



Journal of Agricultural Policy and Transformation (AgriPaT)

Journal homepage: <http://www.ageconfrontiers.com/agripat>



Food Insecurity, Oral Health, and Nutritional Status among University Students in Faisalabad, Pakistan

Bilal Saddique¹, Muhammad Khalid Bashir^{1,2,*}, Javaria Nasir^{1,2} & Izhar Ul Haq¹

¹Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, Pakistan

²Policy, Advocacy, and Outreach, Pak-Korea Nutrition Center, University of Agriculture, Faisalabad, Pakistan

* khalid450@uaf.edu.pk

ARTICLE INFO

Keywords:

Local Government
Food insecurity
Oral health
Nutritional status
University students
Pakistan
Policy interventions
Received: 05 April
2026

Received in revised
form: 30 April 2026

Accepted:
30 April 2026

Available online: 01
May 2026

ABSTRACT

Food insecurity and oral health problems are critical yet often separately addressed determinants of nutritional status among university students in low- and middle-income settings. This study investigates their combined effects on dietary behavior, health outcomes, and academic performance among 237 students in Faisalabad using a cross-sectional mixed methods design with strong internal reliability (Cronbach's $\alpha = 0.823$). The findings indicate moderate levels of food insecurity ($M = 2.43$) alongside a notable oral health impact on nutrition ($M = 2.66$), suggesting a dual constraint on both food access and food utilization. Statistical analysis reveals significant associations between nutritional status and residential status ($\chi^2 = 16.72$, $p < 0.05$), fatigue ($\chi^2 = 26.85$, $p < 0.01$), concentration difficulties ($\chi^2 = 15.91$, $p < 0.05$), academic performance ($\chi^2 = 17.69$, $p < 0.05$), and access to on-campus food ($\chi^2 = 28.91$, $p < 0.01$), while household income shows no significant effect ($\chi^2 = 9.43$, NS). These results highlight that structural and institutional factors may outweigh purely economic ones in shaping student nutrition.

Importantly, oral health issues limit the consumption of nutrient-dense, fibrous foods, while food insecurity reduces overall dietary intake. Together, they form a synergistic "double burden" that compromises both physical health and academic outcomes. The study underscores the need for integrated university-level interventions, including subsidized meal programs, improved campus food environments, and accessible on-campus dental care services to address these intersecting challenges effectively.

1. Introduction

Agriculture Nutritional health is a fundamental pillar of human well-being, influencing physical growth, cognitive development, immune function, and productivity. Adequate nutrition prevents both communicable and non-communicable diseases and enhances an individual's capacity to learn, work, and thrive. The World Health Organization emphasizes that optimal nutritional status is particularly critical during adolescence and young adulthood, a period of rapid physical, emotional, and intellectual development (WHO, 2022). University students, who largely fall within this age group, represent a population for whom nutrition directly affects academic performance, mental health, and quality of life.

Despite global progress in food production and healthcare, malnutrition remains a pressing public health challenge worldwide. Malnutrition encompasses undernutrition, micronutrient deficiencies, and overnutrition. Undernutrition impairs growth, immunity, and cognition,

while overnutrition contributes to obesity and non-communicable diseases such as diabetes and cardiovascular disorders (FAO, 2021). Among young adults, poor nutritional status adversely affects attention, memory, and problem-solving skills essential for academic success (Alaimo et al., 2001). University students experiencing inadequate nutrition frequently report fatigue, elevated stress, and increased susceptibility to illness, all of which undermine academic achievement (Defeyter and Smith, 2020).

The challenge of malnutrition is particularly acute in low- and middle-income countries (LMICs), where economic constraints, food price volatility, and limited public health interventions exacerbate nutritional vulnerabilities. Pakistan exemplifies this burden. According to the Global Hunger Index (2022), Pakistan faces serious challenges related to hunger and malnutrition. Although the country is largely agrarian, a significant proportion of the population experiences food insecurity and poor dietary diversity.

Simultaneously, urbanization and sedentary lifestyles have contributed to a growing prevalence of overweight, obesity, and diet-related non-communicable diseases (Global Burden of Disease, 2020).

Within this national context, university students represent a particularly vulnerable yet under-researched group. Many students transition from family-supported environments to independent living while managing limited finances, academic pressures, and time constraints. These challenges frequently result in irregular eating patterns, skipped meals, and reliance on inexpensive, energy-dense, nutrient-poor foods (Bruening and Smith, 2017). Students from rural or low-income backgrounds face additional difficulties adapting to urban food environments where nutritious food is often prohibitively expensive.

An often-overlooked determinant of nutritional status is oral health. Healthy teeth and gums are essential for effective chewing and digestion, enabling consumption of diverse nutrient-rich foods. Conversely, oral health problems such as dental caries, periodontal disease, tooth loss, and oral pain can severely restrict food choices and reduce dietary quality (Moynihan & Petersen, 2004). Individuals with oral discomfort may avoid fibrous foods like fruits, vegetables, and protein-rich items requiring adequate mastication, instead opting for softer, highly processed foods of lower nutritional value. This relationship is bidirectional: poor oral health limits dietary intake, while inadequate nutrition particularly diets high in refined sugars and low in calcium, vitamin C, and vitamin D contribute to oral disease progression (Petersen, 2005). Undernutrition further compromises immune function, increasing susceptibility to oral infections and delaying healing (Sheiham, 2006). Among university students already facing dietary challenges, untreated oral health problems may intensify stress, hinder academic performance, and restrict adequate food consumption.

Another major determinant of nutritional status among university students is food insecurity, defined as the lack of consistent access to sufficient, safe, and nutritious food for an active and healthy life (FAO, 2021). For students, food insecurity often manifests as limited affordability of nutritious food, inadequate meal frequency, and poor dietary diversity. Food-insecure students are significantly more likely to experience physical health problems, psychological distress, and academic difficulties than their food-secure peers (Jessiman-Perreault & McIntyre, 2017). In LMICs such as Pakistan, food insecurity among university students is exacerbated by inflation, rising tuition fees, limited financial aid, and weak institutional support systems. Urban centers like Faisalabad present high living costs and food environments dominated by inexpensive fast-food outlets,

further constraining access to healthy options (FAO, 2021; Global Hunger Index, 2022).

Faisalabad, one of Pakistan's largest cities and a major educational hub, provides a relevant context for examining these intersecting challenges. The city attracts many university students, many from rural or low-income households facing substantial socio-economic constraints. Limited availability of affordable dental care and the absence of targeted student nutrition programs heighten vulnerability to poor nutritional outcomes. Although global literature increasingly recognizes the importance of student nutrition, a notable gap remains in research on university students in LMIC settings, particularly in Pakistan. Existing studies tend to address food insecurity or oral health in isolation, with limited attention to their combined influence on nutritional status. This study seeks to address this gap by analyzing the nutritional status of university students in Faisalabad, investigating how oral health, food insecurity, socioeconomic factors, and behavioral factors jointly affect dietary patterns, well-being, and academic performance; assessing the influence of oral health problems including chewing capacity and tooth loss on student diet and nutrition; and formulating evidence-based policy recommendations to address food security, oral health awareness, and financial assistance interventions within the university environment.

2. Literature Review

Every story has a beginning, and the story of how university students struggle with nutrition, oral health, and food insecurity begins long before they step onto campus. It begins in childhood kitchens, in neighborhood dental clinics that few can afford, and in the economic realities that shape what a family can put on the table. For students in Faisalabad, Pakistan, this story is still being written, and the existing literature provides the opening chapters.

University life marks a dramatic turning point. Young people leave the relative stability of family homes and enter a world of late-night study sessions, tight budgets, and newfound independence. This is precisely when lifelong eating habits take root for better or worse. Researchers have consistently found that meal skipping, dependence on fast food, and poor dietary diversity are widely reported among university students, whether in affluent or deprived environments (Laska et al., 2015; Barkley et al., 2015). These patterns are not merely personal choices; they have profound consequences. Students who rely on high-carb, fried foods and sweetened beverages while avoiding fruits, vegetables, and proteins are setting themselves up for

fatigue, poor concentration, and diminished academic performance (Saif-Ur-Rehman et al., 2017; Shaheen et al., 2019).

The stress of examinations amplifies these problems. Barkley et al. (2015) found that during exam periods, students gravitate toward high-sugar, low-protein snacks simply because they are convenient. This stress-related eating, characterized by high-fat and high-sugar foods, reduces fiber, vitamin, and mineral intake while contributing to weight gain and weakened immune responses (Jones et al., 2020; Johnson et al., 2023). Singh and Lal (2021) similarly documented that academic and financial pressures lead to meal skipping, sweet bingeing, and excessive coffee consumption, resulting in low energy, gastrointestinal disorders, and rising body mass index.

Oral Health and Nutrition Intertwined

But the story does not stop with what students choose to eat. It extends to what they are physically able to eat. Healthy teeth and gums are the gatekeepers of nutrition. Thomson (2015) explored this dynamic interplay, showing that balanced meals containing calcium, vitamin D, and phosphates support healthy gums and teeth, while processed foods and high sugar increase the risk of gum disease and tooth decay. Conversely, dental diseases curtail food choices, leading to poor diet quality in a vicious cycle. Petersen and Kwan. (2016) confirmed this bidirectional relationship globally, particularly in low- and middle-income countries (LMICs), where dietary deficiencies (low vitamin C, vitamin D, and antioxidants) worsen gum disease.

The evidence is compelling: students with chewing difficulty, tooth pain, missing teeth, or cavities consume fewer fresh vegetables, lean proteins, and fibrous foods (Brown and Green, 2019; Ahmed et al., 2020). Instead, they depend on softer, processed, high-sugar, high-fat alternatives (Pinto and Sharma ., 2018; Griffin et al., 2017). Farzana et al. (2021) assessed low-socioeconomic university students in Faisalabad specifically, finding a high prevalence of untreated dental caries and poor oral hygiene, which directly reduced dietary diversity as students avoided hard, fibrous foods. Hussain and Amjad (2022) reinforced this, finding a strong correlation between malnutrition and poor oral hygiene among Faisalabad university students those with irregular brushing habits had untreated cavities and gum problems that limited their intake of fibrous foods.

Similarly, Kausar et al. (2023) found that untreated dental disorders caused students to avoid fruits, vegetables, and nuts, instead consuming soft, processed foods with limited nutritional value. Aziz et al. (2024) most recently confirmed that Faisalabad university students with tooth decay and gum disease struggle to maintain dietary variety, consistently avoiding hard or fibrous foods in favor of softer, less nutritious alternatives.

Food Insecurity on Campus

Alongside oral health runs another, equally powerful narrative thread: food insecurity. Defined as the lack of consistent access to sufficient, safe, and nutritious food, food insecurity has emerged as a silent crisis on university campuses worldwide. Smith and Brown (2015) were among the first to quantify it, finding that 37% of American college students were food insecure, with negative effects on academic performance, recall, and concentration. Food-insecure students had significantly lower GPAs. Nguyen and Tran. (2018) found a 41% prevalence among urban college students, with food-insecure students eating fewer nutrient-dense foods and depending on affordable but high-calorie options. Martin and Ferris (2019) reported 42% prevalence in the US, with coping strategies including skipping meals, purchasing cheap nutrient-devoid foods, and relying on food banks.

The psychological toll is equally severe. Defeyter and Smith. (2020) researched food poverty's impact on mental health among UK university students, finding that food insecurity correlated with depression and anxiety, leading to stress, difficulty focusing, and feelings of helplessness. Walker and Mather. (2018) examined the intersection more deeply, showing that food insecurity elevates anxiety, despair, and stress, while poor mental health worsens food insecurity by reducing the ability to plan and prepare balanced meals. Jessiman-Perreault and McIntyre (2017) found strong associations between food insecurity and lower grades, higher dropout likelihood, poor concentration, memory issues, and stress among Canadian students. Watkins and Harris. (2019) found a strong correlation between food insecurity and increased anxiety, sadness, and perceived academic stress, with food-insecure students reporting isolation and embarrassment.

Bruening and Smith. (2017) added a critical nuance: food insecurity is often episodic, striking hardest during high-stress periods and exams. Students skip meals or rely on

cheap convenience foods exactly when their bodies and brains need the most nourishment. This pattern leads to fatigue, ill health, and low grades.

The Pakistani and Faisalabad Context

Within Pakistan, these global patterns take on local color and sharper edges. Ali et al. (2015) examined oral health practices among low-income students at the University of Karachi, finding a high percentage of untreated dental problems caused by unhealthy diets and limited access to affordable dental services. Students commonly consumed sugary foods and beverages, explaining prevalent dental caries. Javed et al. (2016) examined oral health access among Pakistani urban adolescents, revealing that despite proximity to dental clinics, a high burden of dental symptoms persisted due to low knowledge of preventive care, high sugar consumption, and insufficient school-based dental health programs. Kumar et al. (2017) measured oral health awareness among South Asian youth more broadly, finding general ignorance of simple oral care, regular dental visits, and the links between nutrition and oral diseases, with barriers including financial limitations, cultural biases, and information scarcity.

On the food security front, Farooq and Batool (2018) studied dietary inadequacies in Pakistani LMIC students, finding lack of iron, calcium, and vitamin D. Low-finance students consumed fast foods and processed carbs, lacking dietary diversity. Ijaz et al. (2019) found that poor oral hygiene behaviors correlated with higher consumption of sweet snacks and beverages, while students with good dental health practices consumed more fruits, vegetables, and whole grains. Alamgir and Khan (2020) found a strong correlation between poor dietary diversity and deficiencies in vitamin B12, calcium, and iron among Pakistani university students, with budgetary constraints and poor food knowledge as primary causes.

Hussain and Raza. (2020) specifically examined Faisalabad university students, finding that food insecurity correlated with advanced anxiety and sadness. Food-insecure students reported humiliation, social isolation, and constant worry about financial limits. Hassan and Iqbal (2021) found significant gaps in institutional and government food support policies in Pakistani cities, leaving low-income students vulnerable. Khan and Akbar. (2022) found that food-insecure Pakistani Every story has a beginning, and the story of how university students struggle with nutrition, oral

health, and food insecurity begins long before they step onto campus. It begins in childhood kitchens, in neighborhood dental clinics that few can afford, and in the economic realities that shape what a family can put on the table. For students in Faisalabad, Pakistan, this story is still being written, and the existing literature provides the opening chapters.

University life marks a dramatic turning point. Young people leave the relative stability of family homes and enter a world of late-night study sessions, tight budgets, and newfound independence. This is precisely when lifelong eating habits take root for better or worse. Researchers have consistently found that meal skipping, dependence on fast food, and poor dietary diversity are widely reported among university students, whether in affluent or deprived environments (Laska et al., 2015; Barkley et al., 2015). These patterns are not merely personal choices; they have profound consequences. Students who rely on high-carb, fried foods and sweetened beverages while avoiding fruits, vegetables, and proteins are setting themselves up for fatigue, poor concentration, and diminished academic performance (Saif-Ur-Rehman et al., 2017; Shaheen et al., 2019).

The stress of examinations amplifies these problems. Barkley et al. (2015) found that during exam periods, students gravitate toward high-sugar, low-protein snacks simply because they are convenient. This stress-related eating, characterized by high-fat and high-sugar foods, reduces fiber, vitamin, and mineral intake while contributing to weight gain and weakened immune responses (Jones et al., 2020; Johnson et al., 2023). Singh and Lal (2021) similarly documented that academic and financial pressures lead to meal skipping, sweet bingeing, and excessive coffee consumption, resulting in low energy, gastrointestinal disorders, and rising body mass index.

Oral Health and Nutrition Intertwined

But the story does not stop with what students choose to eat. It extends to what they are physically able to eat. Healthy teeth and gums are the gatekeepers of nutrition. Thomson (2015) explored this dynamic interplay, showing that balanced meals containing calcium, vitamin D, and phosphates support healthy gums and teeth, while processed foods and high sugar increase the risk of gum disease and tooth decay. Conversely, dental diseases curtail food choices, leading to poor diet quality in a vicious cycle.

Petersen and Kwan. (2016) confirmed this bidirectional relationship globally, particularly in low- and middle-income countries (LMICs), where dietary deficiencies (low vitamin C, vitamin D, and antioxidants) worsen gum disease.

The evidence is compelling: students with chewing difficulty, tooth pain, missing teeth, or cavities consume fewer fresh vegetables, lean proteins, and fibrous foods (Brown and Green, 2019; Ahmed et al., 2020). Instead, they depend on softer, processed, high-sugar, high-fat alternatives (Pinto and Sharma, 2018; Griffin et al., 2017). Farzana et al. (2021) assessed low-socioeconomic university students in Faisalabad specifically, finding a high prevalence of untreated dental caries and poor oral hygiene, which directly reduced dietary diversity as students avoided hard, fibrous foods. Hussain and Amjad (2022) reinforced this, finding a strong correlation between malnutrition and poor oral hygiene among Faisalabad university students those with irregular brushing habits had untreated cavities and gum problems that limited their intake of fibrous foods. Similarly, Kausar et al. (2023) found that untreated dental disorders caused students to avoid fruits, vegetables, and nuts, instead consuming soft, processed foods with limited nutritional value. Aziz et al. (2024) most recently confirmed that Faisalabad university students with tooth decay and gum disease struggle to maintain dietary variety, consistently avoiding hard or fibrous foods in favor of softer, less nutritious alternatives.

Food Insecurity on Campus

Alongside oral health runs another, equally powerful narrative thread: food insecurity. Defined as the lack of consistent access to sufficient, safe, and nutritious food, food insecurity has emerged as a silent crisis on university campuses worldwide. Smith and Brown (2015) were among the first to quantify it, finding that 37% of American college students were food insecure, with negative effects on academic performance, recall, and concentration. Food-insecure students had significantly lower GPAs. Nguyen and Tran. (2018) found a 41% prevalence among urban college students, with food-insecure students eating fewer nutrient-dense foods and depending on affordable but high-calorie options. Martin and Ferris (2019) reported 42% prevalence in the US, with coping strategies including skipping meals, purchasing cheap nutrient-devoid foods, and relying on food banks. The psychological toll is equally severe. Defeyer and

Smith. (2020) researched food poverty's impact on mental health among UK university students, finding that food insecurity correlated with depression and anxiety, leading to stress, difficulty focusing, and feelings of helplessness. Walker and Mather. (2018) examined the intersection more deeply, showing that food insecurity elevates anxiety, despair, and stress, while poor mental health worsens food insecurity by reducing the ability to plan and prepare balanced meals. Jessiman-Perreault and McIntyre (2017) found strong associations between food insecurity and lower grades, higher dropout likelihood, poor concentration, memory issues, and stress among Canadian students. Watkins Harris. (2019) found a strong correlation between food insecurity and increased anxiety, sadness, and perceived academic stress, with food-insecure students reporting isolation and embarrassment.

Bruening and Smith. (2017) added a critical nuance: food insecurity is often episodic, striking hardest during high-stress periods and exams. Students skip meals or rely on cheap convenience foods exactly when their bodies and brains need the most nourishment. This pattern leads to fatigue, ill health, and low grades.

The Pakistani and Faisalabad Context

Within Pakistan, these global patterns take on local color and sharper edges. Ali et al. (2015) examined oral health practices among low-income students at the University of Karachi, finding a high percentage of untreated dental problems caused by unhealthy diets and limited access to affordable dental services. Students commonly consumed sugary foods and beverages, explaining prevalent dental caries. Javed et al. (2016) examined oral health access among Pakistani urban adolescents, revealing that despite proximity to dental clinics, a high burden of dental symptoms persisted due to low knowledge of preventive care, high sugar consumption, and insufficient school-based dental health programs. Kumar et al. (2017) measured oral health awareness among South Asian youth more broadly, finding general ignorance of simple oral care, regular dental visits, and the links between nutrition and oral diseases, with barriers including financial limitations, cultural biases, and information scarcity.

On the food security front, Farooq and Batool (2018) studied dietary inadequacies in Pakistani LMIC students, finding lack of iron, calcium, and vitamin D. Low-finance students consumed fast foods and processed carbs, lacking dietary

diversity. Ijaz et al. (2019) found that poor oral hygiene behaviors correlated with higher consumption of sweet snacks and beverages, while students with good dental health practices consumed more fruits, vegetables, and whole grains. Alamgir and Khan (2020) found a strong correlation between poor dietary diversity and deficiencies in vitamin B12, calcium, and iron among Pakistani university students, with budgetary constraints and poor food knowledge as primary causes.

Hussain et al. (2020) specifically examined Faisalabad university students, finding that food insecurity correlated with advanced anxiety and sadness. Food-insecure students reported humiliation, social isolation, and constant worry about financial limits. Hassan and Iqbal (2021) found significant gaps in institutional and government food support policies in Pakistani cities, leaving low-income students vulnerable. Khan and Akbar (2022) found that food-insecure Pakistani university students exhibited significantly higher anxiety and depression compared to their food-secure peers. Rahman and Iqbal (2023) found that low financial resources forced urban Pakistani university students to depend on energy-rich but nutrient-scarce food, leading to micronutrient deficiencies, fatigue, and poor academic output. Rasheed and Shaikh (2024) identified a double burden of malnutrition in urban Pakistani university students: undernutrition (micronutrient deficiencies) and over-nutrition (excess calories), both driven by lack of money, meal skipping, and fast-food addiction. Hassan and Malik (2023) confirmed major gaps in food security support systems for Faisalabad university students, with many lacking adequate foods due to insufficient financial support and affordable meal plans.

Global Disruptions and Recent Trends

The COVID-19 pandemic added a devastating chapter to this story. Thompson et al. (2020) found that during the pandemic, 52% of students experienced significant challenges accessing affordable healthy food due to job losses, campus food outlet closures, and supply chain disruptions. White and Gomez (2024) recently confirmed that 35% of students across ten countries still lack access to healthy food due to financial uncertainties and the absence of sustainable food support networks.

Positive findings also emerge from literature. Ali et al. (2021) found that students consuming proteins, fresh fruits, vegetables, and whole grains performed better academically,

while those relying on fried snacks and sweetened beverages recorded lower scores due to poor concentration and fatigue. Ahmed et al. (2022) found a positive correlation between nutritional awareness and healthy eating habits. Students with low nutritional literacy resorted to highly processed, calorie-dense foods, while those with greater knowledge made better choices. Chen et al. (2024) found that students with good oral health knowledge consumed balanced diets including fruits, vegetables, and lean protein, while those lacking awareness consumed processed and sweet meals.

Reading across this body of literature, a coherent but incomplete story emerges. The evidence overwhelmingly confirms three interconnected realities. First, university students are nutritionally vulnerable due to the convergence of developmental transition, financial constraints, academic stress, and

environmental barriers (Laska et al., 2015; Barkley et al., 2015; Bruening and Smith, 2017; Saif-Ur-Rehman et al., 2017). Second, oral health status fundamentally shapes dietary intake; students with untreated dental problems consistently avoid nutrient-dense fibrous foods, creating a pathway from poor oral health to malnutrition (Brown and Green, 2019; Ahmed et al., 2020; Farzana et al., 2021; Hussain & Amjad, 2022; Kausar et al., 2023; Aziz et al., 2024). Third, food insecurity is highly prevalent among university students globally and in Pakistan, with profound effects on mental health, academic performance, and dietary quality (Smith & Brown, 2015; Defeyer and Smith, 2020; Jessiman-Perreault & McIntyre, 2017; Hussain and Raza, 2020; Khan and Akbar, 2022; Rahman and Iqbal, 2023).

However, significant gaps remain that this study directly addresses. Most of the studies examine oral health and food insecurity as separate phenomena, despite theoretical reasons to believe they interact synergistically. While researchers have documented that poor oral health limits food choices and that food insecurity limits food access, very few studies have asked how these two barriers operate together. A student who is both food insecure and suffering from untreated dental caries faces a double constraint: limited access to food overall, and additional restriction to only soft, processed foods that may be less nutritious. No identified study has quantitatively examined this interaction effect among university students.

Furthermore, while Faisalabad has been the site of isolated studies on oral health (Farzana et al., 2021; Hussain &

Amjad, 2022; Aziz et al., 2024) and food insecurity (Hussain and Raza, 2020; Hassan & Malik, 2023), no research has integrated these two streams of inquiry within a single framework. Existing Faisalabad studies also tend to be descriptive, lacking analysis of how socioeconomic and behavioral factors mediate the relationships between oral health, food insecurity, and nutritional status. Finally, the literature offers ample documentation of problems, but few evidence-based, context-specific policy recommendations tailored to the realities of Pakistani universities.

This study therefore steps into the gap. By investigating nutritional status among Faisalabad university students through the dual lenses of oral health and food insecurity, and by examining how socioeconomic and behavioral factors shape these relationships, the research aims to complete a chapter of the story that has, until now, remained unwritten. In doing so, it seeks not only to contribute to academic knowledge but to inform the policy interventions and institutional support mechanisms that could rewrite the ending for vulnerable students.

3. Materials and Methods

Research Design

This study employed a cross-sectional research design to examine the nutritional status of university students in Faisalabad, Pakistan, with specific focus on the influence of oral health and food insecurity. The cross-sectional design was selected for its practicality and effectiveness in assessing socio-economic and behavioral phenomena within a constrained timeframe, enabling the evaluation of prevailing relationships between the key constructs at a single point in time. To complement the quantitative structure, qualitative elements were incorporated to capture students lived experiences, perceptions, and behavioral choices, thereby allowing the study to document both measurable patterns and contextual explanations for dietary behaviors and health-related decisions.

Data Collection

Primary data were collected directly from participants to ensure that findings accurately reflected the real-life circumstances of university students in Faisalabad. This approach enabled the documentation of personal experiences related to food affordability, oral health challenges, and dietary habits without reliance on secondary interpretations. A self-administered structured questionnaire was developed for data collection, selected for its efficiency, accessibility, and suitability for reaching a diverse student

population. The questionnaire was distributed online, allowing participants to respond conveniently while minimizing time and geographic barriers.

Pilot Testing and Instrument Refinement

Prior to full deployment, the questionnaire underwent a pilot-testing phase involving a small group of students of the target population. Feedback from this phase was used to refine question wording, improve clarity, and ensure internal coherence, thereby enhancing the validity and reliability of the data collection instrument.

Sampling Strategy

A stratified multistage random sampling technique was employed to obtain a representative sample. Universities in Faisalabad were first categorized into two strata: public and private. This stratification was essential to capture socio-economic diversity, as public and private institutions in Pakistan serve distinct student populations with differing financial backgrounds. Within each stratum, faculties and departments were randomly selected, followed by the random selection of individual students from these academic units. This multistage approach minimized selection bias and ensured variation across

demographic, academic, and socio-economic characteristics. The final sample comprised 237 active university students from diverse academic backgrounds, a sample size deemed sufficient for meaningful statistical analysis while remaining logistically feasible.

Ethical Considerations

Ethical considerations were rigorously addressed throughout the research process. Participation was entirely voluntary, and confidentiality was assured through anonymous online responses. Informed consent was obtained electronically, with participants clearly informed about the purpose of the study, their right to withdraw at any time without penalty, and the protection of their personal information. Ethical approval was granted by the relevant institutional review board prior to data collection, ensuring compliance with established research ethics standards.

Questionnaire Structure

The questionnaire consisted of 42 items organized into thematic sections: personal and socio-economic characteristics, food consumption patterns, food insecurity experiences, dietary intake and nutritional status, oral health impacts, and perceived effects on health and academic performance. Most items employed Likert-scale formats to

facilitate consistency and quantitative analysis, while open-ended questions were included to capture qualitative insights and personal narratives.

Data Analysis

Data analysis involved both quantitative and qualitative techniques. Quantitative data were analyzed using SPSS software, while qualitative responses from open-ended questions were examined using thematic analysis to identify recurring patterns, thereby enriching the quantitative findings.

Reliability Testing

The reliability of the questionnaire was evaluated using Cronbach's alpha, a widely used statistical measure for assessing internal consistency and reliability of scales (Cronbach, 1951). This test was applied to Likert-scale-based sections covering key areas: food consumption, food insecurity, dietary intake, oral health impact, and health and academic performance. Cronbach's alpha is mathematically expressed as:

$$\alpha = K/(K - 1) (1 - (\sum \sigma_{Yi^2})/(\sigma_{X^2}))$$

Where:

- α = Cronbach's Alpha
- K = Number of items in the scale
- σ_{Yi^2} = Variance of each individual item
- σ_{X^2} = Variance of the total score

The alpha value ranges from 0 to 1, with values of 0.70 or higher considered acceptable, indicating that the instrument effectively measures the intended constructs ($\alpha \geq 0.9$: excellent; $0.8 \leq \alpha < 0.9$: good; $0.7 \leq \alpha < 0.8$: acceptable; $\alpha < 0.7$: needs improvement). The results confirmed the instrument's reliability, ensuring that the collected data were robust and dependable for subsequent analysis.

Descriptive Statistics

Descriptive statistics formed the core analytical approach for summarizing the data and enabling meaningful interpretation of observed patterns (Gravetter & Wallnau, 2017). Various measures, including frequencies, percentages, means, and standard deviations, were used to describe the dataset. The mean was calculated as:

$$\bar{X} = 1/N \sum_{(i=1)}^N X_i$$

Where \bar{X} is the mean, X_i is each value, and N is the number of observations. The standard deviation, measuring data spread around the mean, was calculated as:

$$SD = \sqrt{1/(N - 1) \sum_{(i=1)}^N (X_i - \bar{X})^2}$$

Variance was computed as:

$$S^2 = 1/(N - 1) \sum_{(i=1)}^N (X_i - \bar{X})^2$$

The range, indicating the span from smallest to largest value, was calculated as:

$$Range = X_{max} - X_{min}$$

Variable-Specific Analysis

For each research objective, targeted statistical methods were employed. For Objective 1 (examining nutritional status in relation to oral health, food insecurity, socioeconomic factors, and behavioral aspects), variables analyzed included: oral health (dental issues and chewing pain), food insecurity (accessibility, affordability, and frequency of shortages), socioeconomic factors (household income, parental education, financial support), dietary habits (food group intake, meal regularity), and academic performance (attendance, concentration, self-reported outcomes). For Objective 2 (evaluating the impact of oral health on food choices and nutritional intake), variables analyzed included: chewing ability (perceived ease or difficulty), tooth loss (self-reported missing teeth and impact on food selection), and common oral health issues (cavities, gum bleeding, dental pain).

Cross-tabulations were used to assess associations between demographic factors (e.g., income, academic background) and key variables such as food insecurity and oral health status. Frequencies and percentages were calculated to describe patterns in dietary habits, food insecurity, and oral health issues. Means and standard deviations were used to capture central tendencies and variabilities in responses related to nutritional intake and perceived academic performance.

Chi-Square Test of Independence

To examine associations between categorical variables related to nutritional status, oral health, and food insecurity, the Chi-square test of independence was applied. This non-parametric statistical technique is suitable for testing relationships between qualitative variables and determining whether observed distributions differ significantly from expected distributions. The test assessed whether factors such as oral health practices, food insecurity levels, and

demographic characteristics had statistically significant relationships with students' nutritional status. The Chi-square statistic was calculated as:

$$X^2 = \sum (O_{ij} - E_{ij})^2 / E_{ij}$$

Where O_{ij} is the observed frequency in the i -th row and j -th column, E_{ij} is the expected frequency in the i -th row and j -th column, and \sum represents summation across all cells of the contingency table. Expected frequencies were obtained from:

$$E_{ij} = \frac{(\text{Row Total}_i \times \text{Column Total}_j)}{\text{Grand Total}}$$

The null hypothesis (H_0) assumed no significant association between the variables under study, while the alternative hypothesis (H_1) stated that a significant association existed. The calculated χ^2 value was compared with the critical value at a 5% significance level and appropriate degrees of freedom ($df = (r-1)(c-1)$), where r represents the number of rows and c the number of columns.

Qualitative Analysis

Open-ended responses from the questionnaire were analyzed thematically to identify recurring patterns. Thematic analysis involved reading all qualitative responses multiple times, identifying recurring themes and patterns, coding responses according to these themes, and synthesizing the findings to complement and contextualize the statistical results.

4. Results and Discussion

Results

Reliability of the Instrument

The internal consistency reliability of the 42-item questionnaire was evaluated using Cronbach's alpha (α), with analysis focused on the 28 Likert-scale-based items covering key constructs: food consumption, food insecurity, dietary intake, oral health impact, and health and academic performance. Following listwise deletion to address incomplete responses, 237 valid cases (97.9% of the 242 participants) remained for analysis.

Table 1: Reliability Statistics

Statistic	Value
Cronbach's Alpha (α)	0.823
Number of Items (N)	28
Valid Cases	237 (97.9%)

Cronbach's alpha coefficient for the overall scale was 0.823, which falls within the "good" range of internal reliability

according to established psychometric benchmarks (George & Mallery, 2019; Tavakol & Dennick, 2011). This value exceeds the acceptable threshold of 0.70 specified in the methodology, confirming that the instrument effectively measures the intended constructs. The result demonstrates that the scale exhibits robust internal consistency, implying that its items measure the intended constructs reliably and cohesively without significant measurement error.

According to the interpretation framework presented in the methodology ($\alpha \geq 0.9$: excellent; $0.8 \leq \alpha < 0.9$: good; $0.7 \leq \alpha < 0.8$: acceptable; $\alpha < 0.7$: needs improvement), the obtained alpha of 0.823 is classified as good internal consistency. This indicates that the scale items are sufficiently inter-correlated to measure the underlying constructs while avoiding the redundancy that can occur when alpha values exceed 0.90 (Tavakol & Dennick, 2011). Internal consistency is particularly relevant in social sciences research involving multidimensional constructs such as attitudes, perceptions, and self-reported behaviors (DeVellis, 2016). The reliability established here provides confidence that subsequent analyses testing the interactions between oral health, food insecurity, and nutritional status are not undermined by measurement inconsistencies.

Descriptive Analysis of Core Study Variables

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were computed to summarize participant characteristics and identify patterns related to dietary behavior, food insecurity, and oral health conditions, as specified in the analytical framework. Table 2 presents descriptive statistics for the primary variables examined in relation to students' nutritional status, food insecurity, oral health, and academic outcomes.

The mean food insecurity score of 2.43 (SD = 1.05) reflects moderate levels of food insecurity within the student sample. The dietary intake and nutritional status score (M = 2.92, SD = 0.85) indicates moderate challenges in achieving optimal nutritional outcomes. The oral health impact on nutrition (M = 2.66, SD = 0.86) and oral health problems score (M = 2.56, SD = 1.23) suggest moderate interference of oral health concerns with dietary habits, including difficulties consuming certain foods due to dental conditions.

Chewing ability (M = 3.33, SD = 1.33) showed relatively better reported comfort, though the substantial variability (SD = 1.33) indicates significant struggles for specific subgroups. The self-reported impact of health on academic performance (M = 2.93, SD = 0.94) underscores moderate perceived limitations arising from health challenges. Notably, monthly family income showed substantial

variability (Mean = 75,904.96 PKR, SD = 81,878.89, range: 10,000–800,000 PKR), revealing profound socioeconomic disparity among participants.

Table 2: Percentage of studies in given dimensions in different countries

Variable	Mean (M)	Standard Deviation (SD)	Range
Food Insecurity	2.43	1.05	1 (low) – 5 (high)
Dietary Intake & Nutritional Status	2.92	0.85	-
Oral Health Impact on Nutrition	2.66	0.86	-
Health & Academic Performance	2.93	0.94	-
Chewing Ability	3.33	1.33	1 (low) – 5 (high)
Oral Health Problems	2.56	1.23	1 (low) – 5 (high)
Food Average Score (Dietary Intake)	2.82	0.66	-
Monthly Family Income (PKR)	75,904.96	81,878.89	10,000–800,000

Bivariate Analysis: Chi-Square Tests of Association

As specified in the methodology, Chi-square tests of independence were conducted to examine associations between categorical variables related to nutritional status, oral health, and food insecurity. Tables 3 through 8 present these results.

Table 3 reveals a statistically significant association between residential status and nutritional status ($\chi^2 = 16.72$, $p < 0.05$).

The Gamma value of 0.247 ($p < 0.05$) indicates a positive and significant relationship, suggesting that students living with their families are more likely to have better nutritional status compared to those residing in university hostels or private accommodations. Among students living with family, 39.7% had good nutritional status compared to only 21.4% of hostel residents and 21.1% of those in private accommodation. Conversely, 57.9% of students in private accommodation and 50.0% of hostel residents had poor nutritional status.

Table 3: Relationship between Residential Status and Nutritional Status

Residential Status	Poor (f, %)	Normal (f, %)	Good (f, %)	Total (f, %)
University Hostel	7 (50.0%)	4 (28.6%)	3 (21.4%)	14 (6.0%)
Private Accommodation	11 (57.9%)	4 (21.1%)	4 (21.1%)	19 (8.0 %)
Living with Family	38 (18.6%)	85 (41.7%)	81 (39.7%)	204 (86.0%)
Total	56 (23.6%)	93 (39.2%)	88 (37.1%)	237 (100%)

* $\chi^2 = 16.72$ * ($p < 0.05$); Gamma = 0.247* ($p < 0.05$)*

The Chi-square value of 9.43 was statistically non-significant ($p > 0.05$), and the Gamma value of 0.127 was also non-significant (Table 4). The null hypothesis of no association between household income and nutritional status cannot be rejected. This indicates that within the sampled population, students' nutritional condition does not vary

significantly across different levels of household income. Other factors, such as food access, residential status, or eating habits, may play stronger roles in determining nutritional outcomes than income alone, consistent with the variable-specific analysis plan outlined in the methodology.

Table 4: Relationship between Household Income and Nutritional Status

Household Income (PKR)	Poor (f, %)	Normal (f, %)	Good (f, %)	Total (f, %)
Up to 50,000	34 (27.6%)	41 (33.3%)	48 (39.0%)	123 (51.9%)
50,001–75,000	10 (22.7%)	24 (54.5%)	10 (22.7%)	44 (18.6%)
>75,000	12 (17.1%)	28 (40.0%)	30 (42.9%)	70 (29.5%)
Total	56 (23.6%)	93 (39.2%)	88 (37.1%)	237 (100%)

* $\chi^2 = 9.43^{\wedge}NS^*$; Gamma = $0.127^{\wedge}NS^*$

Table 5 shows a statistically significant association between fatigue levels and nutritional status ($\chi^2 = 26.85$, $p < 0.01$). The negative Gamma value (-0.241 , $p < 0.01$) indicates that as students report higher levels of fatigue, their nutritional

status tends to decline. Among students who agreed or strongly agreed with experiencing fatigue, 43.6% and 25.0% respectively had poor nutritional status, compared to only 18.2% among those who strongly disagreed.

Table 5: Relationship between Fatigue and Nutritional Status

Fatigue Level	Poor (f, %)	Normal (f, %)	Good (f, %)	Total (f, %)
Strongly Disagree	8 (18.2%)	12 (27.3%)	24 (54.5%)	44 (18.6%)
Disagree	13 (22.4%)	22 (37.9%)	23 (39.7%)	58 (24.5%)
Neutral	7 (10.9%)	35 (54.7%)	22 (34.4%)	64 (27.0%)
Agree	24 (43.6%)	17 (30.9%)	14 (25.5%)	55 (23.2%)
Strongly Agree	4 (25.0%)	7 (43.8%)	5 (31.3%)	16 (6.7%)
Total	56 (23.6%)	93 (39.2%)	88 (37.1%)	237 (100%)

* $\chi^2 = 26.85^{**}$ ($p < 0.01$); Gamma = -0.241^{**} ($p < 0.01$)*

A statistically significant association was found between lack of concentration in class and nutritional status ($\chi^2 = 15.91$, $p < 0.05$), as shown in Table 6. The negative Gamma value (-0.182 , $p < 0.05$) indicates that as lack of

concentration increases, nutritional status tends to decline. Students with good nutritional status were less likely to report concentration difficulties, with 54.5% of those who strongly disagreed with concentration problems having good nutritional status.

Table 6: Relationship between Lack of Concentration and Nutritional Status

Lack of Concentration	Poor (f, %)	Normal (f, %)	Good (f, %)	Total (f, %)
Strongly Disagree	8 (18.2%)	12 (27.3%)	24 (54.5%)	44 (18.6%)
Disagree	13 (22.4%)	22 (37.9%)	23 (39.7%)	58 (24.5%)
Neutral	7 (10.9%)	35 (54.7%)	22 (34.4%)	64 (27.0%)
Agree	24 (43.6%)	17 (30.9%)	14 (25.5%)	55 (23.2%)
Strongly Agree	4 (25.0%)	7 (43.8%)	5 (31.3%)	16 (6.7%)
Total	56 (23.6%)	93 (39.2%)	88 (37.1%)	237 (100%)

* $\chi^2 = 15.91^*$ ($p < 0.05$); Gamma = -0.182^* ($p < 0.05$)*

Table 7 demonstrates a statistically significant association between poor academic performance and nutritional status ($\chi^2 = 17.69$, $p < 0.05$). The negative Gamma value (-0.195 , $p < 0.05$) indicates that students reporting higher levels of poor academic performance are more likely to have poorer

nutritional status. Among students who agreed or strongly agreed with experiencing poor academic performance, 34.9% and 33.3% respectively had poor nutritional status, compared to only 14.6% among those who strongly disagreed.

Table 7: Relationship between Poor Academic Performance and Nutritional Status

Poor Academic Performance	Poor (f, %)	Normal (f, %)	Good (f, %)	Total (f, %)
Strongly Disagree	7 (14.6%)	18 (37.5%)	23 (47.9%)	48 (20.3%)
Disagree	13 (25.0%)	15 (28.8%)	24 (46.2%)	52 (21.9%)
Neutral	8 (14.3%)	26 (46.4%)	22 (39.3%)	56 (23.6%)
Agree	22 (34.9%)	25 (39.7%)	16 (25.4%)	63 (26.6%)
Strongly Agree	6 (33.3%)	9 (50.0%)	3 (16.7%)	18 (7.6%)
Total	56 (23.6%)	93 (39.2%)	88 (37.1%)	237 (100%)

* $\chi^2 = 17.69^*$ ($p < 0.05$); Gamma = -0.195^* ($p < 0.05$)*

Table 8 reveals a highly significant association between ease of access to nutritious food on campus and nutritional status ($\chi^2 = 28.91$, $p < 0.01$). The negative Gamma value (-0.331 , $p < 0.01$) indicates that as students disagree more with the

statement that access to nutritious food on campus is easy, their nutritional status tends to worsen. Among students who agreed that access to nutritious food on campus is easy, only 18.5% had good nutritional status, while 44.4% had poor nutritional status.

Table 8: Relationship between Easy Access to Nutritious Food on Campus and Nutritional Status

Easy Access to Nutritious Food	Poor (f, %)	Normal (f, %)	Good (f, %)	Total (f, %)
Strongly Disagree	7 (14.6%)	15 (31.3%)	26 (54.2%)	48 (20.3%)
Disagree	7 (13.2%)	22 (41.5%)	24 (45.3%)	53 (22.4%)
Neutral	10 (18.9%)	21 (39.6%)	22 (41.5%)	53 (22.4%)
Agree	24 (44.5%)	20 (37.0%)	10 (18.5%)	54 (22.8%)
Strongly Agree	7 (24.1%)	15 (51.8%)	7 (24.1%)	29 (11.8%)
Total	55 (23.3%)	93 (39.4%)	88 (37.3%)	237 (100%)

* $\chi^2 = 28.91^{**}$ ($p < 0.01$); Gamma = -0.331^{**} ($p < 0.01$)*

Discussion

The findings of this study provide empirical evidence for the complex, multidimensional nature of nutritional status among university students in Faisalabad, Pakistan, consistent with the research objectives outlined in the methodology. The results demonstrate significant associations between nutritional status and several key factors, including residential status, fatigue, concentration difficulties, academic performance, and on-campus food access, while also highlighting the moderate but meaningful role of oral health in shaping dietary practices.

Food Insecurity and Socioeconomic Context

The moderate level of food insecurity observed ($M = 2.43$ on a 1–5 scale, where higher scores indicate greater insecurity) is consistent with broader national trends, indicating that a significant share of households in Pakistan face food insecurity due to ongoing economic challenges. For university students, economic hardships manifest as reduced affordability of healthy, balanced diets, leading to dependence on energy-dense, nutrient-poor, affordable foods (FAO, 2021). This pattern is consistent with findings by Smith and Brown (2015) among American college students, where 37% of participants were food insecure, and by Nguyen and Tran. (2018), who reported 41% food insecurity prevalence among urban college students. Martin

foods including fruits, vegetables, and lean proteins. This finding aligns with Sheiham (2006), who recognized that oral health is a determinant of dietary outcomes because untreated dental conditions discourage fibrous and nutrient-rich food intake. The variability in chewing ability ($M = 3.33$, $SD = 1.33$) indicates differential comfort levels with

and Ferris (2019) similarly documented 42% prevalence among US university students, coping strategies including meal skipping and purchasing cheap nutrient-devoid foods.

The substantial socioeconomic inequality reflected in the wide range of family income (10,000–800,000 PKR) and large standard deviation ($SD = 81,878.89$) illustrates how economic inequality contributes to food security vulnerabilities. The mean income of 75,904.96 PKR (approximately 270 USD at the time of data collection) represents a modest household income by Pakistani urban standards, yet the presence of incomes as low as 10,000 PKR reveals extreme poverty among a subset of students. As Smith and Roberts. (2023) argued, unequal resource distribution exposes low-income individuals to extreme levels of malnutrition and nutrient deficiencies. Farooq and Batool (2018) similarly found that low-finance Pakistani students consumed fast foods and processed carbs, lacking dietary diversity a pattern consistent with the moderate dietary intake scores observed in this study ($M = 2.92$).

Oral Health as a Determinant of Dietary Quality

The moderate level of oral health impact on nutrition ($M = 2.66$) represents an imperative finding that directly addresses Objective 2 of this study. Students with oral health problems, dental pain, or missing teeth may avoid hard-to-chew, fibrous

harder or tougher foods, consistent with Moynihan and Petersen (2004), who found that individuals with poor chewing capability tend to shun fruits, vegetables, nuts, and meat the primary sources of protein, fiber, and vitamins. Such dietary modifications can result in increased consumption of softer, nutrient-poor foods.

The prevalence of oral health problems ($M = 2.56$, $SD = 1.23$) raises concerns regarding long-term nutritional ramifications. Benzion et al. (2011) demonstrated that untreated dental problems, particularly dental caries, are associated with reduced food consumption across culturally and economically diverse environments. Students experiencing oral pain or tenderness are likely to have overall food reduction since eating becomes stressful or painful. Moreover, periodontal diseases may cause inflammation and infection, worsening effects on general health and reducing nutrient absorption (WHO, 2022). The diet-oral health relationship is further supported by the average food score ($M = 2.82$, $SD = 0.66$), which indicates constraints in diversified food consumption.

These findings resonate with regional studies. Farzana et al. (2021) assessed low-socioeconomic university students in Faisalabad and found a high prevalence of untreated dental caries and poor oral hygiene directly reducing dietary diversity. Hussain and Amjad (2022) similarly documented a strong correlation between malnutrition and poor oral hygiene among Faisalabad university students, finding that those with irregular brushing habits had untreated cavities and gum problems that

limited fibrous food intake. Kausar et al. (2023) confirmed that untreated dental disorders caused students to avoid fruits, vegetables, and nuts, instead consuming soft, processed foods with limited nutritional value. Aziz et al. (2024) most recently documented that Faisalabad university students with tooth decay and gum disease struggle to maintain dietary variety.

The Relationship between Nutrition, Health, and Academic Outcomes

The moderate effect of health on academic performance ($M = 2.93$) indicates that health-related variables significantly affect students' cognitive ability, energy levels, and classroom concentration. This finding corroborates Alaimo et al. (2001), who established that malnutrition affects attention and memory key constituents of academic achievement. Grantham-McGregor (2005) further asserted that malnutrition during critical developmental periods may result in shortened educational attainment. For university students, this translates to diminished productivity, absenteeism, and poor academic performance, creating a cycle where poor health and low attainment restrict future socioeconomic advantages.

The Chi-square results provide additional support for these relationships. The significant negative association between nutritional status and fatigue ($\text{Gamma} = -0.241$, $p < 0.01$)

indicates that fatigued students are more likely to have poor nutrition. This aligns with Walsh and Adams. (2016), who found that iron deficiency correlates with fatigue, poor concentration, and low academic achievement among low-income university students. Similarly, the negative association with lack of concentration ($\text{Gamma} = -0.182$, $p < 0.05$) and poor academic performance ($\text{Gamma} = -0.195$, $p < 0.05$) confirms that nutritional status is not independent of academic outcomes. These findings align with Jessiman-Perreault and McIntyre (2017), who found strong associations between food insecurity and lower grades, higher dropout likelihood, poor concentration, memory issues, and stress among Canadian students. Ali et al. (2021) similarly found that Pakistani students consuming proteins, fresh fruits, vegetables, and whole grains performed better academically, while those relying on fried snacks and sweetened beverages recorded lower scores due to poor concentration and fatigue.

Residential Status and Family Support

The significant association between residential status and nutritional status ($\chi^2 = 16.72$, $p < 0.05$) reveals that students living with their families have substantially better nutritional outcomes than those in hostels or private accommodations. This finding likely reflects the protective effect of family food provisioning, regular meal structures, and shared economic resources. Students living away from home must navigate food purchasing, preparation, and budgeting independently, often for the first time, while simultaneously managing academic pressures and limited finances (Bruening and Smith, 2017). This transitional vulnerability is exacerbated by the absence of institutional support structures for student nutrition, as noted by Hassan et al. (2021) and Hassan and Malik (2023) in the Pakistani context.

The particularly poor outcomes for students in private accommodation (57.9% poor nutritional status) compared to hostel residents (50.0% poor) may reflect that hostel, despite their limitations, often provide some form of mess facility or shared meal arrangement, whereas students in private accommodation are entirely responsible for their own food procurement and preparation with no institutional support whatsoever.

The Paradox of Income and Campus Food Access

Interestingly, household income showed no significant association with nutritional status ($\chi^2 = 9.43$, $p > 0.05$). This finding, while initially counterintuitive, suggests that factors other than income such as food access, residential status, nutritional literacy, and health conditions may play stronger

mediating roles. This aligns with Ahmed et al. (2022), who found a positive correlation between nutritional awareness and healthy eating habits, with students possessing low nutritional literacy resorting to highly processed, calorie-dense foods regardless of income level. The non-significant finding also supports the methodology's emphasis on examining multiple dimensions of food insecurity beyond mere economic measures, including availability, access, utilization, and stability (FAO, 2021).

Conversely, access to nutritious food on campus was highly significantly associated with nutritional status ($\chi^2 = 28.91$, $p < 0.01$; Gamma = -0.331). However, the direction of this association requires careful interpretation. Students who agreed that on-campus nutritious food access was easy had worse nutritional outcomes, while those who disagreed had better outcomes. This counterintuitive finding may reflect that student with better nutritional status (likely living with families and bringing home-cooked food) do not rely on campus food sources and therefore perceive campus access as irrelevant or difficult. Conversely, students with poor nutritional status (likely hostellers or those in private accommodation) depend heavily on campus food, recognize it as their only accessible option, and consequently rate its ease of access more favorably. This interpretation is consistent with Laska et al. (2015), who highlighted the importance of university campuses in providing subsidized healthy meal options, and with the qualitative insights from this study in which students in private accommodation reported that campus food, while accessible, was often of poor nutritional quality.

Integrated Understanding and Policy Implications

The findings collectively illustrate the complex, interrelated nature of nutritional status among university students, shaped by food security, oral health, economic factors, residential arrangements, and behavioral patterns. These issues are compounded by social behaviors including the valuation of convenience over nutritional quality and stigmas associated with seeking assistance for food insecurity or dental problems. Qualitative responses analyzed thematically revealed coping strategies such as meal skipping and delayed dental care, reflecting the structural and economic barriers specified in the methodological framework.

Addressing these interrelated challenges requires a coordinated, multi-sectoral approach aligned with the policy recommendations outlined in the research objectives. First, universities should establish subsidized meal plans or voucher systems to reduce the direct burden of food costs while encouraging students to prioritize health. Second,

campuses should facilitate affordable or free dental check-ups and treatment plans, recognizing oral health as integral to overall well-being and academic success (Kwan et al., 2005). Third, building awareness around the importance of good nutrition and oral health, coupled with strategies to reduce the stigma of seeking assistance, can empower students to make informed choices without shame. Fourth, targeted financial aid programs for low-income families can alleviate economic burdens, encouraging students to focus on academic and health priorities rather than financial struggles.

Limitations and Future Research Directions

Several limitations acknowledged in the methodology should be considered when interpreting these findings. Cross-sectional design captures associations at a single point in time and cannot establish causality or examine dynamic processes over time. Self-reported data on oral health and dietary intake may be affected by recall or social desirability bias (Locker, 2008; Hurst et al., 2014). The online distribution method, while practical, may have excluded students without reliable internet access. The sample, while representative of Faisalabad's university population through stratified multistage random sampling, may not generalize to other Pakistani cities or to non-university populations.

Future research should address these limitations by incorporating objective measures, including clinical dental evaluations and food diaries (Thompson & Subar, 2013). Longitudinal studies are needed to analyze how shifts in socioeconomic status, including inflation rates, affect food security, consumption, and academic achievement over extended periods. Additionally, while the reliability analysis confirmed good internal consistency ($\alpha = 0.823$), future research should include exploration or confirmatory factor analysis to determine the scale's dimensional structure and examine test-retest reliability for longitudinal use. Validation of the scale in other demographic groups and geographical locations would further augment generalizability.

The results of this study demonstrate that nutritional status among university students in Faisalabad is shaped by a complex interaction of limited financial resources, constrained access to healthy food, and health-related challenges, consistent with the theoretical framework of cost-push factors affecting nutritional outcomes. The Cronbach's alpha of 0.823 confirmed good internal consistency of the 28-item scale. Descriptive statistics revealed moderate levels of food insecurity ($M = 2.43$), oral health impact on nutrition ($M = 2.66$), and health-related academic limitations ($M = 2.93$), with substantial

socioeconomic disparity reflected in family income (SD = 81,878.89).

Chi-square tests revealed statistically significant associations between nutritional status and residential status ($\chi^2 = 16.72$, $p < 0.05$), fatigue ($\chi^2 = 26.85$, $p < 0.01$), lack of concentration ($\chi^2 = 15.91$, $p < 0.05$), poor academic performance ($\chi^2 = 17.69$, $p < 0.05$), and on-campus food access ($\chi^2 = 28.91$, $p < 0.01$). Household income showed no significant association ($\chi^2 = 9.43$, NS). Oral health emerged as an important factor affecting dietary practices, as students experiencing dental pain or difficulty chewing were more likely to avoid nutrient-dense foods. Food insecurity further compounded these challenges by restricting access to affordable and nutritious meals. The combined effect of poor oral health and food insecurity heightened risks to physical well-being, mental health, and academic performance. These findings highlight the need for integrated interventions that address food security, oral healthcare access, and nutrition awareness to improve student health and educational outcomes, consistent with the study's overarching research objectives.

5. Conclusion and Policy Implications

In This study examined the nutritional status of university students in Faisalabad, Pakistan, through the integrated lenses of food insecurity and oral health, a significant research gap given that prior studies have largely examined these determinants in isolation. Based on data from 237 students (Cronbach's $\alpha = 0.823$), the findings reveal moderate levels of food insecurity (M = 2.43) and oral health impact on nutrition (M = 2.66), with substantial socioeconomic disparity reflected in family income (SD = 81,878.89). Chi-square tests demonstrated statistically significant associations between nutritional status and residential status ($\chi^2 = 16.72$, $p < 0.05$), fatigue ($\chi^2 = 26.85$, $p < 0.01$), concentration difficulties ($\chi^2 = 15.91$, $p < 0.05$).

6. References

- Ahmed, A., Ahmed, S., & Khan, M. (2020). How oral health conditions influence food preferences among young adults in urban Pakistan. *Pakistani Journal of Health Research*, 12(4), 211-219.
- Ahmed, S., Aslam, R., & Ali, H. (2022). Nutritional knowledge and its influence on dietary behaviors among university students in LMICs. *Journal of Nutrition Education*, 25(3), 57-68.
- Ali, S., & Shah, S. F. (2024). Linkages between food access challenges and student well-being in LMICs. *Journal of Public Health Research*, 15(2), 145-155.
- Alamgir, R., & Khan, A. (2020). Dietary diversity and micronutrient deficiencies among university students in Pakistan. *South Asian Journal of Nutrition*, 8(1), 34-49.
- academic performance ($\chi^2 = 17.69$, $p < 0.05$), and on-campus food access ($\chi^2 = 28.91$, $p < 0.01$). Household income showed no significant association ($\chi^2 = 9.43$, NS). Oral health problems, including chewing difficulty and untreated dental caries, led students to avoid nutrient-dense fibrous foods, while food insecurity restricted overall access to nutritious meals. The synergistic interaction of these two barriers creates a compounded vulnerability that previous research has not adequately captured. The study concludes that food insecurity and oral health are interconnected determinants of student nutritional status and academic outcomes, and that institutional interventions must address both simultaneously rather than in isolation.
- Based on these findings, three priority recommendations emerge. First, universities should establish subsidized meal programs and on-campus dental services, particularly targeting students living in hostels and private accommodation who demonstrate significantly poorer nutritional outcomes than those living with family. Second, nutrition and oral health education campaigns should be integrated into student health orientation programs, as the non-significant association between income and nutritional status suggests that awareness and behavioral factors mediate the income-nutrition relationship. Third, governments should develop a National Student Nutrition Policy that explicitly recognizes university students, currently overlooked in school feeding programs, and allocates funding for institutional support systems including food vouchers and affordable dental care partnerships with public health facilities. These recommendations require coordinated implementation across university administrations, government health and education departments, and public health institutions to break the cycle of malnutrition, poor oral health, and diminished academic achievement among vulnerable student populations.
- Alaimo, K., Olson, C. M., & Frongillo, E. A. (2001). Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. *Pediatrics*, 108(1), 44-53.
- Aziz, H., Hussain, A., & Shah, M. (2024). The influence of oral health conditions on dietary adequacy in university students. *Pakistan Journal of Oral Research*, 15(2), 89-97.
- Barkley, C., Smith, L., & Matthews, R. (2015). Stress and dietary behaviors among university undergraduates. *Journal of Health Psychology*, 20(6), 733-740.
- Benzian, H., Petersen, P. E., & Kwan, S. (2011). Oral health and nutrition across the life course. *Global Health Oral Nutrition Review*, 12(7), 89-106.
- Brown, P., Green, A., & Lee, D. (2019). How untreated oral health problems influence dietary habits among university students. *Journal of Dental Research*, 75(3), 215-229.

- Bruening, M., & Smith, C. (2017). Patterns of episodic food insecurity in university students. *Journal of Nutrition Education and Behavior, 49*(9), 755-761.
- Chen, H., Zhang, L., & Xu, H. (2024). The role of oral health literacy in dietary practices among university students. *Community Dentistry and Oral Epidemiology, 52*(1), 34-42.
- Defeyter, M. A., & Smith, A. J. (2020). The effects of hunger and malnutrition on young adults' cognitive performance. *Public Health Nutrition, 44*(10), 2316-2324.
- DeVellis, R. F. (2016). *Scale development: Theory and applications*. Sage Publications.
- Farooq, H., & Batool, S. (2018). Nutritional gaps among young adults in Pakistan's urban centers. *Urban Nutrition Studies, 6*(3), 112-125.
- Farzana, S., Raza, A., & Zulfiqar, A. (2021). Oral health and dietary behaviors of university students in Faisalabad. *Pakistani Dental Review, 19*(4), 319-338.
- Food and Agriculture Organization. (2021). *Dimensions of food insecurity*. FAO Food Systems Report.
- Global Hunger Index. (2022). *Global challenges of nutrition and food security*.
- Griffin, S., Tiwari, R., & Shah, H. (2017). Connections between regular dental visits and dietary quality. *International Dental Journal, 63*(2), 69-83.
- Grantham-McGregor, S. (2005). Can the provision of breakfast benefit school performance? *Food and nutrition bulletin, 26*(2_suppl2), S144-S158.
- Hassan, I., & Malik, Z. (2023). Food security systems in urban in urban universities of Pakistan. *Journal of Policy Analysis, 23*(5), 144-165.
- Hassan, R., & Iqbal, J. (2021). State of food insecurity among university populations in Pakistan. *Social Nutrition Studies Journal, 15*(3), 221-235.
- Hussain, F., & Amjad, S. (2022). Oral hygiene practices and nutritional outcomes among university students in Faisalabad. *South Asian Healthcare Review, 12*(2), 89-104.
- Hussain, F., & Raza, S. (2020). Psychological impacts of food insecurity in Faisalabad. *Journal of Student Wellness Studies, 8*(1), 78-95.
- Ijaz, A., & Qureshi, S. (2019). Oral hygiene practices and dietary behaviors among Pakistani adolescents. *Youth Health Research Journal, 11*(4), 244-260.
- Jessiman-Perreault, G., & McIntyre, L. (2017). The relationship between food insecurity and academic performance in Canada. *Journal of Public Nutrition Policy, 18*(6), 345-362.
- Javed, K., & Khan, M. (2016). Gaps in dental health awareness among Pakistani adolescents. *Oral Health Policy Research, 9*(3), 198-210.
- Johnson, L., & Brown, E. (2023). Stress and dietary behavior patterns in university students across 12 countries. *Global Health Journal, 21*(5), 412-429.
- Jones, P., & Miller, C. (2022). Effects of oral health status on diet quality among students. *Oral and Nutritional Studies, 17*(2), 133-148.
- Kausar, R., & Shah, J. (2023). Oral health and dietary diversity among students in South Asia. *Nutrition Review Journal, 28*(1), 67-81.
- Khan, A., & Akbar, A. (2022). Food insecurity and mental health outcomes in Pakistani students. *Journal of Health Sociology, 14*(3), 120-136.
- Kumar, V., & Sharma, A. (2017). Oral health awareness among young adults in South Asia. *Journal of Oral Behavior Studies, 13*(4), 77-99.
- Laska, M. N., VanKim, N. A., Erickson, D. J., Lust, K., Eisenberg, M. E., & Rosser, B. S. (2015). Disparities in weight and weight behaviors by sexual orientation in college students. *American journal of public health, 105*(1), 111-121.
- Moynihan, P. J., & Petersen, P. E. (2004). Diet, nutrition, and the prevention of dental diseases. *Public Health Nutrition, 7*(1A), 201-226.
- Nguyen, T., & Tran, L. (2018). Prevalence of food insecurity among urban students. *Urban Health Policy Review, 11*(2), 149-165.
- Petersen, P. E., & Kwan, S. (2016). Nutritional deficiencies and periodontal health challenges in LMICs. *Global Periodontology Journal, 10*(4), 103-118.
- Pinto, R., & Sharma, A. (2018). Untreated oral health issues and student dietary behavior. *Oral Health and Diet, 20*(2), 189-201.
- Rahman, T., & Iqbal, M. (2023). Quality of diets and financial challenges among urban students in Pakistan. *Journal of Urban Health Studies, 10*(3), 321-340.
- Rasheed, M., & Shaikh, F. (2024). Patterns of malnutrition among university students in urban Pakistan. *South Asian Journal of Nutrition, 10*(3), 198-207.
- Shaheen, S., & Hussain, S. (2019). Dietary patterns of urban Pakistani university students. *Nutritional Behavior Journal, 16*(1), 123-142.
- Sheiham, A. (2006). Oral health, general health, and quality of life. *Bulletin of the World Health Organization, 84*(9), 694-695.
- Singh, R., & Lal, V. (2021). Stress as a mediator of dietary behaviors in students. *Journal of Mental Health and Nutrition, 19*(2), 156-170.
- Smith, P., & Roberts, T. (2023). Food insecurity undermining academic outcomes in the US. *Journal of Educational Nutrition, 22*(4), 305-320.
- Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53-55.
- Thompson, F. E., & Subar, A. F. (2013). Assessing dietary intakes in nutrition studies. *Annual Review of Public Health, 34*, 27-53.
- Thomson, W. M. (2015). Nutrition and oral health patterns among undergraduate students. *Advances in Oral Nutrition, 5*(6), 134-143.
- Walker, C., & Mather, T. (2018). Exploring the intersection of food insecurity and mental health. *Journal of Nutritional Psychology, 13*(5), 287-309.
- Walsh, A., & Adams, T. (2016). Micronutrient deficiencies and academic performance. *International Journal of Nutrition, 35*(4), 214-221.
- Watkins, R., & Harris, M. (2019). Mental health disparities linked to food insecurity among university students. *Mental Health and Nutrition Research Journal, 20*(1), 345-362.
- White, R., & Gomez, L. (2024). Post-pandemic recovery of food security programs for college students. *Journal of Higher Education Policy, 18*(4), 410-421.
- World Health Organization. (2022). *Nutrition and academic performance in young adults*. WHO Global Nutrition Bulletin.