

Fruit in the Desert: Assessing Student Access and Consumption, and Barriers and Opportunities for Improvement in the University Environment

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Abstract

Background

Fruits and vegetables (FV) consumption is below World Health Organisation (WHO) recommendation among University of Ibadan (UI) students. The UI's food environment has been implicated in this low consumption and has been perceived as a "FV desert" necessitating a need for interventions aimed remedying this, development of which requires a good understanding of environmental and behavioural dynamics. This study, therefore, sought to map retail access, identify behavioural barriers and enablers, and explore stakeholder's strategies to improve FV access and consumption in UI.

Methods

This mixed-methods study mapped FV retail points in UI using Geographic Information System (GIS), randomly surveyed 1038 students to assess FV access and consumption, Willingness to pay (WTP) and explore improvement strategies. A sub sample of 145 students participated in a barrier and enabler analysis. While three UI administrators involved in FV retail were engaged in key informant interviews. Quantitative data was analysed using the IBM SPSS version 21.0 and summarized as frequencies and percentages; barrier analysis was done using the Barrier Analysis Calculator; while qualitative responses were analysed thematically.

Results

Fourteen FV retail points were identified, and there was low adherence to the WHO 5-a-day recommendation among male (87.5%) and female (88.2%) respondents. While students demonstrated high self-efficacy and knowledge of FV health benefits as enablers, they identified high cost, proximity and limited availability as significant barriers. Notably, 85% of students expressed willingness to purchase FV if made readily available. However, administrators interview revealed that supply is constrained by structural factors like unreliable electricity and inadequate infrastructure which, which increases food spoilage and operational costs for vendors. To improve FV consumption and access, students suggested enhancing accessibility (22.0%), improving affordability (21.3%), and ensuring availability (6.8%) while administrators emphasized the need for supportive policies, reliable electricity, and infrastructure

Conclusion

Inadequate FV in UI is a consequence of systematic and infrastructure failure rather than individual choices solely. Despite students' high WTP, demand remains unmet due to structural barriers. Addressing this requires shifting from behaviour focused to coordinated system wide interventions.

Effective strategies to improve this situation should be multifaceted, supported by enabling infrastructure and policy interventions.

BACKGROUND

Unhealthy diets and poor nutrition are some of the prominent risk factors for non-communicable diseases including cardiovascular diseases like heart attacks, high blood pressure, and stroke; diabetes and some cancers [1, 2] especially among youths [3]. In Nigeria, globalisation has caused a significant shift in our traditional diet and invariably increased the burden of non-communicable diseases (NCDs). About 2% of NCDs were attributed to diet before globalisation; the narrative has however changed post globalisation with the data reading 26.85% in 2014. This burden continues to rise with 30.37% of all mortality as a result of NCDs in 2019 [4–7].

A review of researches from different countries including Nigeria revealed that risky health behaviours like excessive alcohol consumption; unhealthy diets related to excessive intake of fat, sugar, salt and the inadequate consumption of fruits and vegetables as well as lack of physical activities are the major reasons for the continued increase in the prevalence of NCDs [8, 9]. These unhealthy behaviours are more common among youths, as revealed in an assessment of behaviour risk factors for non-communicable diseases study among undergraduates of UI. The study revealed that 99.7% of the respondents indulged in at least one risk behaviour and 66% of these were attributed to unhealthy diet of which 70.6% were based on fruit and vegetable intake [3].

Adequate consumption of fruit and vegetable is essential for reducing the occurrence of NCDs [1]. However, recent studies have shown the consumption of FV in Nigeria is below the recommendations by WHO [10–12]. Moreso, FV consumption in the University of Ibadan has been reported to be low over time [3, 13, 14]. Adegoke and his colleagues, reported that the contribution of FV to the fiber intake of the students in the university was the lowest with an average of 10.2% [13]. Folasire *et al* discovered that more than half of this population consumed fruits and vegetables less than three times in a week [14]. A study by Owopetu *et al*, also revealed that the consumption of fruits and vegetables among UI students was below recommendation [3].

Various factors have been identified as determinants of choice and quality of diet. The food environment is one of these factors [15, 16]. Communities with healthy food environments have high consumption of fruits and vegetables whereas low fruit and vegetable consumption has been found to be related to poor food environments [17–19].

Some researchers reported that the consumption of fruits and vegetables may increase with interventions aimed at improving their availability and affordability [17, 20]. Several studies in the United States have been done to determine the influence of farmers' market [21], and mobile fruits and vegetables market in places considered deserts for these produce [22–25]. All these studies reported improvement in fruit and vegetable consumption of the communities. In Nigeria, the *Veg-on-Wheels* intervention was conducted in Akure, the capital city of Ondo State. The intervention provided access to

fresh, ready to prepare and affordable vegetables. The result was an improvement in the consumption of vegetables in the study area [26].

In the University of Ibadan, the international students perceived the environment to be a fruit and vegetable desert [27]. It is therefore important to carry out an intervention that would provide access to affordable and safe fruits and vegetables in the university and increase their consumption. To develop effective interventions of such, it is important to have a comprehensive understanding of the factors influencing consumer behaviour [9]. Stakeholder involvement is also important for the success of such initiatives [28]. Furthermore, as UI is a leading and heterogeneous institution in terms of socioeconomic and sociodemographic characteristics, insights gained may be scaled to larger populations.

This study therefore sought to address these gaps. The objectives were to map existing FV retail points, identify barriers and enablers to accessibility and adequate consumption of FV among UI students, explore stakeholders' (students and university administrators) strategies and students' willingness to pay (WTP) for improved FV access.

METHODS

Study Design

This study adopted a cross-sectional design utilizing both quantitative and qualitative techniques to map existing FV retail points, identify barriers and enablers to accessibility and adequate consumption of FV among UI students, explore stakeholders' (students and university administrators) strategies and students' willingness to pay (WTP) for improved FV access.

Study Area

The study was carried out in University of Ibadan, Ibadan Oyo State. The university has 17 faculties, 205 departments, over 41 743 students, 15 halls of residence and a total staff strength of 5 339 [29].

Study Population

The study participants were students of the University of Ibadan (undergraduates and postgraduates) who were surveyed with open ended questionnaires; and key university administrators who participated in a key informant interview. The key administrators were those who authorised vendors to sell in the university

Sample Size

A total of 1038 students (out of which 145 students were selected for a Barrier), and all three administrators participated in this study.

Sampling Technique

Student Sampling: Simple random technique was employed to recruit the 1038 students who participated in the survey. For Barrier Analysis, 145 students were selected Analysis based on their FV consumption and accessibility scores. Participants were categorized as “doers” if they consumed FV from ≥ 4 groups in the previous 24 hours ((assuming that affirmative response to consumption of fruit and/or vegetables from one group is equivalent to consumption of 80g of fruit and/or vegetable from that group) and purchased FV within the campus while “non-doers” were those who consumed < 4 groups or purchased FV outside campus.

Administrative Sampling: All three university administrators in charge of vendor licensing participated in key informant interviews (KIIs).

Data Collection Procedure

Data collection was conducted in four distinct phases:

Phase One- Environmental Mapping: FV sales points on campus were mapped using GIS mapping system guided by a local tricycle operator (*keke man*), with coordinates visualised by a university geographer.

Phase Two- Quantitative Survey: The faculty presidents, acting as gatekeepers, were contacted physically and electronically via phone calls and “Whatsapp” messages. They were duly informed of the objectives and significance of the study and they provided facilitative access to the students. The survey was conducted using a semi structured questionnaire which included sections on sociodemographic and socioeconomic characteristics; FV consumption pattern (using the FV-GDR Score), FV accessibility, open-ended question for suggestions on strategies for improved accessibility and consumption of FV and students’ WTP for FV using the Contingent Valuation (CV). CV is a questionnaire-based tool for investigating consumers’ willingness to pay by valuing a product or products in a hypothetical market [30]. The CV was complemented with worded questions and responses were collected using a Likert Scale [31].

Phase Three-Barrier Analysis: The Barrier Analysis Questionnaire was administered to the sub-sample of 145 students to identify psychosocial and environmental drivers of behaviour (barriers and enablers to FV consumption and access). These participants were contacted through their phone numbers which was collected as part of Phase two.

Phase Three- KII: An introductory letter was presented to administrators to secure a date for interviews and interviews were conducted on the scheduled dates. They were duly informed of the study and a structured interview guide was employed to conduct the interview. The interview guide had two sections. The first section collected data on socio-demographic data of the respondents and the second section was the interview section used to gain perspectives on challenges and strategies to improve

accessibility of fruits and vegetables within the university. This section was audio recorded using a recorder; recordings were appropriately named and saved as a folder in a personal computer. Administrators were isolated to minimise distraction and collect comprehensive data.

All questionnaires were encrypted into the Kobo toolbox and data was afterwards extracted to Microsoft Excel for data cleaning. Subsequently, the cleaned data for the quantitative survey was exported to Statistical Package for Social Sciences (SPSS) version 25 for data analysis.

The recordings from the interviews were transcribed verbatim and cleaned appropriately. They were then exported to Dedoose for coding.

Data Analysis

Data on sociodemographic and socioeconomic characteristics collected from the survey were exported and cleaned in Excel. This was subsequently imported into Statistical Package for Social Sciences (SPSS) version 21 and analysed. Mean, standard deviations, frequencies including percentages were employed to summarize the characteristics of respondents.

Responses of participants in the FV consumption as well as accessibility sections of the first survey were grouped into doers and non-doers. Association between categorical variables was computed using the Chi-square test.

Responses collected through the Barrier Analysis Questionnaire were processed using the Barrier Analysis Calculator, a tool designed to extract insights from barrier analysis surveys [32]. The calculator facilitates the identification and prioritisation of barriers influencing behavior, based on respondent inputs and differences between doers and non-doers.

All audio recordings were transcribed verbatim, and a code book was generated based on the key themes from the data generated. The transcripts were then imported into Dedoose software for systematic coding based on the established codebook. The coded text segments were subjected to thematic analysis, and a detailed report was prepared elucidating suggested strategies aimed at improving fruit and vegetable consumption within the University of Ibadan.

Quality Control

To evaluate the validity of the questionnaires, a pre-test of the questionnaire was executed at The Polytechnic, Ibadan. The Polytechnic, Ibadan is a federal institution situated adjacent to The University of Ibadan and with students of similar characteristics with the students of The University of Ibadan. The pre-test not only facilitated the identification of potential deficiencies within the questionnaire but also enabled adequate corrections and modifications of questions deemed inappropriate or ambiguous.

Moreover, expert validation was sought through consultation with the supervisor and some lecturers in the Department of Nutrition and Dietetics, University of Ibadan, ensuring the questionnaire's robustness

and suitability for the intended research objectives.

RESULTS

Fruits and Vegetables Retail Points in the University of Ibadan

Fourteen sales points of fruits and vegetables were identified in the university of Ibadan. These places are shown in Fig. 1. Most of the vendors sold banana and fruits available in their seasons while only one vendor sold varieties of fruits and vegetables including canned vegetables. One of the vendors sold smoothies and parfait.

Sociodemographic and Socioeconomic Characteristics of Respondents

socio-demographic and socio-economic characteristics of the students are presented in Table 1. More than half (62.2%) of the students who participated in this study were female, while 37.8% of them were male. A greater proportion (64.5%) were between the ages of 20–24 years and almost all (93.9%) were single. On socio-economic characteristic, less than half (35.4%) of the students had other source of income asides from the allowance collected from home and 24.4% had an average income above ₦50 000.

Table 1
Sociodemographic and Socioeconomic Characteristics
of Respondents

Variable (Students)	Frequency	Percentage
Gender		
Male	392	37.8
Female	646	62.2
Age (years) (Mean/SD)	9.02 ± 1.71	
16–19	126	12.1
20–24	669	64.5
25–29	153	14.7
30–34	52	5.0
Above 35	38	3.7
Marital Status		
Married	63	6.1
Single	975	93.9
Religion		
Christian	899	86.6
Islam	129	12.1
Traditional	4	0.4
Others	6	0.6
Ethnicity		
Yoruba	877	84.5
Igbo	79	7.6
Hausa	1	0.1
Others	81	7.8
Faculty	367	35.4
Sciences	103	9.9
Arts	243	23.4
Clinical Sciences	87	8.4
Social Sciences	150	14.5

Variable (Students)	Frequency	Percentage
Education	88	8.5
Law		
Study Level		
100	136	13.1
200	181	17.4
300	303	29.2
400	217	20.9
500	61	5.9
600	4	0.4
Postgraduate	140	13.5
Average Allowance		
Below 10000	147	14.2
11000–30000	391	37.7
31000–50000	223	21.4
Above 50000	253	24.4
No responses	24	2.3
Additional Income		
No	671	64.6
Yes	367	35.4

Sociodemographic Characteristics of Administrators in the University of Ibadan

All three administrators who authorised fruit and vegetables vendors in the university were interviewed. Regarding age distribution, the majority of Administrators are aged 51–60, constituting 66.7% of the group. All the administrators were married, Yoruba and Christians.

Table 2 presents the sociodemographic characteristics of these respondents.

Table 2
Sociodemographic Characteristics of
Administrators and Fruit and vegetable Vendors
in the University of Ibadan

Variable/ Category	Administrators	
	Frequency (%)	
Age		
51–60	2	66.7
Above 60	1	33.3
Gender		
Female	1	33.3
Male	2	66.7
Marital Status		
Married	3	100
Single	0	0
Religion		
Christianity	3	100
Islam	0	0
Ethnicity		
Igbo	0	0
Yoruba	3	100
Others	0	0

Fruits and Vegetables Accessibility of Respondents in the University of Ibadan

The findings, presented in Table 3, revealed that the majority (88% and 90.2%) of respondents purchased fruits and vegetables outside the university environment respectively. Respondents provided varying perspectives on physical and economic access to FV within UI. A notable portion considered it somewhat difficult (44.6% for fruits and 43.9% for vegetables) to physically access these commodities. A significant proportion of respondents perceived FV to be expensive (76.9% for fruits and 75.9% for vegetables) and majority reported that FV were financially difficult to access (58.4% for fruits and 56.9% for vegetables).

Table 3: Fruits and Vegetables Accessibility of Respondents in the University of Ibadan

	Fruits	Vegetables
	Frequency (%)	Frequency (%)
Place of Purchase		
Outside the university environment	913 (88)	936 (90.2)
Within the university environment	125 (12)	102 (9.8)
Perceived ease of physical accessibility within the University		
Somewhat difficult	463 (44.6)	456 (43.9)
Somewhat easy	238 (22.9)	193 (18.6)
Very difficult	220 (21.2)	299 (28.8)
Very easy	117 (11.3)	90 (8.7)
Perceived cost of fruits and vegetables within the University		
Expensive		788 (75.9)
inexpensive	798 (76.9)	250 (24.1)
	240 (23.1)	
Financial accessibility within the University		
Inaccessible	606 (58.4)	591 (56.9)
Accessible	111 (10.7)	121 (11.7)
Don't know	321 (30.9)	326 (31.4)

Fruit and Vegetable Consumption of Students in the University of Ibadan

The table below presents FV consumption among students of the University of Ibadan within the 24 hours preceding the survey. A notable disparity emerged in the consumption of various types of fruits, categorized into three distinct groups. Among vitamin A-rich fruits (ripe mango, ripe pawpaw, locust bean fruit, hog plum, or bush mango fruit), a statistically significant discrepancy was observed ($p = 0.042$), with a higher proportion of male students (18.6%) reporting consumption compared to female students (13.8%). Similarly, within the citrus fruit category, comprising orange, tangerine, tangelo, or grapefruit, a greater percentage of male students (13.5%) reported consumption compared to their female counterparts (11.3%). Conversely, among other types of fruits such as banana, agbalumo,

watermelon, apple, avocado, coconut, pineapple, guava, or cashew fruit, more female students (29.9%) reported consumption in comparison to male students (25.5%).

Vegetables were categorized in the same way and similar variations were observed. Within the vitamin A-rich vegetable category, including carrot, pumpkin, or orange or yellow-fleshed sweet potato, a statistically significant difference was noted, with more females (24.3%) reporting consumption compared to males (20.7%). Conversely, within the dark green vegetable category, encompassing ewedu, amaranthus leaves, water leaf, shoko, bitter leaf, ugu, osun, or spinach, a higher proportion of male students (36.5%) reported consumption compared to their female counterparts (31.9%). Finally, among other vegetables such as tomato, cucumber, okro, or garden egg, a statistically significant difference ($p = 0.018$) was observed, with more female students (48.1%) reporting consumption compared to male students (40.6%). Overall, majority of the respondents (87.5% males and 88.2% females) did not meet the WHO recommendation of the consumption of at least five FV daily. This is presented in Fig. 2.

Table 4
Fruit and Vegetable Consumption among students in the University of Ibadan

Consumption in the last 24hr		Female	Male	Total	p-value
Fruit Groups					0.042*
Vitamin A Rich					
	Yes	89(13.8)	73(18.6)	162(15.6)	
	No	557(86.2)	319(81.4)	876(84.4)	
Citrus					0.327
	Yes	73(11.3)	53(13.5)	126(12.1)	
	No	573(88.7)	339(86.5)	912(87.9)	
Others					0.136
	Yes	193(29.9)	100(25.5)	293(28.2)	
	No	453(70.1)	292(74.5)	745(71.8)	
Vegetable groups					0.195
Vitamin A Rich					
	Yes	157(24.3)	81(20.7)	238(22.9)	
	No	489(75.7)	311(79.3)	800(77.1)	
Dark Green					0.136
	Yes	206(31.9)	143(36.5)	349(33.6)	
	No	440(68.1)	249(63.5)	689(66.4)	
Others					0.018*
	Yes	311(48.1)	159(40.6)	470(45.3)	
	No	335(51.9)	233(59.4)	568(54.7)	
*Values are statistically significant at $p < 0.05$					

Barriers and Enablers to Accessibility and Adequate Consumption of Fruits and Vegetables in the University of Ibadan

Figure 3 presents an overview of the responses to the survey question on barrier and enablers to accessibility and adequate consumption of FV. From the survey, 61.1% reported that they had self-

efficacy in their ability to eat FV daily while 33.3% did not have this self-efficacy. Majority (83.3%) reported that they knew how to prepare and serve FV, indicating perceived self-efficacy an enabler.

Open-ended responses on perceived self-efficacy and social norms were thematically analysed and presented in Fig. 4. Affordability emerged as the most cited barrier (45.6%), market access (14.4%) and availability (12.2%) also emerged as barriers. However, knowledge of the importance of FV and respondents' preference was more frequently identified as an enabler factor (23.3%) than as a barrier (7.8%).

Figure 5 presents the themes highlighted from open-ended questions on sources of support and discouragement for FV consumption. Friends (30%), parents (23.3%) and other family members (27.8%) were the most cited sources of support. Few (13.3%) of the respondents cited friends as sources of discouragement while minimal discouragement (1.1%) came from respondents themselves.

Suggested Strategies from Students to Improve Accessibility and Adequate Consumption of Fruits and Vegetables in the University of Ibadan

Table 4 below presents suggested strategies aimed at improving the consumption of fruits and vegetables among students. The most commonly suggested strategy (suggested by 22.0% of the students) is to enhance the accessibility of fruits and vegetables within the university environment. A student suggested that;

There should be a stand at SUB for the fruits and should be easily accessible. When faculties or department are having programs these fruits stand should be made available to students

-Male, 300level, Clinical Sciences

About 21.3% of the student suggested that fruit and vegetable should be more affordable to student. This suggests that reducing costs or offering subsidies could encourage greater consumption among students, especially those on limited budgets. One of the students who participated in the study stated that;

"They should make affordable portions of fruit and vegetable especially the salad. It should encourage students to purchase it- if it is affordable. They should provide varieties of fruits and vegetables to encourage students to purchase according to their pocket"

- Female, 300level, Public Health

A small percentage (6.8%) of the student highlighted the importance of ensuring consistent availability of fruits and vegetables. This includes maintaining sufficient stock levels in retail points regardless of the seasonality of some fruits and time of the day in order to meet student demand. Some suggestions, such as "Accessibility and Hygiene" (0.9%) and "Appearance/Hygiene/Freshness" (11.2%), emphasise the significance of factors like cleanliness, packaging, and freshness in attracting students to consume fruits and vegetables.

Vendors should be given the necessary assistance to have a stand in an easy to access location; they should be educated on the importance of neat/hygienic and properly packaged products to attract customers

-Female, 700level, Public Health

Several respondents proposed combined approaches to improve consumption, such as "Accessibility and Affordability" (9.7%) and "Availability and Affordability" (9.7%). This underscores the importance of addressing availability, accessibility and affordability barriers simultaneously. Customer Service and Appearance of the fruit" (0.9%) and "presence of more vendor" (4.7%), suggest enhancing customer service experiences and increasing the number of vendors offering fruits and vegetables on campus. Additionally, "Varieties and Accessibility" (2.5%) highlights the importance of ensuring a diverse range of options is readily accessible to students.

"Aesthetics would be nice and inviting. It's not exactly the point of setup but it will go a long way in grabbing attention; this would include arrangement of the fruits and vegetables such that their colours sync into a beautiful eye-catching scene. Rinsed fruits would be nice too."

-Female, 200level, Renewable Natural Resources

It will be beautiful to see a stall or stand dedicated solely to providing good and fresh fruits for the university community. The establishment should find a good area for this. Maybe around SUB and around Zik Cafeteria. They could also provide small notes or tips about the benefits and nutritional value of each fruit a customer buys. It gives the customer a feeling that they are doing something good for themselves and would likely come back again. The sales rep should also be cheerful and friendly.

-Male, 400level, Sciences

Table 4
Suggested Strategies to improve consumption of fruit and vegetable

Suggestions	Frequency	Percentage
Accessibility	116	22.0
Affordability	112	21.3
Availability	36	6.8
Accessibility and Hygiene	5	0.9
Accessibility and Affordability	51	9.7
Affordability and Appearance	39	7.4
Appearance/Hygiene/Freshness	59	11.2
Availability and Affordability	51	9.7
Customer Service and Appearance	5	0.9
More vendor	25	4.7
Publicity/Awareness/Marketing	13	2.5
Varieties	2	0.4
Varieties and Accessibility	13	2.5

Suggested Strategies from Administrators to Improve Accessibility and Adequate Consumption of Fruits and Vegetables in the University of Ibadan

Responses from the interviews with university administrators also provided various strategies to improve the accessibility and consumption of fruits and vegetables within the university community. According to one of the key informants interviewed, the appearance (i.e. freshness) of fruits and vegetables is one of the strategies to attract students to purchase from vendors within the university.

My advice is that they should sell good-looking and fresh fruits... not the ones that are already spoilt and black. You know, some people will go and buy fruits that are already spoiling because they are cheaper and will be selling... so buy fine ones that are fresh and start small

Female, Hall Administrator, 51–60 years

Another administrator mentioned the importance of good customer service in encouraging student patronage.

If you are customer-friendly, even if I don't want to buy, I will buy

Male, Hall Administrator, 51–60 years.

Furthermore, another administrator highlighted the importance of policies that would encourage more vendors to operate within the university premises. Currently, the number of vendors is significantly small compared to the student population in the institution. He emphasized the need for access to electricity to preserve fruits and vegetables, as they are perishable items.

"The primary factor that can encourage vendors is, as I mentioned earlier, consistent access to electricity. Without it, it's difficult to attract anyone to set up shop. You see, these vegetables are perishable and can spoil easily. Even if they don't spoil, consuming them in that state can adversely affect a person's health. So, when we have a reliable power supply, we can proceed with plans to establish a sort of "market" near the student area where these items can be sold. But without electricity..."

Male, Director, above 60 years

Consumers' Willingness to Pay for Fruits and Vegetables

Figure 6 reveals the willingness of the students to purchase fruits and vegetables if made readily available within the school environment. Almost all (85%) of the respondents were willing (56.2% very willing and 28.8% somewhat willing) to purchase FV if made available with the UI environment.

While Table 5 shows the frequencies and percentages of the price range students are willing to pay for fruits and vegetables if made available within the University of Ibadan. Almost half of the students were willing to pay ₦100 for a portion size of almost all the fruits and vegetables presented and 46.3% of them were willing to pay between ₦120 and ₦150 for a portion size of apple. However, more students were willing to pay between ₦200- ₦300 for fruit salad (36.5%), vegetable salad (35.9%) and fruit and vegetable salad (27.6%).

Table 5
Contingent Valuation of Student's Willingness to Pay for FV in UI

Fruit/Vegetable	No payment	20–50	50–70	100	More than 100	Do not eat/buy
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Pawpaw	15 (1.4)	65 (6.3)	164 (15.8)	503 (48.5)	184 (17.7)	107 (10.3)
Pineapple	15 (1.4)	78 (7.5)	173 (16.7)	480 (46.2)	178 (17.1)	114 (11.0)
Banana	15 (1.4)	88 (8.5)	172 (16.6)	442 (42.6)	274 (26.4)	47 (4.5)
Watermelon	12 (1.2)	58 (5.6)	150 (14.5)	517 (49.8)	247 (23.8)	54 (5.2)
Cucumber	18 (1.7)	80 (7.7)	170 (16.4)	462 (44.5)	146 (14.1)	162 (15.6)
Carrot	13 (1.3)	125 (12.0)	246 (23.7)	446 (43.0)	136 (13.1)	72 (6.9)
Garden egg	24 (2.3)	121 (11.7)	191 (18.4)	355 (34.2)	94 (9.1)	253 (24.4)
	No payment	50–100	120–150	200–250	More than 250	Do not eat/buy
Apple	11 (1.1)	199 (19.2)	481 (46.3)	249 (24)	49 (4.7)	49 (4.7)
	200–300	400–500	500–700	800–1000	More than 1000	Do not eat/Buy
Fruit Salad	379 (36.5)	150 (14.5)	210 (20.2)	112 (10.8)	50 (4.8)	137 (13.2)
Vegetable Salad	373 (35.9)	141 (13.6)	174 (16.8)	92 (8.9)	38 (3.7)	220 (21.2)
Fruit and Vegetable Salad	286 (27.6)	184 (17.7)	217 (20.9)	117 (11.3)	53 (5.1)	181 (17.4)

DISCUSSION

From the sociodemographic findings, majority of participants were young, unmarried students between the ages of 20–24 years, with a higher representation of females in the study. Conversely, the predominance of administrators in the 51–60 age range signifies a cohort with extensive experience and institutional knowledge accumulated over years of service within the university. This wealth of experience equips them with a deep understanding of the institution's policies, procedures, and historical contexts, which can be invaluable in navigating complex issues such as vendor authorization and campus governance. However, this could also suggest a potential generational gap in decision-making processes related to vending regulations. Engaging with younger administrators and stakeholders in university governance could foster more inclusive and forward-thinking approaches to improve fruit and vegetable accessibility and consumption on the campus. The socioeconomic characteristics of the

students indicated that a considerable proportion of them had additional sources of income beyond allowances from home, and a notable percentage have average incomes above 50,000 naira. This suggests some level of financial independence among students, which could influence their purchasing power and food choices. However, it is essential to recognize that socioeconomic status encompasses various dimensions beyond income, including education, occupation, and access to resources, which may influence dietary behaviors [33].

In examining the fruit and vegetable consumption patterns among students at UI, the result of this study aligns with previous researches in Nigeria and UI indicating suboptimal consumption levels among students [3, 11, 13, 14]. While these studies have mostly linked suboptimal FV consumption to individual-level factors like knowledge gap or lack of motivation this study points to a broader systematic explanation. A lack of motivation cannot account for the majority of respondents' inadequate intake. Barrier analysis revealed high levels of self-efficacy and knowledge of the benefits of consuming FV, almost all (85%) the students expressed willingness to buy FV if made easily accessible in UI, and about 90% already purchase FV outside the university environment; affirming that demand for FV exists, but the current food environment cannot meet it.

As found in the study, fourteen fruit and vegetable retail points were mapped in the University of Ibadan. Considering the population, this appears to be very sparse and demonstrates a degree of inaccessibility to fresh produce. This finding resonates with the results of Samuel et al., whose study among international students at the University of Ibadan revealed a perception of the environment as a "fruit and vegetable desert" [27]. Moreover, the limited variety offered by most vendors, with a predominant focus on bananas and fruits available while in their seasons, raises concerns about the adequacy of options available to students. The presence of only one vendor offering a diverse range of fruits and vegetables, including local, exotic and canned varieties, further supports the notion of barriers to accessing a comprehensive selection of nutrient-rich foods on campus. This shifts the narrative from student poor dietary choice to a market infrastructure and food environment failure.

Barrier analysis of the survey revealed high rate of reported difficulties (89.8%) despite the high perceived self-efficacy recorded. Availability, access, affordability and perceived high cost were cited as significant barriers to FV access and consumption. While students identified these barriers, interview with administrators revealed that vendors face serious challenges like unreliable electricity and inadequate infrastructure which increase spoilage and operational risks which increases the prices of these commodities. This reveals that affordability is not merely a demand-side issue, high costs can be a sign of ineffective supply system [34] indicating important factors for a successful intervention like improving local FV supply chains and promoting market level interventions to increase consumption of FV [35].

The suggestions provided by students and administrators offer valuable insights into potential strategies aimed at improving the consumption of fruits and vegetables among students at the University of Ibadan. These suggestions encompass various factors, including accessibility, affordability, availability,

aesthetics, customer service, and policy considerations. Integrating these suggestions into campus policies and initiatives can help address barriers and create a more conducive environment for promoting healthy eating habits. Furthermore, suggestion of combined approaches to improve consumption, such as "Accessibility and Affordability" and "Availability and Affordability", underscores the importance of addressing availability, accessibility and affordability barriers simultaneously.

The most commonly suggested strategy by students is to enhance the accessibility of fruits and vegetables within the university environment. This aligns with the notion that easy access to fresh produce encourages consumption [17, 20]. Additionally, addressing affordability concerns, as highlighted by students advocating for reduced costs or subsidies, can help ensure that fruits and vegetables are financially accessible to all students, especially those with limited budgets [11, 36–41].

Ensuring consistent availability of fruits and vegetables on campus is also crucial for meeting student demand, as emphasized by both students and administrators. Maintaining sufficient stock levels regardless of seasonality and time of day can enhance convenience and promote regular consumption. Moreover, prioritizing freshness and quality, as suggested by stakeholders, can enhance the attractiveness of fruits and vegetables [42] to students and foster trust in vendors. Suggestions related to aesthetics, such as attractive display arrangements and well-packaged products [43] highlight the importance of visual appeal in attracting students to purchase fruits and vegetables. Moreover, emphasizing good customer service experiences, as advocated by administrators, can enhance satisfaction and encourage repeat patronage among students.

Stakeholders, however, highlighted the importance of supportive policies to facilitate the operation of fruit and vegetable vendors within the university premises. For example, policies that provide infrastructural support such as, access to reliable electricity is identified as a critical factor for preserving perishable items and attracting vendors. Administrators stressed that vendors cannot store perishable goods, such as FV, without reliable and consistent electricity. Policies that prioritize access to electricity and create conducive market spaces can foster a vibrant food environment that promotes healthy choices. Furthermore, there could be policies that support adequate monitoring and legislation within the university to ensure that vendors provide a minimum standard of fruits and vegetables in terms of freshness, food safety and hygiene. This finding and suggestion is particularly crucial for LMIC contexts and agrees with literature that basic service provision and policy are directly related to nutrition outcomes [44, 45].

CONCLUSION

This study shows that UI is not only a FV desert but also has a limited food system where the current demand for FV is not met as a result of market and infrastructure constraints. Students' high willingness to buy FV if made accessible indicates a crucial opportunity for intervention. To address this gap, it is important to move from individual-level education to coordinated and multifaceted interventions that incorporate infrastructure development and enabling policies. Implementing these strategies will result

into a collaborative work among university administrators and policymakers which will create a supportive environment that fosters healthy eating habits among students, ultimately contributing to their overall well-being and academic success. This is a scalable approach that can transform university food environments across similar LMIC.

LIMITATION AND STRENGTH

This study has some limitations. First, causal relationships cannot be conclusively proven due to the cross-sectional design the study employed. Second, self-reported measures were used to collect data on FV accessibility and consumption, which may be subject to recall or social desirability bias. Finally, the particular infrastructure issues found in UI may differ in other institutions or geographies, thus necessitating careful generalization.

A major strength is however, the comprehensive, mixed methods approach employed by the study. This method combines spatial mapping (GIS), quantitative surveys, and qualitative stakeholder interviews to provide a multifaceted view of the campus food environment. In contrast to traditional dietary studies that focus on individual knowledge, this study used barrier Analysis and CV to identify the supply side inadequacies in UI. Additionally, the large sample size of 1038 students and the inclusion of key administrators ensure that the findings reflect demand side, supply side and institutional governance dynamics.

Abbreviations

FV-Fruits and Vegetables

UI- University of Ibadan

GIS: Geographic Information System

NCD: Non-communicable disease

WTP: Willingness to Pay

KII: Key informant Interview

FV-GDR: Fruit and vegetable component of the global dietary recommendation score.

UI/UCH: The University of Ibadan/University College Hospital

WHO: World Health Organisation

Declarations

Ethical Approval and Consent to Participate: Ethical approval was obtained from the UI/UCH ethical committee College of Medicine, university of Ibadan (UI/UCH Ethics Committee assigned number UI/EC/23/0746) on 4th December, 2023. The study was conducted at the University of Ibadan, where institutional admission policy stipulates that all candidates must have attained a minimum age of sixteen (16) years as of the first day of October in the year of admission. Consequently, all participants were aged 16 years and above and thus provided informed consent independently, with no requirement for parental or guardian consent.

This study was done in accordance with the declaration of Helsinki.

Consent for Publication: not applicable

Availability of Data and Materials: The dataset generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interest: The authors declare that they have no competing interests

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Authors' contribution: Conceptualisation, data collection, analysis, and writing of the original draft, T.A.; funding acquisition, supervision and review of manuscript, F.S. All authors have read and agreed to the publication of this manuscript.

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Figures

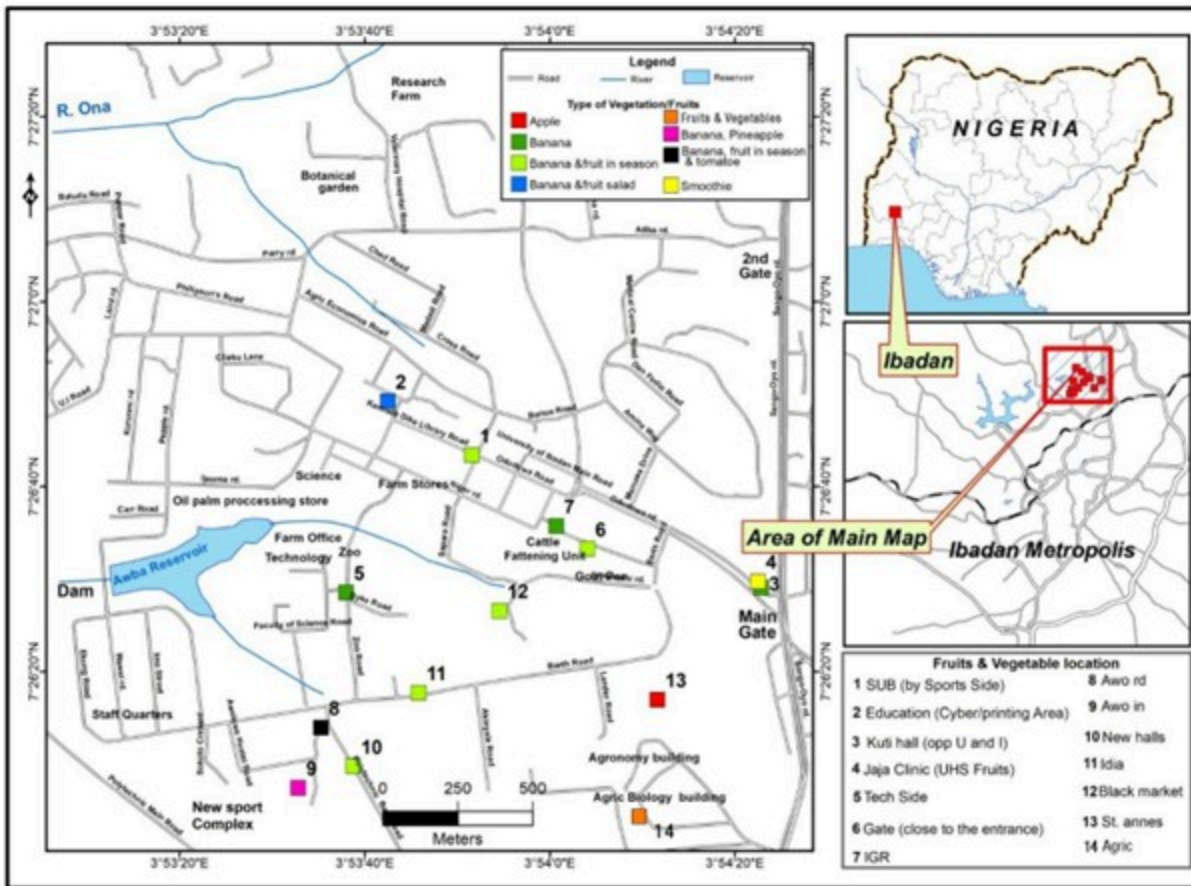


Figure 1

Map of University of Ibadan showing fruit and vegetable Vendors' location

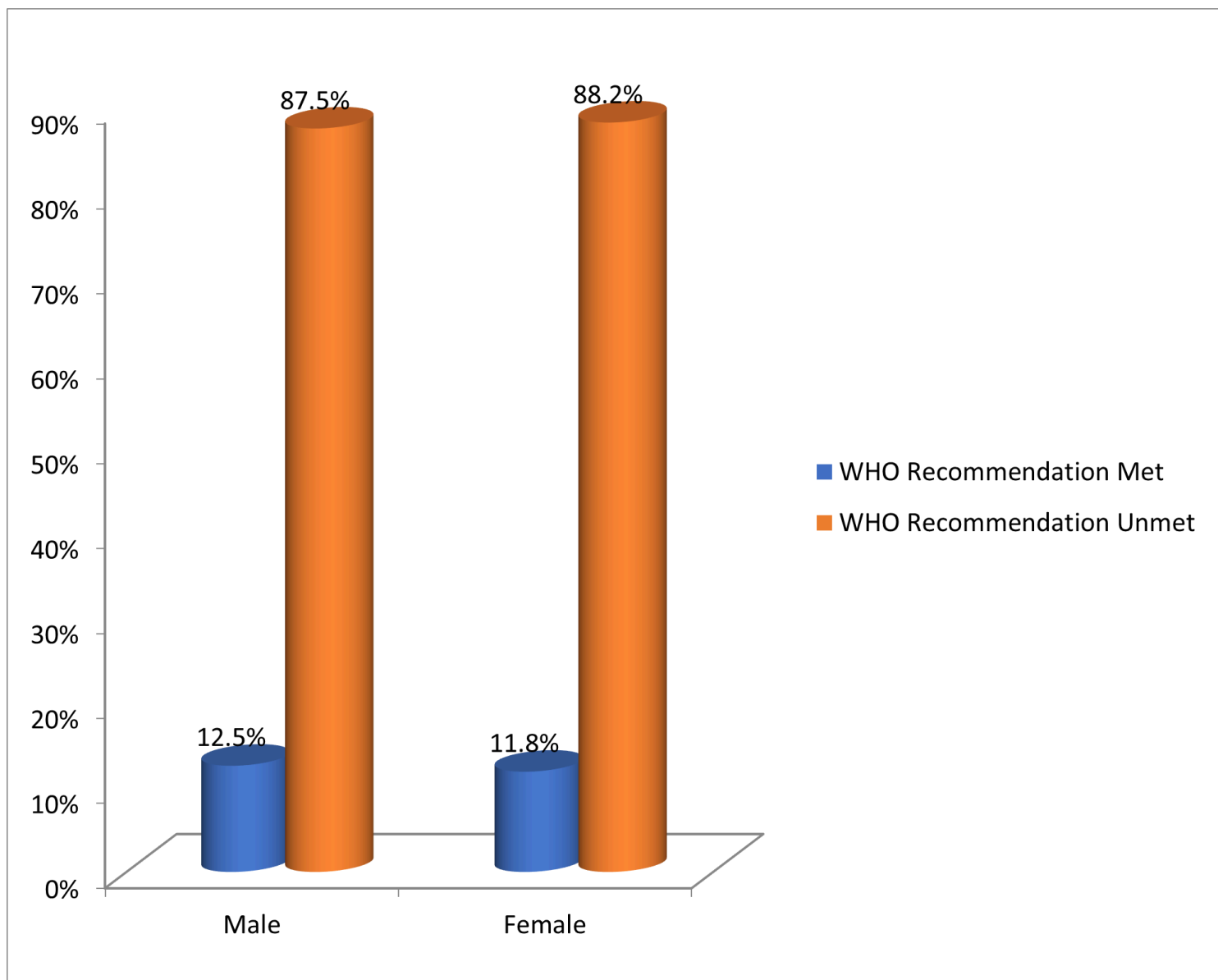


Figure 2

Respondent Compliance with WHO's 5-A-Day Fruit and Vegetable Intake

Overview barriers and enabling factors for FV Access and consumption

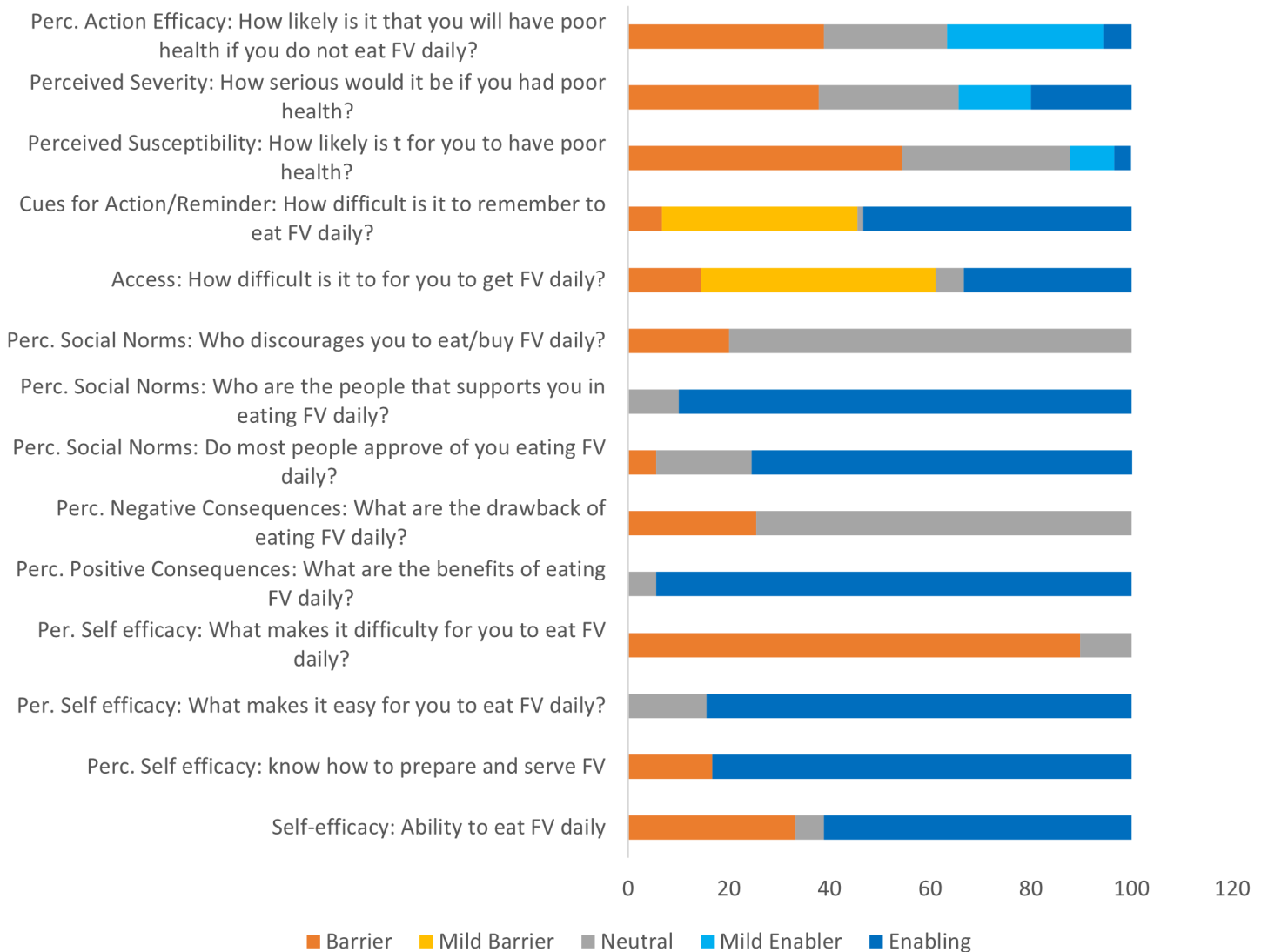


Figure 3

Overview barriers and enabling factors for FV Access and consumption

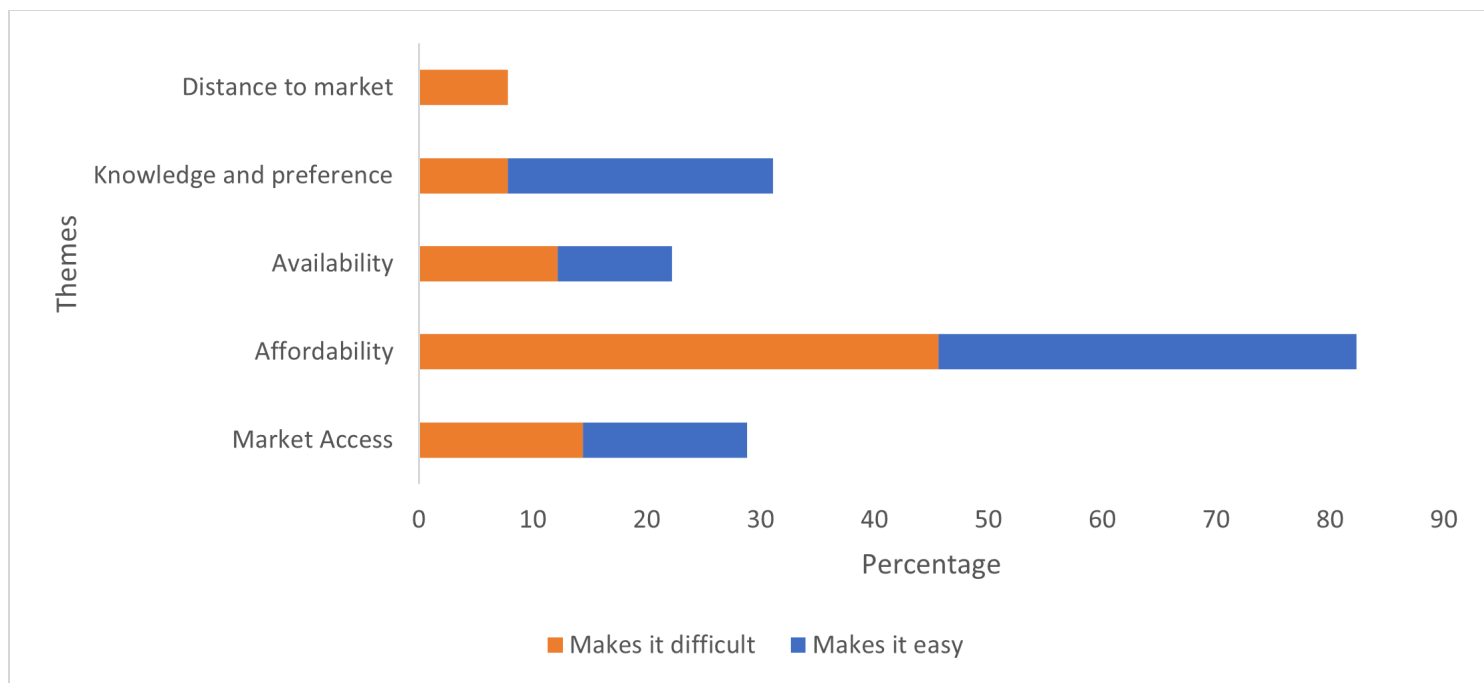


Figure 4

Themes highlighted in the answers to open questions regarding “what makes it easy” and “what makes it difficult” for the respondents to eat FV every day.

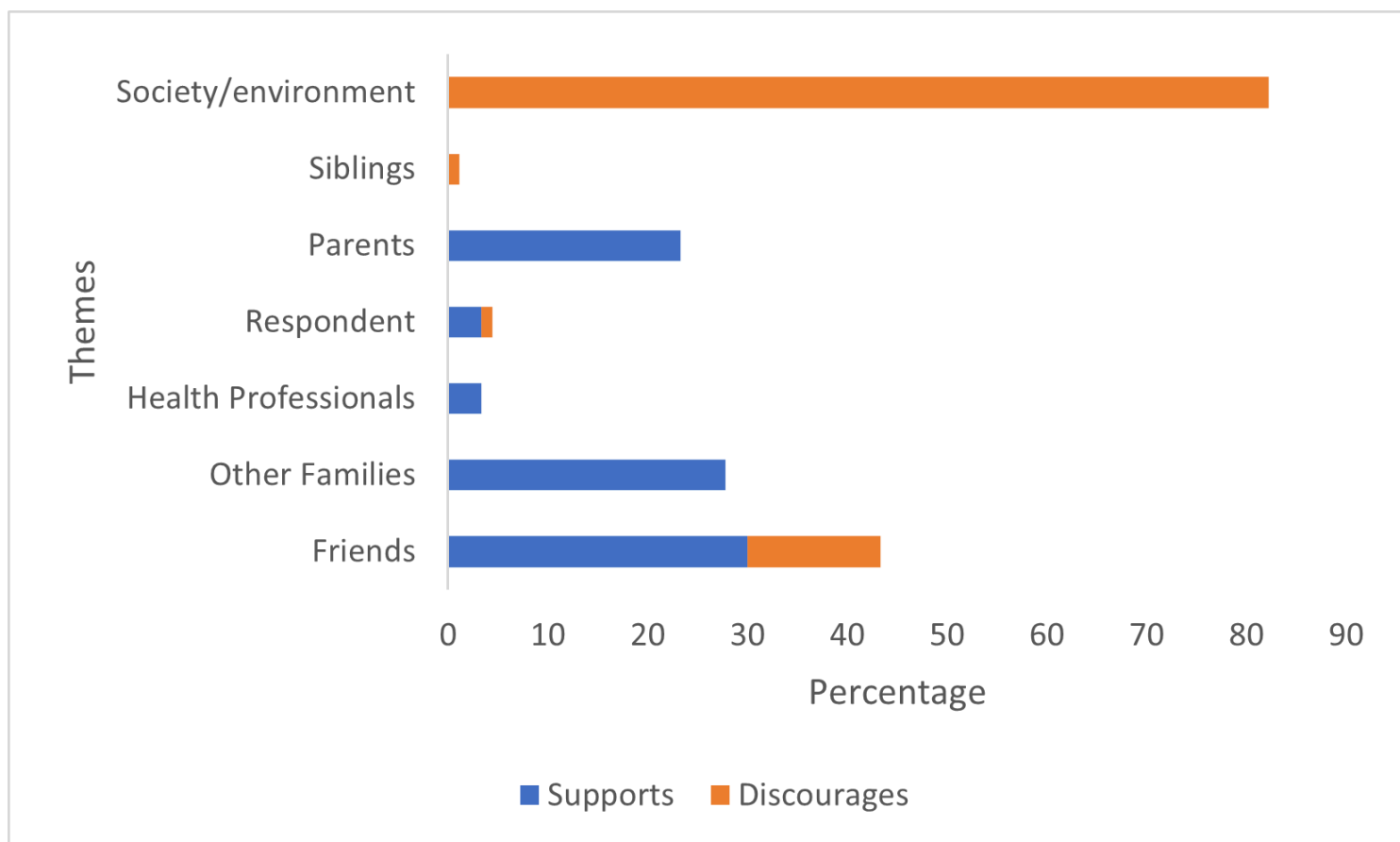


Figure 5

Themes highlighted in the answers to open questions regarding “who supports” and “who discourages” the respondents

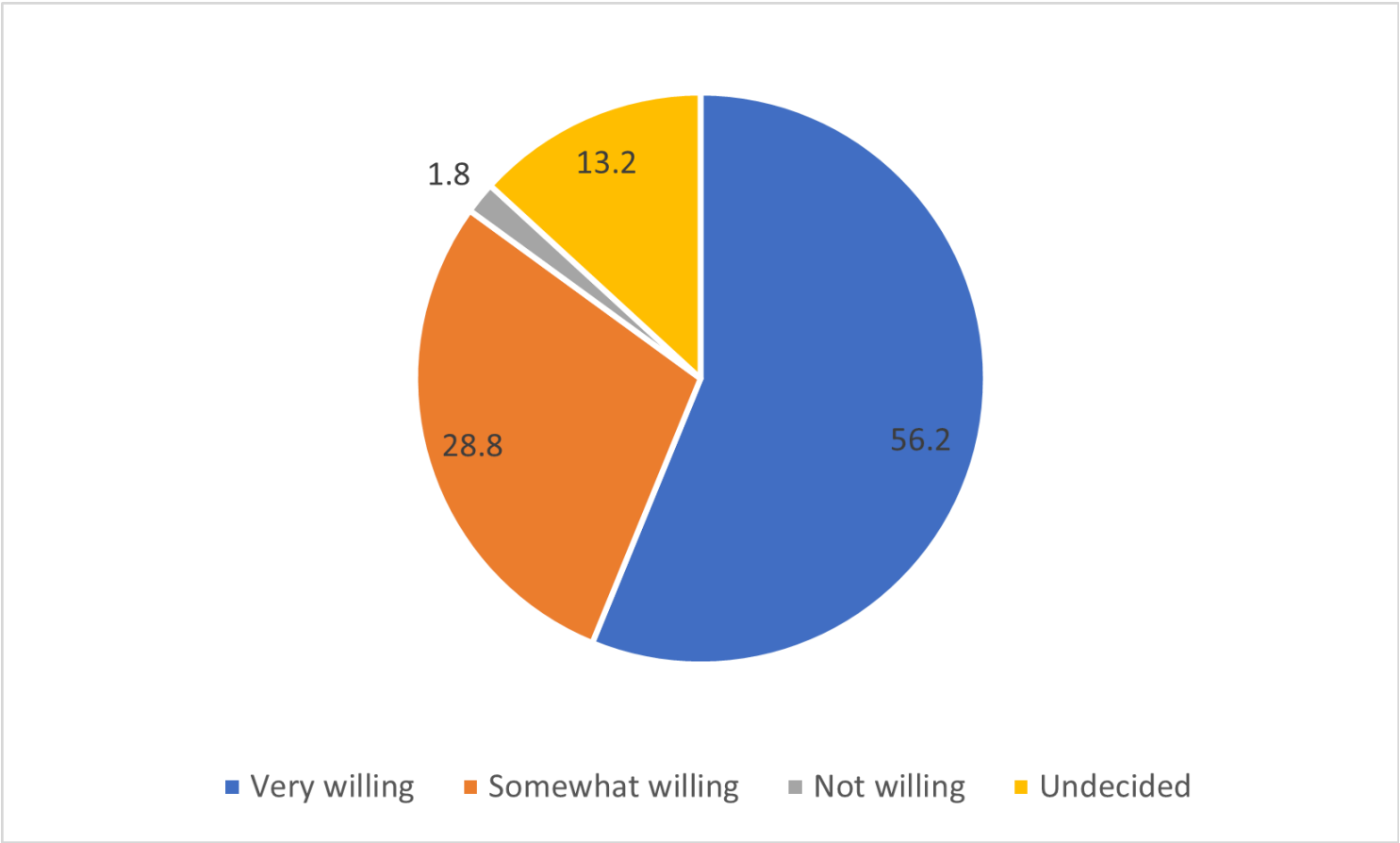


Figure 6

Students’ willingness to purchase and consume FV if Made Readily Available in UI