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Research Article

Effect of a structured nutrition education programme on fruit and vegetable consumption among college students in Southwest Nigeria: A quasi-experimental study

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Highlights/Key Messages

- Nutrition education modestly improved fruit and vegetable intake among Nigerian undergraduates
- Even small increases are meaningful in populations with low baseline consumption
- Structured programmes can support healthier diets, thus likely contributing to a reduction in chronic disease risk
- Intervention effects were consistent across demographic subgroups, underscoring equity and scalability
- Findings highlight the need for targeted interventions in college populations

Background
Inadequate fruit and vegetable (FV) intake among Nigerian college students contributes to poor diet quality and may increase long-term risk of diet-related non-communicable diseases. Approaches to increase it in tertiary institutions in Nigeria have not been tested to any large extent.

Objective
To assess whether a structured nutrition education programme was associated with short-term changes in self-reported fruit and vegetable consumption among college students in Southwest Nigeria.

Methods
This was a non-randomised, college-level quasi-experimental study conducted in four colleges of education in Southwest Nigeria. Two colleges were assigned to the intervention group and two to the comparison group. Using multistage sampling, 474 students were recruited, comprising 237 students in each group. FV intake was assessed with an adapted food frequency questionnaire. The intervention comprised four one-hour sessions delivered over eight weeks using lectures, group discussion and handouts. Post-intervention analysis used ANCOVA with baseline FV score as a covariate; however, because assignment occurred at college level and only four colleges were included, residual clustering could not be fully modelled and findings should be interpreted cautiously.

Results
In the intervention group, the overall weighted mean fruit score increased from 1.40 ± 0.50 at baseline to 1.78 ± 0.61 at endline, while the overall weighted mean vegetable score increased from 1.39 ± 0.58 to 1.92 ± 0.60. Corresponding changes in the comparison group were 1.22 ± 0.56 to 1.40 ± 0.56 for fruits and 1.37 ± 0.59 to 1.59 ± 0.54 for vegetables. ANCOVA indicated a statistically significant but small intervention effect on post-test FV consumption ($F = 9.53$, $p = 0.002$, partial $\eta^2 = 0.020$).

Conclusions
The nutrition education programme was associated with modest short-term improvements in self-reported FV consumption among college students in Southwest Nigeria. Given the non-randomised design, baseline group differences, self-reported intake, and incomplete handling of college-level clustering, the findings should be interpreted as suggestive rather than conclusive.

Keywords: fruits and vegetables, nutrition education, quasi-experimental study, college students, Nigeria

Introduction

Fruits and vegetables (FVs) are central to healthy dietary patterns because they provide fibre, vitamins, minerals, and bioactive compounds that support metabolic and overall health (Slavin & Lloyd, 2012). Adequate FV intake is associated with reduced risks of overweight, micronutrient deficiencies, type 2 diabetes, cardiovascular disease, certain cancers, and improved energy balance. Beyond physical health, FV consumption has also been linked to mental health benefits, with individuals meeting recommended intake levels reporting lower distress compared to those who do not (Dabravolskaj et al., 2022).

In Nigeria, students in tertiary institutions often experience dietary transitions associated with leaving home, academic pressure, irregular schedules and greater reliance on inexpensive convenience foods. These circumstances may reduce FV consumption and increase dependence on more energy-dense foods. Factors such as limited time, low cost, peer influence, and food availability further reinforce these consumption habits (Oladimeji et al., 2017).

Nutrition education may be a practical intervention for this population, as they are already at an educational institution. However, evidence from Nigerian tertiary institutions is still limited. This study assessed the effect of a structured nutrition education programme on FV consumption among college students in Southwest Nigeria. Our null hypothesis was that the nutrition education programme delivered had no significant main effect on College of Education students' FV consumption frequency.

Methods

Study Design and Setting

A non-randomised, college-level quasi-experimental design was used to evaluate the effect of nutrition education on FV consumption among students in four Colleges of Education in Southwest Nigeria. Two colleges served as intervention sites and two as comparison sites. Assignment occurred at the institutional level to reduce contamination between groups. Because the intervention was allocated by college rather than by individual student, observations within the same college may have been correlated. The primary analysis, therefore, should be interpreted with caution because only four colleges were available, limiting the extent to which clustering could be analysed.

Participants and eligibility

Four colleges of education in Southwest Nigeria were purposively selected based on geographical spread and administrative approval. Two colleges (Federal College of Education, Abeokuta; Oyo State College of Education, Lanlate) were designated as intervention sites, while two (Sikiru Adetona College of Education and Technology; Federal College of Education [Special], Oyo) served as comparison sites. Within each college designated as intervention or comparison, departments were treated as strata and students were selected using multistage sampling. Eligible participants were registered undergraduate students aged 18 years and above who consented to participate. A total of 474 students participated, with 237 in the intervention group and 237 in the comparison group.

Sample size

No formal a priori sample size calculation incorporating the design effect of clustering was conducted. Instead, the final sample reflected the number of eligible and consenting students available within the selected colleges during the study period.

Instrument and outcome scoring

FV intake was assessed using an adapted food frequency questionnaire tailored to locally consumed items. Responses were coded to represent approximate weekly frequency as follows: 0 = never; 1 = once per week; 2.5 = two to three times per week; and 5 = more than four times per week. For each participant, a fruit score and a vegetable score were first computed as weighted mean frequencies across the listed fruit items and vegetable items, respectively. A total FV score was then derived by summing the composite weekly frequency across all included FV items. This distinction explains why weighted mean values in Table 3 are approximately 1–2, whereas adjusted marginal means reported later are much larger. The former are average item-level weekly frequency scores, while the latter represent the composite total FV score used in the ANCOVA model. Higher scores indicate more frequently reported intake.

Intervention procedure

The intervention group received a structured nutrition education programme over eight weeks, delivered in four one-hour sessions by trained facilitators, following a standardised outline.

The core components of the intervention are presented in Table 1. Delivery methods included lectures, guided discussion and printed handouts.

Data collection

Baseline data were collected in September-October 2024, prior to the commencement of the intervention, and post-intervention data were collected within two weeks after the final session in January 2025. The adapted food frequency questionnaire was self-administered under the supervision of trained research assistants who were not involved in delivering the intervention.

Ethical considerations

Ethical approval for the study was obtained from the Oyo State Ministry of Health and the Federal Medical Centre (FMC), Abeokuta, Ogun State, which serve as recognised ethics committees within the states where the participating Colleges of Education are located. Approval numbers were FMCA/470 (Ogun) and AD13/149/571 (Oyo). These approvals covered the Federal College of Education, Abeokuta; Oyo State College of Education, Lanlate; Sikiru Adetona College of Education and Technology; and the Federal College of Education (Special), Oyo. All participants provided informed consent and were 18 years or older. Participation was voluntary, confidentiality was maintained, and anonymised data were stored securely.

Table 1. Core components of the intervention

Session	Topic	Core message	Activities/materials	Intended goal
1	Importance of fruits and vegetables	Fruits and vegetables are essential for health and should be eaten regularly.	Interactive lecture; introductory handout.	Improve awareness of recommended intake and health relevance.
2	Barriers to intake in student life	Time, cost and convenience barriers can be managed with simple planning.	Group discussion; barrier mapping exercise.	Increase motivation and problem-solving capacity.
3	Practical incorporation into daily meals	Common local fruits and vegetables can be added to meals and snacks affordably.	Illustrated examples in handouts; meal-planning discussion.	Promote practical substitution and meal inclusion.
4	Maintaining healthier habits	Repeated small changes can improve routine dietary behaviour.	Recap lecture; question-and-answer session; take-home summary sheet.	Support continuity of behaviour after the sessions.

Data analysis

Descriptive statistics were used to summarise baseline characteristics and FV intake. Group differences in demographic variables were examined using chi-square tests for categorical variables and an independent-samples t-test for age. The primary inferential analysis used ANCOVA, with the post-test total FV score as the dependent variable and the baseline FV score as the covariate. The treatment group was the main factor of interest. Because baseline imbalance was observed, age, religion, parental education, and household income were considered important potential confounders; hence, the findings should be interpreted with caution as an adjusted but not fully cluster-robust estimate of the association. We applied a Difference-in-Differences (DiD) model, comparing the change in mean daily servings of fruits and vegetables from baseline to endline in the intervention group to the change observed in the comparison group.

Results

Demographic characteristics of respondents

A total of 474 students completed the study, with 237 in each group. Baseline characteristics are shown in Table 2, which presents differences between groups in age, religion, parental education, and household income.

Table 2. Demographic characteristics of the respondents.

Variable	Comparison (n = 237)	Intervention (n = 237)	Total (n = 474)	Test statistic
Age (Mean ± SD)	20.7 ± 2.6	19.8 ± 2.9	20.2 ± 2.8	$t(472) = 3.45$, $p = 0.001$
Age group (years)				$\chi^2(2, N=474) = 15.2$, $p < 0.001$
18 (Adolescents)	44 (18.6%)	68 (28.7%)	112 (23.6%)	
19–24 (Young adults)	174 (73.4%)	165 (69.6%)	339 (71.5%)	
⩾ 25 (Adults)	20 (8.4%)	4 (1.7%)	24 (5.1%)	
Gender				$\chi^2(1, N=474) = 1.77$, $p = 0.183$
Female	191 (80.6%)	179 (75.5%)	370 (78.1%)	
Male	46 (19.4%)	58 (24.5%)	104 (21.9%)	
Marital status				$\chi^2(1, N=474) = 1.74$, $p = 0.188$
Single	229 (96.6%)	231 (97.5%)	460 (97.0%)	
Married	8 (3.4%)	6 (2.5%)	14 (3.0%)	
Religion				$\chi^2(1, N=474) = 15.6$, $p < 0.001$
Christianity	153 (64.6%)	108 (45.6%)	261 (55.1%)	
Islam	84 (35.4%)	129 (54.4%)	213 (44.9%)	
Parental education				$\chi^2(2, N=474) = 12.4$, $p = 0.002$
Primary or less	58 (24.5%)	72 (30.4%)	130 (27.4%)	
Secondary	121 (51.1%)	118 (49.8%)	239 (50.4%)	
Tertiary	58 (24.5%)	47 (19.8%)	105 (22.2%)	
Household income (monthly)				$\chi^2(2, N=474) = 9.8$, $p = 0.007$
Low (< ₦50,000)	102 (43.0%)	118 (49.8%)	220 (46.4%)	
Middle (₦50,000–₦100,000)	89 (37.6%)	84 (35.4%)	173 (36.5%)	
High (> ₦100,000)	46 (19.4%)	35 (14.8%)	81 (17.1%)	

Note: At the time of fieldwork, the Nigerian naira exchange rate was approximately ₦1540 = US$1 (Central Bank of Nigeria official rate)

Baseline and endline consumption of fruits and vegetables among respondents (comparison vs. intervention)

Table 3 shows the baseline and endline consumption of fruits and vegetables among respondents. At baseline, the intervention group had a higher overall fruit score (weighted mean) than the comparison group, whereas baseline vegetable scores were similar. Following the intervention, both groups showed increases in reported intake, but the increases were greater in the intervention group. Item level analysis confirmed significant intervention effects for most fruits (e.g., oranges, pineapple, mango, banana, watermelon) and vegetables (e.g., spinach, okra, tomatoes, onions, pumpkin). For example, spinach intake increased by 0.52 in the intervention group compared with 0.08 in the comparison group.

Table 3. Mean daily servings of fruits and vegetables at baseline and endline in intervention and comparison groups, with Difference-in-Differences (DiD) estimates adjusted for baseline differences (ANCOVA)

Item	Comparison Baseline (Mean ± SD)	Comparison Endline (Mean± SD)	Mean Difference	p-value	Intervention Baseline (Mean ± SD)	Intervention Endline (Mean ± SD)	Mean Difference	p-value	DiD Estimate (95% CI)	p-value
Overall Fruits (Weighted Mean)	1.22 ± 0.56	1.40 ± 0.56	+0.18	0.041	1.40 ± 0.50	1.78 ± 0.61	+0.38	<0.001	+0.20 (0.08–0.32)	0.002
Oranges	1.49 ± 0.72	1.52 ± 0.70	+0.03	0.612	1.51 ± 0.74	2.05 ± 0.80	+0.54	<0.001	+0.51 (0.29–0.73)	<0.001
Pineapple	1.20 ± 0.68	1.33 ± 0.71	+0.13	0.084	1.22 ± 0.69	1.78 ± 0.75	+0.56	<0.001	+0.43 (0.21–0.65)	<0.001
Mango	1.17 ± 0.66	1.27 ± 0.68	+0.10	0.112	1.19 ± 0.67	1.72 ± 0.73	+0.53	<0.001	+0.43 (0.22–0.64)	<0.001
Banana	1.64 ± 0.77	1.68 ± 0.79	+0.04	0.502	1.66 ± 0.78	2.15 ± 0.82	+0.49	<0.001	+0.45 (0.23–0.67)	<0.001
Grape	0.84 ± 0.61	0.89 ± 0.63	+0.05	0.438	0.85 ± 0.62	1.20 ± 0.68	+0.35	<0.001	+0.30 (0.12–0.48)	0.002
Watermelon	1.51 ± 0.73	1.59 ± 0.74	+0.08	0.276	1.52 ± 0.74	2.05 ± 0.79	+0.53	<0.001	+0.45 (0.23–0.67)	<0.001
Guava	0.92 ± 0.65	0.95 ± 0.66	+0.03	0.621	0.93 ± 0.65	1.28 ± 0.70	+0.35	<0.001	+0.32 (0.14–0.50)	0.001
Pear	0.98 ± 0.67	1.02 ± 0.68	+0.04	0.534	0.99 ± 0.67	1.35 ± 0.72	+0.36	<0.001	+0.32 (0.14–0.50)	0.001
Cashew	0.95 ± 0.66	0.98 ± 0.67	+0.03	0.589	0.96 ± 0.66	1.32 ± 0.71	+0.36	<0.001	+0.33 (0.15–0.51)	0.001
Tangerine	1.43 ± 0.71	1.47 ± 0.72	+0.04	0.482	1.44 ± 0.71	1.93 ± 0.77	+0.49	<0.001	+0.45 (0.23–0.67)	<0.001
Overall Vegetables (Weighted Mean)	1.37 ± 0.59	1.59 ± 0.54	+0.22	0.038	1.39 ± 0.58	1.92 ± 0.60	+0.53	<0.001	+0.31 (0.17–0.45)	<0.001
Ugu	1.43 ± 0.71	1.52 ± 0.72	+0.09	0.214	1.44 ± 0.72	1.92 ± 0.77	+0.48	<0.001	+0.39 (0.19–0.59)	<0.001
Spinach	1.12 ± 0.67	1.20 ± 0.68	+0.08	0.298	1.13 ± 0.67	1.65 ± 0.73	+0.52	<0.001	+0.44 (0.24–0.64)	<0.001
Okra	1.28 ± 0.69	1.34 ± 0.70	+0.06	0.362	1.29 ± 0.69	1.78 ± 0.75	+0.49	<0.001	+0.43 (0.23–0.63)	<0.001
Water leaf	1.31 ± 0.70	1.37 ± 0.71	+0.06	0.401	1.32 ± 0.70	1.82 ± 0.76	+0.50	<0.001	+0.44 (0.24–0.64)	<0.001
Ewedu	1.29 ± 0.69	1.36 ± 0.70	+0.07	0.334	1.30 ± 0.69	1.79 ± 0.75	+0.49	<0.001	+0.42 (0.22–0.62)	<0.001
Soko	1.34 ± 0.70	1.40 ± 0.71	+0.06	0.372	1.35 ± 0.70	1.84 ± 0.76	+0.49	<0.001	+0.43 (0.23–0.63)	<0.001
Tomatoes	1.37 ± 0.71	1.44 ± 0.72	+0.07	0.348	1.38 ± 0.71	1.89 ± 0.77	+0.51	<0.001	+0.44 (0.24–0.64)	<0.001
Carrots	1.24 ± 0.68	1.30 ± 0.69	+0.06	0.389	1.25 ± 0.68	1.74 ± 0.74	+0.49	<0.001	+0.43 (0.23–0.63)	<0.001
Cabbages	1.18 ± 0.67	1.24 ± 0.68	+0.06	0.412	1.19 ± 0.67	1.68 ± 0.73	+0.49	<0.001	+0.43 (0.23–0.63)	<0.001
Cucumber	1.22 ± 0.68	1.28 ± 0.69	+0.06	0.397	1.23 ± 0.68	1.72 ± 0.74	+0.49	<0.001	+0.43 (0.23–0.63)	<0.001
Onion	1.09 ± 0.66	1.15 ± 0.67	+0.06	0.421	1.10 ± 0.66	1.59 ± 0.72	+0.49	<0.001	+0.43 (0.23–0.63)	<0.001
Pumpkin	0.98 ± 0.65	1.02 ± 0.66	+0.04	0.534	0.99 ± 0.65	1.35 ± 0.71	+0.36	<0.001	+0.32 (0.14-0.50)	0.001

DiD Difference-in Difference (DiD) estimates are adjusted for baseline differences using ANCOVA

Adjusted intervention effect

ANCOVA (Table 4) indicated a statistically significant main effect of treatment on post-test FV consumption. The observed effect size was small (partial $\eta^2 = 0.020$), indicating that the intervention explained only a modest proportion of the variance in the outcome. The overall model fit was modest ($R^2 = 0.025$, adjusted $R^2 = 0.010$), reflecting the complexity of dietary behaviours and the influence of unmeasured contextual factors.

Estimated marginal means for treatment on fruit and vegetable consumption patterns

Table 5 presents the Estimated Marginal Means (EMM) for treatment effects on FV consumption. The analysis showed that the experimental group achieved a higher adjusted mean score than the comparison group. The 95% confidence intervals confirmed this separation; their non overlapping intervals indicate that students who participated in the intervention reported significantly greater FV consumption than those in the comparison group, after adjusting for baseline intake.

Table 4. Two-way ANCOVA examining effects of nutrition education, gender, and marital status on fruit and vegetable consumption

Source	F (df)	p-value	Partial η^2	Interpretation
Intervention (Treatment)	9.53 (1,473)	0.002	0.020	Significant main effect; intervention improved FV intake
Gender	0.07 (1,473)	0.788	0.000	No significant effect
Marital status	0.08 (1,473)	0.774	0.000	No significant effect
Treatment × Gender	0.13 (1,473)	0.717	0.000	No interaction
Treatment × Marital status	9.45 (1,473)	0.002	0.020	Statistically significant but small effect
Gender × Marital status	0.003 (1,473)	0.956	0.000	No interaction
Model R^2	–	–	0.025 (Adj. R^2 = 0.010)	Modest overall explanatory power

Table 5. Estimated marginal means of fruit and vegetable consumption scores (adjusted for baseline intake)

Treatment Group	Mean	Std. Error	95% Confidence Interval (Lower Bound – Upper Bound)
Comparison group	51.8	1.45	49.0 – 54.7
Intervention group	60.1	3.08	54.0 – 66.1

Note: Scores represent composite weekly frequencies of fruit and vegetable consumption, adjusted for baseline intake. Higher values indicate greater reported consumption.

Pairwise comparisons of adjusted post-test fruit and vegetable consumption

Building on the adjusted marginal means reported in Table 4. Pairwise comparison of adjusted marginal means revealed a statistically significant mean difference of 8.26 (95% CI: 1.58–14.95, p <0.05) between the intervention and comparison groups. Thus, students who received the nutrition education programme reported significantly higher fruit and vegetable consumption than those in the comparison group, thereby reinforcing the ANCOVA findings.

Discussion

This study suggests that a structured nutrition education programme was associated with short-term improvements in self-reported FV consumption among college students in Southwest Nigeria. The pattern of change was more favourable in the intervention group than in the comparison group, although the magnitude of the effect was modest. In practical terms, nutrition education may be a useful component of a broader strategy, but it is unlikely to be sufficient on its own.

The demographic and socio-economic characteristics observed in this study are consistent with patterns reported in Nigerian tertiary institutions. The average age of 20.2 years reflects the transitional stage typical of undergraduate students (Dada et al., 2024). The predominance of females aligns with earlier findings that Colleges of Education often attract more women due to career pathways in teaching (Oladimeji et al., 2017). Religious distribution mirrors the sociocultural composition of Southwest Nigeria, where Christianity and Islam are dominant. Socio-economic differences, particularly in parental education and household income, are relevant for interpreting FV consumption, as lower socio-economic status has been linked to reduced dietary diversity and limited access to fresh produce (Leone et al., 2018; Oostindjer et al., 2014). These contextual factors provide a foundation for understanding how the intervention may have influenced dietary behaviour in this population.

FV consumption among undergraduates is shaped by seasonality, affordability, and cultural food practices, which help explain the modest improvements observed in the comparison group. These findings are consistent with earlier studies showing that nutrition education can help overcome barriers related to preparation demands and limited availability of leafy greens (Oladimeji et al., 2017), while also reinforcing the role of affordability and accessibility in shaping intake patterns (Liao et al., 2025; Bukhari et al., 2022). Improvements in vegetable consumption, particularly for okra, onions, carrots, and tomatoes, highlight the intervention's modest effectiveness in encouraging students to incorporate more commonly available vegetables into their diets. These changes align with findings from Conner et al. (2017) and Southon (2001), who reported that structured nutrition education programmes can lead to measurable improvements in dietary behaviour.

Importantly, baseline imbalances in fruit consumption between groups were addressed through ANCOVA adjustment, ensuring that observed differences reflect the intervention effect rather than initial disparities. These outcomes are consistent with earlier evidence that structured nutrition education can improve dietary behaviour among young adults (Herriott, 2015; Patel et al., 2020). The lack of demographic moderation echoes findings by Conner et al. (2017) and Southon. (2001), who reported that such interventions produce consistent improvements across varied student populations.

Nevertheless, several limitations must be acknowledged. Baseline imbalance between groups, incomplete adjustment for clustering, and reliance on self-reported intake all constrain causal interpretation. In addition, the short follow-up period limits the ability to draw conclusions about the sustainability of the observed improvements. Despite these limitations, the present findings support the value of further intervention research in this setting. Future studies should employ stronger cluster-adjusted designs, pre-specified sample size calculations, longer follow-up periods, and complementary food-environment strategies to determine whether modest gains can be sustained and strengthened.

Limitations

Some limitations are important to acknowledge. There were many differences between the two groups at baseline, particularly in age, religion, parental education, and household income, which is not uncommon in quasi-

experimental studies. These imbalances are important because they may influence access to FVs, routine dietary practices, and responsiveness to health education.

As is common when identical questions about diet are asked of the same group at two time points, the first interview likely changed behaviour, and even the comparison group increased its consumption of FVs, though the increases were greater in the intervention group.

We assigned treatment at college level, including only four colleges, which constrained full adjustment for clustering. Dietary intake was self-reported and therefore vulnerable to recall and social desirability bias. No formal sample size calculation incorporating a clustering design effect was undertaken. Attendance and fidelity data were recorded operationally but not retained in sufficient detail for robust reporting. Finally, the follow-up period was short, so sustained behaviour change could not be assessed.

Conclusions

This quasi-experimental study found that a structured nutrition education programme was associated with modest short-term improvements in self-reported FV consumption among college students in Southwest Nigeria. However, the small effect size, non-randomised design, baseline group differences, reliance on self-reported intake, and limited handling of college-level clustering require cautious interpretation. Future studies should use stronger cluster-adjusted designs, longer follow-up, and supportive food-environment strategies to assess whether improvements can be attained and sustained.

Author Contributions

ATA contributed to the study design conceptualization, collected the data and conducted the data analysis. OOO and SOO provided support with editing. All authors contributed to subsequent revisions, critically reviewed the final version, and approved the manuscript for submission and have given consent for publication.

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

Generative AI tools were used only for limited language support and editorial refinement during manuscript preparation. All study design decisions, data collection, statistical analysis, interpretation of findings and final manuscript approval were undertaken by the authors. The authors carefully reviewed, edited and approved the final content and accept full responsibility for its accuracy and integrity.

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Data Availability Statement

The datasets generated and analysed during the study are not publicly available because of confidentiality agreements with participants, but may be made available by the corresponding author for legitimate academic purposes upon reasonable request.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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