59 (19.2)	214 (69.7)	3.55
12	I eat less ultra-processed foods	9 (2.9)	56 (18.2)	38 (12.4)	204 (66.4)	3.42
13	I eat less dairy	11 (3.6)	23 (7.5)	62 (20.2)	211 (68.7%	3.54
14	I have one meat-free day a week	12 (3.9)	75 (24.4)	109 (35.5)	111 (36.2)	3.04

Source: Field Survey, 2024

Option: Always (A=1), Never (N=2), Frequently (F=3) and Occasionally (O=4)

DISCUSSION

The study provides insight into the knowledge and perceptions of food systems and sustainable diets and consumption behavior among undergraduates in two selected universities in Abia State, Nigeria. Respondents were predominantly female, with a mean age of 23.23 years and most aged 19–24 years. This demographic pattern is comparable with previous studies among Nigerian university students, which reported similar age profiles and varying degrees of female representation (Omage & Omuemu, 2018; Otemuyiwa & Adewusi, 2012; Adeoye et al., 2018).

Most respondents were Igbo, reflecting the geographical location of the study, while smaller proportions were Hausa, Yoruba and other ethnic groups. Cultural background may influence food preferences, traditional food practices and perceptions of locally produced and sustainable foods (Osei-Kwasi et al., 2020). The predominance of Christian and single respondents was also consistent with patterns reported among Nigerian university students, although the influence of religion on sustainable-diet perceptions cannot be established from descriptive findings alone. Respondents were represented across all five academic levels, providing variation in educational exposure and experiences that may influence knowledge and perceptions of food, nutrition and sustainability (Al-Awwad et al., 2021). Family size and income provided further socioeconomic context, with many respondents reporting relatively limited monthly financial resources. This is important because financial constraints may restrict students' access to diverse and nutritious foods and are associated with food insecurity and dietary practices among Nigerian university students (Ukegbu et al., 2019; Ikuemonisan, 2024). Recent evidence from Lagos State University similarly indicates that lower-income students may experience greater vulnerability to food insecurity, meal skipping and unhealthy food consumption (Lawal-Arogundade et al., 2026). Residence also varied, with off-campus accommodation accounting for the largest proportion. Living arrangements may influence access to food outlets, food prices, transportation, cooking facilities and opportunities for meal preparation, and have been associated with food insecurity among university students (Ikuemonisan, 2024; Dharmayani et al., 2024). Overall, the sociodemographic characteristics provide important socioeconomic, cultural and educational context for interpreting the respondents' knowledge, perceptions and subsequent food-related behaviours.

Regarding respondents' knowledge of food systems, with particular emphasis on the environmental consequences of food production, consumption, cooking, packaging and waste management. The result of this study indicated that the respondents demonstrated fairly good knowledge of the environmental dimensions of food systems**,** although knowledge varied across the different aspects assessed. This finding is broadly consistent with recent studies among university students, which have reported that students generally recognize some aspects of food sustainability but may have limited understanding of more technical concepts such as environmental footprints, food miles, life-cycle assessment and greenhouse-gas emissions (AlTarrah et al., 2024; Sahadeo et al., 2025). The highest level of knowledge in the study outcome was observed regarding the use of natural resources in everyday consumption, with majority of the respondents indicating that they knew that everything they consume makes use of natural resources. This suggests that most students understood the fundamental relationship between human consumption and environmental resources. Similar findings have been reported among university students, where awareness of the environmental consequences of food consumption was relatively high even though knowledge of specific sustainability concepts was less developed (AlTarrah et al., 2024). In their study among Kuwait University students, AlTarrah et al. (2024) found that most respondents recognized concepts such as local food and environmental impact, although important gaps remained in more specialized areas of food sustainability.

Knowledge that some foods have negative environmental impacts was reported by 67.2% respondents, while 62.2% of the respondents indicated that they were concerned about environmental protection through controlling what they consume. These findings suggest that a considerable proportion of students recognized the connection between dietary choices and environmental sustainability. However, the difference between recognizing environmental impacts and actively considering them when making consumption decisions may indicate a potential knowledge–practice gap. This is supported by Sahadeo et al. (2025), who found that

although university students demonstrated awareness of healthy and sustainable diets, their food choices were also strongly influenced by factors such as cost and difficulty in avoiding less healthy food options. Their findings suggest that knowledge alone may not be sufficient to produce sustainable dietary behaviour when structural and economic barriers are present.

A relatively large number of respondents reported knowing alternative consumption patterns that could help reduce negative environmental impacts. Similarly, 62.5% of respondents indicated that they knew which foods should be avoided because of their environmental effects. These findings suggest that students had some understanding of the practical dimensions of sustainable food consumption. However, research has shown that students' knowledge of sustainable food systems does not always translate directly into purchasing or consumption behaviour. Migliorini et al. (2020), in a multi-country study involving students from eight European universities, found that although students demonstrated interest in sustainable food systems, food choices continued to be influenced strongly by taste, health and other personal considerations. The authors recommended educational approaches that develop students' ability to evaluate and justify food-related decisions rather than focusing only on factual knowledge.

The study results relating to farming and climate change showed varying levels of understanding with more than half of respondents knew that farming generates greenhouse gases, farming significantly influences global warming and that farming practices influence climate change. These findings suggest that students had a general awareness of the relationship between agriculture and climate change, although some may not have had detailed knowledge of the specific processes responsible for agricultural greenhouse-gas emissions. This finding is in line with Meybeck and Gitz (2017), who found that the respondents know that sustainable diets minimize the impact on ecosystems by promoting practices that conserve soil, water, and biodiversity. This observation is in line with a recent study of Italian university students, which identified a knowledge gap regarding greenhouse-gas emissions from the agri-food system and emphasized the need for educational initiatives on sustainable diets and food-system sustainability (Galli et al., 2024). The relatively high number of respondents who recognized the influence of farming on global warming is encouraging because university students represent an important population for developing future sustainable consumption patterns. The variation in responses to the different agriculture-related questions indicates that general awareness may not necessarily reflect detailed understanding. AlTarrah et al. (2024) similarly reported that university students could have positive attitudes toward sustainable diets while still demonstrating misconceptions concerning specific food groups and environmental concepts. The researchers found that greater knowledge of environmental concepts was associated with more favourable attitudes toward sustainable diets. Knowledge regarding the environmental impact of meat production was reported by 65% of respondents. This suggests that a substantial proportion of the students were aware of the environmental implications of meat production. Research among university students has also identified meat consumption as an important component of discussions surrounding sustainable diets. Misconceptions may exist concerning the sustainability of different food groups. AlTarrah et al. (2024) found that many students perceived meat and meat products positively in relation to sustainability, demonstrating that awareness of the general concept of sustainable diets does not necessarily imply accurate understanding of the environmental impacts of particular foods.

The study outcome also revealed relatively substantial knowledge regarding household cooking practices, majority of respondents recognized that burning charcoal or gas during cooking could have negative environmental consequences. This finding demonstrated that

students were aware that environmental impacts occur not only during agricultural production but also during food preparation and consumption. Such understanding is important because food systems encompass interconnected activities extending from production to consumption. Research on sustainable food systems among university students similarly recommends teaching students to consider the entire food chain rather than focusing exclusively on individual dietary choices (Migliorini et al., 2020).

Knowledge of plastic and food packaging was also evident among the respondents with more than half of respondents knew that plastic or polythene is harmful to the environment, recognized that food packaging could have environmental consequences. These findings indicated that students were reasonably aware of the environmental consequences associated with food packaging and consumption. The findings are consistent with Sahadeo et al. (2025), who assessed knowledge of food and nutrition sustainability among university students and included concepts related to environmental impact, recycling, product life cycles and eco-friendly food choices. Their study found substantial gaps in students' understanding of some of these concepts, suggesting that general awareness of environmental problems may coexist with limited technical knowledge about how food products affect the environment throughout their life cycle.

The finding shows that more than half of the respondents recognized household food waste as a serious environmental problem is particularly important. It indicates substantial awareness of the environmental consequences of food waste among the students. This is consistent with research among university students showing that awareness and sustainability attitudes are associated with food-waste-related behaviours. A study involving 495 university students found that sustainability attitudes and food-management skills were related to food-waste reduction intentions and behaviours (Akhter et al., 2024). More recently, Akhter et al. (2024) demonstrated that food-waste behaviour among university students is influenced by attitudes, perceived behavioural control and other behavioural factors, highlighting the importance of moving beyond knowledge alone when addressing food waste.

Knowledge of waste burning and waste sorting was also relatively high. 64.5% of respondents knew that burning waste creates toxic gases, while 63.5% recognized the environmental importance of sorting waste before disposal. These findings indicate that students had a reasonable understanding of appropriate waste-management principles. However, knowledge does not necessarily guarantee appropriate waste-management practices. Evidence from Nigeria indicates that although individuals may demonstrate awareness of food-waste problems, actual waste-management practices can be influenced by household conditions, available facilities, attitudes and other contextual factors (Kolawole et al., 2024). Thus, interventions aimed at improving sustainable waste practices among students should combine education with accessible waste-sorting and disposal infrastructure. The pattern observed in this study, is also comparable with the findings of a recent study among 405 university students in South Africa. Sahadeo et al. (2025) found that students demonstrated some knowledge of sustainable diets and environmental impacts but had considerable gaps in their understanding of more specific sustainability concepts. The authors concluded that targeted educational interventions were needed to strengthen students' ability to make informed and sustainable food choices. The study findings similarly demonstrated that students may possess considerable general awareness while still requiring further education on the specific environmental consequences of food production, consumption and waste.

Recent intervention research suggests that university-based education can improve students' understanding of sustainable food systems. A 2025 study among nutrition and dietetics students found that students initially had limited knowledge of local food systems, but participation in an experiential learning activity significantly improved their knowledge and increased their intention to engage in sustainable food behaviours (Baungaard et al., 2025). This provides support for incorporating practical, experiential sustainability education into university curricula rather than relying exclusively on classroom-based information. However, the variation across individual questions suggests that knowledge was stronger for broad environmental concepts than for some of the specific mechanisms linking food production and consumption to environmental degradation. This pattern agrees with recent research demonstrating that university students may have positive attitudes toward sustainable food but still exhibit important knowledge gaps (AlTarrah et al., 2024; Sahadeo et al., 2025). The findings highlight the need for targeted food-system sustainability education among university students. Such education should address agricultural greenhouse-gas emissions, sustainable dietary patterns, environmental footprints of different foods, food packaging, food waste prevention and responsible waste management. Importantly, educational programmes should also incorporate practical and experiential activities because recent evidence indicates that experiential learning can improve students' knowledge and intentions toward sustainable food behaviours (Crowe et al., 2025).

Based on the respondents' knowledge of sustainable diets, the study findings revealed that the respondents demonstrated a fairly good understanding of sustainable diet concepts, although their knowledge was stronger for some basic concepts than for more complex social, cultural and environmental dimensions of food. The overall knowledge score classified 67.1% of respondents had good knowledge, while 32.8% had lower levels of knowledge. This suggests that sustainable diet concepts were familiar to a substantial proportion of the respondents. This finding is comparable with recent research among university students which showed that students may have reasonable general awareness of sustainable diets while still demonstrating important gaps in specific sustainability concepts (Sahadeo et al., 2025).

Regarding the meaning of food, few respondents identified food as a natural or processed substance that provides nutrients necessary for maintenance, growth and vital functions and also recognized food as essential for physical, mental and emotional health. Few respondents recognized the broader cultural and symbolic dimensions of food, which include the role of food in expressing values, meanings and social behaviours. This pattern suggests that students were more familiar with the nutritional and physiological functions of food than with its broader sociocultural dimensions. Food is not simply a source of nutrients; food choices and eating practices are influenced by culture, social relationships, identity, values, availability and the wider food environment. Recent research continues to emphasize that sustainable diets must account for these social and cultural dimensions alongside nutritional and environmental considerations (Sahadeo et al., 2025; Abdussalaam et al., 2025).

The study revealed that more than half of respondents demonstrated knowledge of the different meanings and dimensions associated with food is important because understanding food as part of a broader system can facilitate appreciation of sustainable diets. Sustainable diets require individuals to consider not only whether foods are nutritious but also how they are produced, where they originate, their environmental effects, affordability and cultural acceptability. Migliorini et al. (2020) similarly found that students considered issues such as organic food, fair trade and organic agriculture important components of education about sustainable food

systems. Their findings also emphasized the value of developing students' ability to evaluate food choices and justify decisions rather than relying solely on factual knowledge.

The results further showed that more than half of respondents demonstrated knowledge of terms associated with sustainable diets, including ecological footprint, carbon footprint, food sustainability, environmental impact, biodiversity, local food and greenhouse-gas emissions. This suggests that a considerable proportion of respondents were familiar with terminology used to describe the environmental dimensions of sustainable food systems. However, the distribution across the individual concepts indicates that knowledge was not equally developed across all areas. This observation is consistent with Sahadeo et al. (2025), who reported that university students understood the general concept of sustainability but had substantially poorer awareness of more technical concepts such as product environmental footprint, life-cycle assessment, greenwashing and food miles. The finding is also consistent with research among Kuwait University students, where most respondents recognized concepts such as local food and environmental impact, but knowledge of more specialized environmental concepts was considerably weaker (AlTarrah et al., 2024). The authors concluded that students generally had favourable attitudes toward sustainable diets but that misconceptions remained concerning some aspects of food sustainability. This comparison suggests that students' knowledge of sustainable diets may develop progressively, beginning with relatively familiar concepts such as environmental impact and local foods before extending to more technical concepts such as ecological footprints, greenhouse-gas emissions and biodiversity.

An important aspect of the findings concerns the apparent understanding of the relationship between healthy diets and sustainable diets. The responses indicate that students associated sustainable diets with concepts such as ecological footprint, carbon footprint, food sustainability, environmental impact and biodiversity. This is appropriate because a sustainable diet extends beyond individual health to incorporate environmental and broader societal considerations. However, recent evidence suggests that university students can sometimes conflate healthy eating with sustainable eating. Sahadeo et al. (2025) found that students generally understood what constituted a healthy diet and recognized the importance of sustainable diets, but still had gaps in knowledge concerning specific sustainability terminology and practices.

The findings also have implications for the way sustainable diet education is delivered. Traditional nutrition education often focuses predominantly on nutrients, food groups and disease prevention, whereas sustainable diet education requires a broader systems perspective. This includes understanding the environmental footprint of food, food production methods, biodiversity, food miles, packaging, waste and social and economic considerations. Recent intervention evidence supports this approach. Crowe et al. (2025) found that an experiential learning intervention involving an indoor aquaponic system significantly improved nutrition students' knowledge of local food systems and strengthened their intentions to engage in sustainable food behaviours.

The study suggest that the students had an important foundation of knowledge on which more advanced sustainable nutrition education could be built. Knowledge should not be interpreted as equivalent to sustainable dietary behaviour. Recent research among 701 university students in Lebanon found that positive attitudes toward sustainable diets were common, but knowledge and practices were substantially weaker; importantly, higher knowledge scores were significantly associated with more sustainable practices (Saade et al., 2026). This finding is particularly relevant to the present study because it demonstrates that strengthening knowledge

may be an important component of encouraging sustainable food practices among university students.

The findings also support the need for university-based interventions that integrate sustainable food systems into nutrition and general education. A recent Nigerian study among students in tertiary institutions in Ogun State found that awareness of sustainable diets remained limited, although students demonstrated positive attitudes toward sustainable nutrition and expressed willingness to adopt some sustainable practices (Abdussalaam et al., 2025). The relatively good knowledge observed among the students in the present study may therefore represent a positive foundation, but continued education is necessary to translate this knowledge into consistent sustainable food choices.

The study findings demonstrated that respondents possessed generally good knowledge of sustainable diets**,** particularly concerning the nutritional function of food and several environmental concepts. Knowledge was less comprehensive regarding the cultural, social and technical dimensions of sustainable food systems. The study therefore suggests the need for educational programmes that move beyond conventional nutrition knowledge and introduce students to the interconnected relationships between food, health, environment, culture and society. Such programmes could use practical and experiential approaches, which have recently been shown to improve sustainable food-system knowledge and behavioural intentions among university nutrition students (Crowe et al., 2025).

Overall, the findings indicate that sustainable food behaviours were selectively practiced among the respondents. Purchasing local and organic foods was more commonly reported, possibly because these practices are relatively familiar, accessible and compatible with existing dietary habits. In contrast, behaviours requiring greater changes in dietary choices, such as reducing meat and dairy consumption, limiting ultra-processed foods, avoiding excessive packaging and selecting environmentally preferred products, were less frequently practiced. This pattern suggests a knowledge–practice gap**,** whereby awareness of the environmental implications of food choices does not necessarily translate into consistent sustainable behaviour. Economic constraints, convenience, food availability, cultural preferences and limited control over product packaging may further influence students' ability to adopt certain sustainable practices. Therefore, interventions should extend beyond sustainability education to include practical strategies that improve access to affordable sustainable foods, encourage feasible dietary alternatives and enable students to make more environmentally responsible food choices within their existing food environment.

Conclusion

The study found that undergraduate students at Michael Okpara University of Agriculture, Umudike, and Abia State University Extension, Abia State, Nigeria, generally had good knowledge and favourable perceptions and attitudes towards food systems and sustainable diets. However, some gaps remained in their understanding of the wider environmental, social and cultural aspects of sustainable diets. Strengthening education on sustainable food choices could help translate their positive attitudes into sustainable dietary practices.

Recommendations

Based on the compelling evidence of this study, the following recommendations are proposed for immediate and strategic action:

1. Integrate sustainable diets and food-system sustainability into relevant university courses.
2. Organize seminars and awareness programmes to address identified knowledge gaps.
3. Promote affordable, nutritious and locally produced foods within the university environment.
4. Encourage practical activities such as food-waste reduction, recycling and campus gardening.
5. Use social media and student platforms to disseminate evidence-based information on sustainable diets.
6. Conduct further research to assess students' actual sustainable dietary practices and evaluate interventions designed to improve them.

Acknowledgements: The authors thank the students of in selected Colleges/departments in Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria who participated in this research.

Author Contributions

C.V.E: worked on the conception, methodology, investigation, data curation, writing original draft, manuscript preparation, revision and provided resources.
E.M.O: worked on the investigation, validation, manuscript preparation, revision, and provided resources.
O.C.S: worked on the conception, methodology, investigation, data curation
U.B.I: worked on the investigation, provided resources, supervision.
MMO: Investigation, resources.
C.F.I: Investigation, resources.
All authors reviewed the manuscript.

Declaration of Generative AI and AI-Assisted Technologies in Scientific Writing

AI was used to comprise and correct grammatical. CHATGPT and quillbot was used.

Availability of data and materials

The data and materials supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Conflict of Interests: The authors have declared no conflicts of interest.

Source of Funding: The authors declared the study received no funding.

Consent for Publication: Not applicable.

Clinical trial number: Not applicable.

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