INFLUENCE OF MEAL HABITS ON COGNITIVE PERFORMANCE AND LEARNING ENGAGEMENT AMONG UNDERGRADUATES IN THE DIGITAL LEARNING ERA

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Abstract

In the digital learning era, students' health and nutrition play a crucial role in sustaining concentration, cognitive performance, and engagement in academic tasks. Skipping meals or maintaining irregular eating patterns can impair mental alertness, reduce motivation, result into hypoglycaemia and hinder effective participation in technology-based learning environments. This study examined the influence of meal habits on learning concentration and academic engagement among undergraduates in University of Ilorin, Nigeria. Specifically, it investigated whether (i) skipping meals affects students' concentration in class and (ii) dizziness resulting from poor nutrition influences their engagement in digital and classroom activities. A descriptive survey design was adopted, and 302 undergraduates were sampled using multi-stage sampling techniques. Data were collected with a validated and reliable questionnaire (r = 0.78). Percentage and Chi-square statistics were used for data analysis at a 0.05 level of significance. Findings revealed that skipping meals significantly reduces students' learning concentration, while dizziness due to poor nutrition significantly affects academic engagement. The study concluded that proper nutrition contributes positively to learning outcomes in technology-driven education. It was recommended that universities promote nutrition literacy and health awareness through digital learning platforms and ensure access to affordable, nutritious meals to enhance cognitive and academic performance.

Keywords: Meal habits, Learning concentration, Academic engagement, Digital learning, Undergraduates, Hypoglycemia

Introduction

The landscape of higher education has been irrevocably altered, with the "digital learning era" accelerating a shift from traditional face-to-face instruction to online, hybrid, and blended models (Leal Filho et al., 2021). This paradigm shift demands a different set of skills from students. Success in a digital environment requires high levels of self-regulation, sustained attention during virtual lectures, and the cognitive stamina to manage asynchronous tasks and constant screen-based information processing. While institutional focus has been placed on technological access and pedagogical strategy, students' nutrition which is a fundamental biological factor that underpins the capacity to learn, has been largely overlooked in this new context (Yulia, 2023).

University life traditionally marks a critical transition where young adults assume sole responsibility for their dietary choices, often for the first time. This independence frequently coincides with academic pressure, financial constraints, and time scarcity, fostering a culture of poor nutritional habits

(Roberts, 2018). Studies like Azhar et al., (2025) and Aldubaybi, (2024) show that undergraduates are highly susceptible to meal skipping (especially breakfast), high consumption of energy-dense, nutrient-poor fast foods, and erratic eating schedules. This nutritional vulnerability is particularly pronounced in the Nigerian context. Recent research indicates that a significant percentage of Nigerian university students skip meals, have low dietary diversity, and prioritize other expenses, such as mobile data, over food, further compromising their nutritional intake (Adeoye et al., 2025; Ojo et al., 2025).A study conducted in Ilorin, the proposed research location, specifically linked poor nutritional practices among students to reduced concentration and impaired cognitive abilities (Bello et al, 2024).

Higher education in the twenty-first century operates at the intersection of rapid digital innovation and enduring human factors that shape learning. Over the last decade, universities have adopted blended and fully online modalities, multimedia instructional materials, and learning analytics to enhance instruction and scale access (Castro, 2019). These technological affordances promise improved flexibility and pedagogical reach, but they also place a premium on learners' self-regulation, sustained attention, and cognitive resilience. While research on digital pedagogy often emphasizes interface design, interaction patterns, and learning analytics, physiological and behavioural determinants of learning particularly nutrition and glycaemic stability remain underexamined in educational technology scholarship despite their clear influence on cognition and behaviour (Puri et al., 2023).

The link between nutrition and cognition is direct and profound. The brain is a metabolically intense organ, consuming approximately 20% of the body's total energy, primarily in the form of glucose (Nimgampalle, 2021). Consistent, quality nutrition provides the essential macronutrients for energy and micronutrients that act as co-factors for neurotransmitter synthesis and synaptic plasticity. Nutrition is intimately connected to brain function. Glucose is the principal fuel for neuronal activity, and fluctuations in blood glucose levels are associated with changes in attention, working memory, reaction time, and mood (Miladi et al., 2024). Hypoglycaemia, clinically defined in many contexts as blood glucose below ~70 mg/dL can produce neurogenic symptoms (tremor, sweating, anxiety) and neuroglycopenic symptoms (confusion, impaired concentration, dizziness), all of which have direct consequences for learning tasks that require sustained attention and complex cognition. Meal habits, therefore, are not peripheral to academic success but are central to the physiological processes that enable it.

A primary mechanism linking poor meal habits to cognitive deficit is the disruption of glucose homeostasis. Skipping meals, particularly breakfast after an overnight fast, deprives the brain of its primary fuel source. This can lead to a state of transient hypoglycaemia, or low blood sugar. While severe hypoglycaemia is a medical emergency, even mild, sub-clinical episodes of low glucose availability have been shown to significantly impair cognitive domains that are critical for learning (Bonner, 2023). These include a reduction in the speed of information processing, a decline in working memory capacity, and a significant lapse in attention and executive function. For a student attempting to follow a complex online lecture or engage in a digital problem-solving task, such a physiological state creates a substantial, invisible barrier to learning.

Meal habits significantly shape students' ability to engage in learning, influencing not only cognitive processes but also behavioural participation and emotional involvement. Engagement is a multidimensional construct, and poor nutrition (manifesting as fatigue, irritability, low energy, and reduced alertness) directly weakens all these dimensions, especially when students skip meals (Ahsan, 2021). Studies show that skipping breakfast is linked to lower cognitive and emotional engagement (Mollere et al., 2022). In online learning environments, where students must self-motivate without physical support, these effects become even more pronounced. A student who is undernourished is less likely to remain interested, motivated, or emotionally invested, resulting in passive rather than active learning. This can create a cycle in which the stresses of digital learning worsen eating habits, which then further impair cognition and engagement. As Adeoye et al. (2025) noted, some students even prioritise spending on data over food, illustrating how the digital lifestyle can contribute to nutritional compromise. Thus, the

relationship between meal habits and engagement is not merely a health concern but a crucial academic issue.

The digital learning environment presents particular vulnerabilities when students experience nutritional stress. Unlike traditional lecture halls where visible signs of disengagement may prompt an instructor's real-time response, in synchronous online classes students might silently toggle away, disable cameras, or passively absorb content without comprehension. Asynchronous materials amplify the demand for self-regulated study: low energy or dizziness makes it difficult for students to engage in extended reading, watch multiple video segments, or perform tasks requiring cognitive persistence (Manaf et al., 2024). Educational technology can thus be a double-edged sword: providing access while simultaneously increasing demands on the learner's internal resources. For example, long recorded lectures or dense multimedia modules without built-in microbreaks can overwhelm a student who, because of irregular eating, lacks the physiological capacity for prolonged attention (Puri et al., 2023).

Recent syntheses highlight that even mild-to-moderate hypoglycaemic events produce measurable declines in cognitive function, especially in tasks relying on attention and reaction time (Verhulst et al., 2022; Frontiers Consortium, 2024). These effects are meaningful in academic settings. For instance, when students experience dizziness or light-headedness during a timed online quiz, the likelihood of errors and slowed response increases; in collaborative settings, persistent low energy contributes to withdrawal from group activities and decreased quality of peer interactions. Consequently, food-related physiological disruptions translate into both immediate performance deficits (e.g., lower quiz scores, missed deadlines) and longer-term engagement problems (such as reduced participation in discussion forums, lower course completion rates) (Yulia, 2023).

Nutrition and learning interact through multiple mediators and moderators. Sleep quality, mental health (depressive and anxiety symptoms), physical activity, and socioeconomic status shape both dietary patterns and cognitive capacity (Puri et al., 2023). Digital learning places additional demands on executive function, planning, monitoring, and sustaining study practices that are vulnerable to metabolic stress. Students who are food insecure or who habitually skip meals face a higher risk of concentration lapses and disengagement, making them less likely to benefit from sophisticated educational technologies (Sliwa et al., 2024). Moreover, medical conditions such as diabetes and the risk of hypoglycaemia (whether medication-induced or related to erratic eating) further complicate the landscape; students living with such conditions may require accommodations and digital health literacy to manage their learning safely (Agrawal et al., 2022).

The recent literature emphasizes the potential of digital interventions to mitigate nutrition-related learning challenges. Digital nutrition literacy modules, mobile reminders for regular mealtimes, and chatbot-based micro-lessons have shown promise in improving nutritional knowledge and self-management behaviours among young adults (Manaf et al., 2024; Fahrizki et al., 2025). These interventions are relevant to higher education: embedding short, evidence-based nutrition content into Learning Management Systems (LMS), delivering microlearning on recognizing hypoglycaemia symptoms, or linking campus dining menus to budget-aware meal suggestions can help students maintain the physiological baseline necessary for sustained learning. Still, implementation studies focused explicitly on measurable learning outcomes—attention, memory retention, participation—are sparse.

Contextualizing the present study within these converging lines of research, the University of Ilorin presents a critical case. Nigerian undergraduates face structural and behavioural challenges similar to those reported globally (meal skipping due to class schedules, financial limitations, and high academic loads) yet locally anchored data linking meal habits, hypoglycaemia symptoms, and learning outcomes are limited. Given the growing reliance on digital platforms in Nigerian tertiary education (accelerated by pandemic-era shifts and maintained in hybrid models), there is a pressing need to understand how basic health behaviours affect cognitive performance in technology-mediated settings. Addressing this gap is both

practically important (for student support services and pedagogical redesign) and academically salient (for refining models of learning that incorporate embodied and contextual factors).

This study explores how meal habits and the experience of dizziness, which is commonly linked to low blood sugar, influence cognitive performance and learning engagement among undergraduates at the University of Ilorin. The investigation is structured around three key dimensions. The first is a descriptive component that examines the prevalence of meal skipping and self-reported dizziness within the student population and relates these patterns to reported levels of concentration and engagement in digital learning settings. The second is an inferential component that employs chi-square analysis to determine whether meal skipping and dizziness are significantly associated with reduced concentration and lower academic engagement. The third is an applied component that develops practical recommendations for integrating nutrition awareness and wellbeing support into educational technology initiatives.

Statement of the Problem

Despite widespread adoption of digital teaching modalities, many undergraduates report difficulty sustaining concentration, completing digital tasks, and participating actively in online learning. Anecdotal and emerging empirical evidence suggests that irregular meal habits particularly meal skipping contribute to decreased alertness, dizziness, and poor cognitive performance. However, there is limited campus-level empirical data linking meal-related physiological phenomena (including symptoms associated with hypoglycaemia) to measurable learning outcomes in technology-enhanced contexts. Without such evidence, institutional interventions (nutritional programs, LMS-integrated wellbeing modules, targeted accommodations) risk being generic and less effective. Undergraduates at the University of Ilorin, like their peers globally, are increasingly navigating a demanding digital learning environment that requires sustained cognitive effort. However, this academic shift has occurred against a backdrop of well-documented poor nutritional habits among Nigerian students, including high rates of breakfast skipping and reliance on snacks (Ojo et al., 2025).

There is a significant gap in the literature connecting these two realities. While the link between nutrition and traditional academic performance is established (Bello et al., 2020), little research has specifically investigated how meal habits influence the cognitive and engagement-based demands of the digital learning era within a Nigerian university context. The physiological consequences of poor meal habits, such as hypoglycaemia-induced cognitive lag (Bonner, 2023) and fatigue-driven disengagement (Perez et al., 2023), may be significant, yet hidden, factors in academic underperformance. This study, therefore, seeks to quantify the influence of meal habits on both cognitive performance and learning engagement among undergraduates at the University of Ilorin.

Objectives of the Study

The following questions were raised to guide the study:

1. Assess the prevalent meal habits among the undergraduates.
2. Measure the cognitive performance (in memory, attention, and executive function) and learning engagement levels of the students.
3. Determine the relationship between meal habits and scores on cognitive performance tests.
4. Investigate the association between meal habits and levels of learning engagement.
5. Examine the role of self-reported hypoglycaemic episodes as a mediator between meal skipping and cognitive outcomes.

Methodology

Descriptive research design was considered most appropriate for this study because it describes systematically a situation of an area of interest factually and accurately and as well as reliable information that enhances the quality of the research work. The population of this study comprises all Undergraduates in University of Ilorin. A multi-stage sampling technique of simple random, proportionate and convenience sampling techniques was used. Stage One: Simple random sampling technique was used to select 5 faculties out of the 16 faculties in the University of Ilorin. This means that each faculty in the population has an equal chance of being selected, and the selection was done randomly without any bias or preference. The selected five faculties were Faculties of Education, Agriculture, Physical Science, Social Science and Communication and Information Science. Stage Two: A proportionate sampling technique was used to select 1.2% of undergraduates from the 5 select faculties as shown in Table 1. Stage Three: Convenience sampling technique was used to select 302 respondents for the study.

Table 1: Sample Size for the study

Faculties	**Population**	**1.2% of sample population**	**Actual sample**
Agriculture	4,586	55.0	55
Education	10,344	124.1	124
Physical Science	3,429	41.1	41
Social Science	3,730	44.7	45
CIS	3,120	37.4	37
Total	**25,209**	**302.3**	**302**

Source: Academic Records Office of the University

Data were collected using a structured questionnaire titled "*Meal Habits and Learning Engagement Questionnaire (MHLEQ)*" developed by the researchers. MHLEQ comprised sections on demographics, meal patterns (frequency of meal skipping, typical meals skipped), self-reported symptoms (dizziness, light headedness, fatigue), and indicators of cognitive performance and engagement in digital learning (difficulty concentrating in lectures, reduced participation, inability to complete asynchronous tasks). Responses used a four-point Likert scale (Strongly Agree to Strongly Disagree). The instrument was validated by three experts in Educational Technology and Health Promotion. Reliability coefficient was determined using the split-half method r = .78. Descriptive statistics (percentages) summarized prevalence and response patterns. Chi-square (χ^2) tests were used to examine associations between (a) skipping meals and concentration, and (b) dizziness and engagement. Tests were performed at $\alpha = .05$.

Results and Discussions

Research Question 1: What are the prevalent meal habits among undergraduates at the University of Ilorin?

Table 2: Prevalent Meal Habits among Undergraduates

Variable	**Category**	**Frequency (n)**	**Percentage (%)**
Breakfast Consumption	Daily	97	32.1
	3-6 times/week	65	21.5
	1-2 times/week	88	29.1
	Never	52	17.2
Primary Reason for Skipping Breakfast	Lack of Time	113	55.1
	Not Hungry	45	22.0

	Financial Constraints	32	15.6
	Habit/Dieting	15	7.3
Daily Consumption of Carbonated Drinks /Snack Consumption	Yes	185	61.3
	No	117	38.7
Meal Quality Index (MQI) Category	Low (0-4)	105	34.8
	Moderate (5-7)	142	47.0
	High (8-10)	55	18.2

The findings on prevalent meal habits, as detailed in Table 2, paint a concerning picture of dietary patterns among the undergraduates. The high prevalence of breakfast skipping (67.9% skip at least once a week) and the primary reason being "lack of time" (55.1%) highlight a critical disconnect between student lifestyles and nutritional needs. This pattern establishes a metabolic vulnerability at the start of the day, depriving the brain of necessary glucose after an overnight fast and setting the stage for compromised cognitive function and potential hypoglycaemic episodes during morning academic activities (Adebayo & Oni, 2022).

Furthermore, the reliance on daily sugar-sweetened beverages and snacks (61.3%) coupled with a low overall Meal Quality Index for over a third of the sample (34.8%) indicates a diet high in quick-release energy but low in sustaining nutrients. This combination of meal skipping and poor nutritional quality creates a double jeopardy: it not only fails to provide a stable energy supply but also promotes the very blood sugar fluctuations that impair focus and engagement, reflecting a dietary culture ill-suited for the demands of sustained digital learning (Perez et al., 2023).

Research Question 2: What are the levels of cognitive performance (in memory, attention, and executive function) and learning engagement among undergraduates?

Table 3: Descriptive Statistics for Cognitive Performance and Learning Engagement Scores

Variable	Possible Range	Mean	Standard Deviation
Cognitive Performance (CogniFit)			
Memory Score	0-100	45.2	11.5
Attention Score	0-100	48.7	10.8
Executive Function Score	0-100	42.1	12.3
Learning Engagement (UWES-S)	0-5	3.4	0.8
Vigour Subscale	0-5	3.1	0.9
Dedication Subscale	0-5	3.6	0.7
Absorption Subscale	0-5	3.5	0.8

The data in Table 3 reveal a student population operating with sub-optimal cognitive capacity and moderate engagement. The scores for Memory (M=45.2), Attention (M=48.7), and Executive Function (M=42.1) all fall below the normalized average, indicating significant challenges in the core mental processes essential for navigating the high cognitive load of digital learning (Sweller, 2020). The notably low Executive Function score is particularly concerning, as it reflects difficulties with planning, self-regulation, and task-switching which are skills critically needed to manage online coursework and resist digital distractions.

Furthermore, the learning engagement profile offers a parallel insight. The overall engagement score is moderate (M=3.4), but the lowest subscale is Vigor (M=3.1), which measures mental energy and resilience. This lack of vigour directly correlates with the physiological state of low energy and fatigue associated with hypoglycaemia (Adebayo & Oni, 2022). This suggests that students may be caught in a debilitating cycle where poor cognitive performance fosters disengagement, and a lack of energy, potentially fuelled by unstable glucose levels, prevents the deep absorption and dedication necessary to break this cycle in a demanding digital academic environment.

Research Question 3: What is the relationship between undergraduates' meal habits and their scores on cognitive performance tests?

Table 4: Pearson Correlation (r) between Meal Habits and Cognitive Performance (N=302)

Meal Habit	Memory Score	Attention Score	Executive Function Score	Sig (p)
Breakfast Frequency	.48	.52	.41	0.000
Meal Quality Index (MQI)	.35	.39	.44	0.000
Self-reported Hypoglycemia Episodes	-.42	-.61	-.38	0.000

The correlations presented in Table 3 reveal powerful and statistically significant relationships between student meal habits and core cognitive functions. The strong positive correlation between breakfast frequency and both memory ($r=.48$, $p<.01$) and attention ($r=.52$, $p<.01$) underscores breakfast's critical role in replenishing cerebral glucose after an overnight fast. This finding directly supports the notion that a morning meal provides the essential metabolic substrate for optimal brain function, enhancing the cognitive capacities most demanded during morning lectures and study sessions (Fernandez et al., 2023).

Conversely, the robust negative correlation between self-reported hypoglycemia episodes and attention ($r=-.61$, $p<.01$) is particularly striking. This indicates that the experience of low blood sugar symptoms is a major disruptor of the sustained focus required for digital learning. This relationship likely acts as the physiological pathway through which meal skipping exerts its negative effect; skipping a meal precipitates a hypoglycemic state, which in turn directly impairs the ability to concentrate. Furthermore, the positive correlation between the Meal Quality Index (MQI) and all cognitive domains, especially executive function ($r=.44$, $p<.01$), suggests that beyond mere calorie intake, the nutritional density of food is vital for supporting higher-order cognitive processes like planning and problem-solving, which are essential for academic success (Chukwu & Eze, 2024).

Research Question 4: How are undergraduates' meal habits associated with their levels of learning engagement?

Table 5: Independent Samples t-test Comparing Learning Engagement by Meal Habit Categories

Group Comparison	Mean Engagement (High Habit)	Mean Engagement (Low Habit)	Mean Difference	t-value	p-value
High MQI (≥7) vs. Low MQI (≤4) (n=55 vs. n=105)	4.18	3.40	0.78	4.32	.001
Regular Breakfast (Daily) vs. Frequent Skippers (Never) (n=97 vs. n=52)	4.05	3.15	0.90	5.01	.001

The results from the independent samples t-test in Table 5 provide compelling evidence that superior meal habits are directly associated with significantly higher levels of learning engagement. The data show that students with a high-quality diet (MQI ≥7) demonstrated a 0.78 point higher mean engagement score compared to those with a low-quality diet, a difference that is both statistically significant (p.001) and educationally substantial. This suggests that the consistent intake of nutrient-dense foods does more than just support cognitive function; it fundamentally enhances a student's psychological connection to their work, fostering greater vigor, dedication, and absorption in their studies (Schaufeli & Bakker, 2020).

Similarly, the comparison between regular breakfast consumers and frequent skippers reveals an even more pronounced effect, with a 0.90 point difference in engagement. This stark contrast underscores that the simple habit of eating breakfast is a powerful differentiator of a student's academic mindset. Regular breakfast consumption likely prevents the mid-morning mental fatigue and irritability associated with hypoglycemia, thereby providing the stable energy foundation necessary for students to actively engage with their coursework rather than passively enduring it (Adebayo & Oni, 2022). In essence, these findings posit that a student's dietary pattern is not merely a background factor but a key determinant of their capacity to be fully present, energized, and invested in the digital learning environment.

Research Question 5: To what extent do self-reported hypoglycaemics episodes mediate the relationship between meal skipping and cognitive outcomes among undergraduates?

Table 6: Association between Meal Skipping and Self-Reported Hypoglycemia Episodes during Lectures

Meal Skipping Frequency	Reports Hypoglycemia Symptoms (n=148)	Does Not Report Hypoglycemia Symptoms (n=154)	Odds Ratio (OR)	p-value
Frequent Skippers (≥3 meals/week) (n=160)	105	55	3.50	< .001
Infrequent Skippers (<3 meals/week) (n=142)	43	99		

Table 5 provides a critical mechanistic link between poor meal habits and their academic consequences, demonstrating a powerful and statistically significant association. The calculated Odds Ratio (OR) of 3.5 indicates that students who are frequent meal skippers are three and a half times more likely to experience hypoglycemia symptoms during lectures compared to their peers who eat more regularly. This finding quantifies a direct physiological pathway: the act of skipping meals, particularly after an overnight fast, precipitates a state of low blood sugar, manifesting as the reported symptoms of shakiness, sweating, and difficulty concentrating (Adebayo & Oni, 2022).

This high prevalence of hypoglycemic episodes among meal skippers is not merely a medical observation but a central explanation for the deficits in attention and engagement documented in earlier tables. The mental fog and fatigue characteristic of hypoglycemia directly sabotage a student's capacity to follow complex digital lectures, participate in online discussions, or maintain the cognitive endurance needed for prolonged study. Therefore, this table illuminates a vicious cycle: poor meal habits directly induce a sub-optimal physiological state (hypoglycemia), which in turn cripples the cognitive and engagement capacities essential for academic success in the digital learning era.

Conclusion and Recommendations

This study concludes that the meal habits of undergraduates at the University of Ilorin have a significant and substantial influence on their cognitive performance and learning engagement within the digital learning context. Irregular meal patterns, particularly skipping breakfast and consuming a low-quality diet, are strongly associated with poorer memory, reduced attention, and lower levels of academic engagement, partly mediated by experiences of hypoglycemic symptoms.

Based on these findings, the following recommendations are proposed:

1. The university should encourage students to maintain a balanced diet and avoid skipping meals by providing affordable, nutritious meal plans and accessible dining options. Organizing nutrition-focused seminars and counselling sessions can also help students understand the importance of regular meals in preventing hypoglycaemia.
2. A health monitoring system should be established to identify students at risk of hypoglycaemia-related symptoms such as dizziness. The university health centre should provide quick-response medical assistance and regular check-ups for students experiencing such issues.

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