



Evaluating Food Safety Knowledge: A Multi-institutional Survey among Tanzanian University Students

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ABSTRACT

Food safety is a significant global health issue, particularly in Africa, where inadequate regulations and sanitation contribute to foodborne illnesses. Studies show limited food safety knowledge among university students in Tanzania, affecting their health and academic performance. Enhanced surveillance and education are essential for improving food safety measures and public health outcomes. This study evaluated the knowledge of students about food safety in three university communities in Iringa Municipality, Tanzania. A cross-sectional study from June to July 2024 involved 660 university students out of 16,520 calculated by the Yamane formula. Purposeful and simple random sampling methods were used to select study areas and students. Data was collected through questionnaires featuring 20 multiple-choice questions. Analysis was conducted with the Statistical Package for the Social Sciences (SPSS) version 26, focusing on frequencies, descriptive statistics, and significant relationships between variables. This study found that 98.3% of university students were aware of the symptoms of foodborne illnesses, and 95.5% understood the importance of handwashing. However, awareness of the risks associated with raw fish was notably low, with only 38.8% correct responses. Overall, 97% of students demonstrated adequate knowledge, with a mean score of 82.47%. Although both were found with adequate knowledge, slight differences were observed between health-related (84.35%) and non-health-related (80.69%) students, but no significant associations were found with all demographic factors. The study found overall adequate food safety knowledge among students, with health program students performing slightly better. Critical areas, particularly related to raw food hazards, require further attention for improvement.

Keywords: Food Safety, Knowledge, Multi-institutional Survey, University Students

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INTRODUCTION

Food safety is a critical public health concern globally, particularly in the context of foodborne illnesses, which are defined as diseases resulting from the consumption of contaminated food. The World Health Organization (WHO) estimates that approximately 600 million people, or nearly 1 in 10 individuals, suffer from foodborne illnesses each year, leading to significant morbidity and mortality worldwide (**Akkina et al., 2022**).

The epidemiology of foodborne illnesses varies across regions, with specific pathogens and food sources implicated in outbreaks. In Africa, foodborne illnesses are significant public health issues exacerbated by inadequate food safety regulations, poor sanitation, and limited access to clean water. A review highlighted that animal-source foods, including meats, dairy, and eggs, are major contributors to the burden of foodborne diseases in Africa, accounting for a substantial proportion of illnesses (**Lee & Yoon, 2021**). In Tanzania, the epidemiology of foodborne illnesses reflects similar trends, with common pathogens, including Salmonella, Escherichia coli, and Campylobacter, frequently implicated in outbreaks (**Masiku et al., 2024**). The lack of robust surveillance systems in many African countries complicates understanding the actual burden of foodborne diseases, as many cases go unreported (**Sharaheeli et al., 2023**).

In Africa, food safety knowledge is particularly pressing due to the high incidence of foodborne diseases, often linked to inadequate food handling practices. A study in Ghana found that university students had limited food safety knowledge, which was associated with their socio-demographic characteristics and academic backgrounds (**Yee et al., 2022**). This situation is echoed in Tanzania, where research indicates that only a small percentage of university students possess good food safety practices, with significant disparities observed between genders (**Masiku et al., 2024**). The reliance on informal food safety information from family and friends worsens the issue, as these sources may not provide accurate or comprehensive guidance, impacting their understanding (**Moy et al., 2018; Sharma et al., 2018**).

Recent studies have emphasized the importance of effective surveillance and response systems to combat foodborne illnesses. For instance, the integration of whole-genome sequencing in outbreak investigations has improved the ability to trace the sources of contamination and identify specific pathogens involved in outbreaks (**Vaughn et al., 2020**). This approach has been particularly beneficial in regions like the United States, where coordinated efforts among health departments have enhanced foodborne illness surveillance and response (**White et al., 2022**). However, similar advancements are needed in African contexts, including Tanzania, to strengthen food safety measures and improve public health outcomes.

Food safety among students and the university or college environment is affected by a lack of adequate knowledge and inappropriate food handling practices, eventually affecting the health status of students (**Luo et al., 2019**). The student population is most vulnerable to foodborne diseases given their transition from home to living alone, poor food handling practices, and local policies regulating food vendors around university premises (**Obande & Young, 2020**). Consequently, foodborne diseases among university students may lead to poor class attendance, low concentration, and poor academic performance (**Whatnall et al., 2020**). There is still limited information on the knowledge of food safety among university students in Tanzania (**Masiku et al., 2024**).

This study aimed to evaluate the knowledge of students about food safety in three university communities in Iringa Municipality, Tanzania. By identifying knowledge gaps, targeted food safety education and training interventions can be developed. Ultimately, the goal is to improve food safety standards, reduce the risk of foodborne illnesses, and contribute to the overall public

health and well-being of university students.

MATERIALS AND METHODS

Study area

The study took place in three university communities in the Iringa municipal council of Tanzania, including Ruaha Catholic University (RUCU), Mkwawa University College of Education (MUCE), and the University of Iringa (UoI). These higher education institutions serve around 16,520 students in need of food services from both on-campus facilities and off-campus food handlers in the surrounding areas. Iringa municipal council is the region's administrative capital, characterized by its urban nature. According to the 2022 census, the municipality has a population of 202,490 residents. Geographically, it is bordered by the Iringa Rural and Kilolo district councils, located between latitudes 7.7° to 7.875° south of the Equator and longitudes 35.620° to 35.765° east of the Greenwich Meridian (Mbunda et al., 2023; Ntungwa et al., 2024).

Study design

A cross-sectional study was conducted from June to July 2024 to evaluate the knowledge of university students regarding food safety.

Sample size determination

The selected three universities collectively had 16,520 students. To determine the requisite sample size, the Yamane formula was employed, applying a margin of error of 4% at a 95% confidence level.

$$\text{Yamane formula: } n = \frac{N}{1+N(e)^2}$$

Where:

n = Sample size

N = Population size

e = Margin of error (expressed as a decimal)

$$\text{Sample size (n)} = \frac{16,520}{1+16,520(0.04)^2} = 602 \text{ Students}$$

The calculated sample size was determined to be 602; however, a total of 660 participants were engaged in order to enhance the reliability and robustness of the findings.

Sampling procedures

In this study, purposeful sampling was used to select all three universities in Iringa municipality, ensuring relevant institutions were included. Subsequently, simple random sampling was applied to choose participants from various strata, including different universities, years of study, and health-related versus non-health-related programs. This two-stage approach

minimized selection bias and enhanced the representativeness of the sample, allowing for a comprehensive analysis of the data gathered.

Data collection

The study utilized structured questionnaires to systematically collect data regarding participants' comprehension of food safety principles. The questionnaires featured 20 multiple-choice questions with three options each, where respondents were required to select the most appropriate answer for knowledge assessment. This approach aimed to identify knowledge gaps, ultimately contributing to enhanced food safety education and interventions within the targeted community.

Data analysis

Data analysis was performed utilizing version 26 of the Statistical Package for the Social Sciences (SPSS). This analysis encompassed the examination of frequencies and percentages, descriptive statistics, as well as the assessment of significant relationships pertaining to the knowledge of university students evaluated in this study.

Definitions and scoring

Participants who scored 60% or higher on the food safety knowledge questions were considered to have adequate knowledge, indicating a good understanding of the subject. Those who scored below 60% were classified as having inadequate knowledge, revealing their understanding gaps.

Ethical considerations

Ruaha Catholic University (RUCU) has granted ethical approval for this research, referenced as RU/RPC/RP/2024/11. Permission to conduct research within the premises of the three universities was authorized by the offices of the deputy vice-chancellors for academics. Informed consent was obtained from all participants involved in the study. All data collected were managed with the utmost regard for confidentiality, ensuring that no personal information was disclosed.

RESULTS

Demographic characteristics among university students

Among the involved participants, the age distribution reveals that the largest group falls within the 23-27 years range, comprising 346 (52.4%) students of the total sample followed by 244 (37.0%) students aged 18-22 years. Regarding gender, the results indicate a higher representation of females, with 388 (58.8%) students compared to 272 (41.2%) males. Regarding education level, a significant majority of the students are undergraduates, totaling 565 (85.6%) students, while 95 students (14.4%) were postgraduate students, underscoring the predominance of undergraduate education within this sample.

Concerning years of study, 146 (22.1%) students were first-year students, followed by 269 (40.8%) students in the second year. The analysis reveals that 490 (74.2%) students attend private universities, compared to 170 (25.8%) students enrolled in public institutions. Regarding residency, most 487 (73.8%) students live off-campus, while 173 (26.2%) students reside on-campus. Lastly, examining the monthly allowance, 336 students (50.9%) received less than TZS 100,000, while smaller 65 (9.8%) students earned more than TZS 300,000, as shown in **Table 1**.

Table 1: Demographic characteristics among university students (N = 660)

Demographic characteristics	Frequency (n)	Percent (%)
Age		
Under 18 years	3	0.5
18-22 years	244	37.0
23-27 years	346	52.4
28-32 years	48	7.3
33 years and above	19	2.9
Gender		
Male	272	41.2
Female	388	58.8
Education level		
Undergraduate student	565	85.6
Postgraduate student	95	14.4
Year of study		
First year	146	22.1
Second year	269	40.8
Third year	238	36.1
Fourth year	7	1.1
Type of university		
Public	170	25.8
Private	490	74.2
Residency status		
On-campus	173	26.2
Off-campus	487	73.8
Monthly allowance (Tsh)		
Less than 100,000	336	50.9
100,000 - 200,000	197	29.8
200,001 - 300,000	62	9.4
More than 300,000	65	9.8
Preferred source of food		
On-campus cafeteria	176	26.7
Off-campus cafeteria	189	28.6
Street vendors	84	12.7
Self-cooked meals	211	32.0
Program of study		
Health-related program	321	48.6
Non-health-related program	339	51.4

Distribution of knowledge among university students

The data from **Table 2** indicates a commendable level of knowledge among students regarding fundamental food safety. Notably, 649 (98.3%) students correctly identified common symptoms of foodborne illnesses. Additionally, the question regarding the primary reason for washing hands before consuming food reported a high correct response, with 630 (95.5%) students answering correctly. Furthermore, 632 (95.8%) students demonstrated knowledge of the

proper method for cleaning fruits and vegetables before consumption.

Conversely, the results reveal critical gaps in knowledge that warrant attention. The question about the potential health risks of consuming raw fish received the lowest correct response rate, with only 256 (38.8%) students answering correctly, indicating a substantial lack of awareness regarding the specific dangers linked to such food items.

Table 2: Distribution of knowledge among university students (N = 660)

Knowledge questions	Knowledge responses	
	Correct n (%)	Incorrect n (%)
What is the primary reason for washing hands before consuming food?	630 (95.5)	30 (4.5)
What is cross-contamination?	610 (92.4)	50 (7.6)
Which practices help to prevent foodborne illnesses?	613 (92.9)	47 (7.1)
Which symptom is commonly associated with foodborne illness?	649 (98.3)	11 (1.7)
Why should you avoid eating raw or undercooked eggs?	617 (93.5)	43 (6.5)
What should you do if you suspect food poisoning?	593 (89.8)	67 (10.2)
Why is it important to keep raw meat separate from other foods?	628 (95.2)	32 (4.8)
What is the maximum time perishable food should be left out at room temperature?	356 (53.9)	304 (46.1)
Why should food handlers avoid using the same cutting board for raw meat and vegetables?	625 (94.7)	35 (5.3)
How can you ensure that leftovers are safe to eat?	478 (72.4)	182 (27.6)
What should you do if you see a food handler not following hygiene practices?	439 (66.5)	221 (33.5)
What is the danger of not cooking food to its recommended temperature?	596 (90.3)	64 (9.7)
Why should food handlers avoid touching their face while handling food?	619 (93.8)	41 (6.2)
What is the most common cause of foodborne illnesses?	509 (77.1)	151 (22.9)
How can you detect if food has spoiled?	596 (90.3)	64 (9.7)
What is the potential health risk of consuming raw fish?	256 (38.8)	404 (61.2)
What health problem can Salmonella infection cause?	482 (73.0)	178 (27.0)
How should you clean fruits and vegetables before eating?	632 (95.8)	28 (4.2)
What is the best way to prevent contamination when storing food?	519 (78.6)	141 (21.4)
What should you do if food smells off but looks fine?	439 (66.5)	221 (33.5)

Knowledge levels among university students

The results from the **Figure** show that 97% of students possess adequate knowledge, while only 3% have inadequate knowledge. This indicates a generally strong understanding of food safety knowledge among university students.

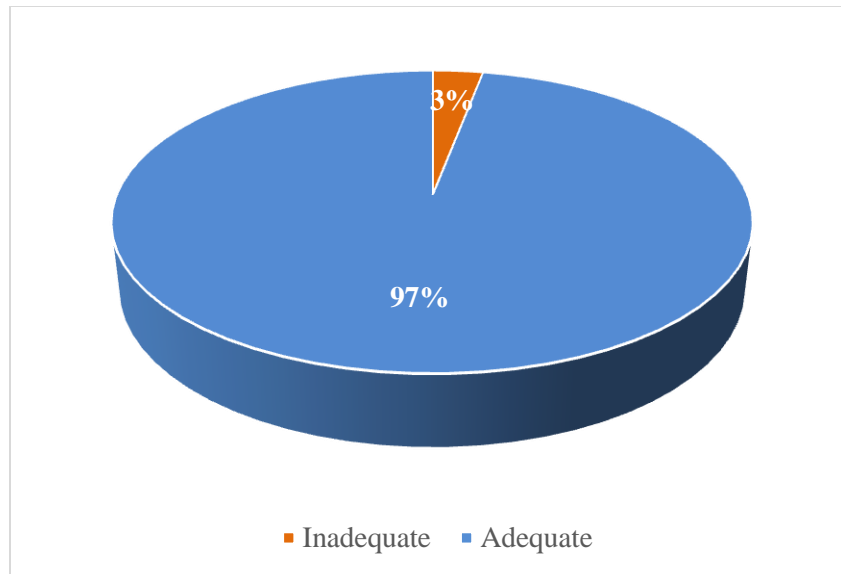


Figure: Knowledge levels among university students

Descriptive statistics of knowledge score among university students

The study demonstrated an overall mean score of 82.47% among participants, indicating a generally satisfactory level of knowledge. The standard deviation of 10.73% reflects moderate variability in the scores obtained. The minimum score recorded was 25%, suggesting that some individuals performed significantly below the average. In comparison, while both groups achieved an adequate level of knowledge, students enrolled in health-related programs achieved a slightly higher mean score of 84.35%, which is higher than the overall mean. In contrast, students in non-health-related programs attained a mean score of 80.69%, which is lower than the overall mean, as illustrated in **Table 3**.

Table 3: Descriptive statistics of knowledge score in percentage among university students in health and non-health programs (N = 660)

Programs of study	N	Mean	Std. Deviation	Minimum	Maximum
Health-related programs	321	84.35	9.994	25	100
Non-health-related programs	339	80.69	11.102	30	100
Total	660	82.47	10.727	25	100

Bivariate analysis of factors associated with levels of food safety knowledge among university students

The analysis shows that all predictor variables examined, including age, gender, education level, year of study, type of university, residency status, monthly allowance, and preferred source of food, do not have a significant relationship with levels of food safety knowledge among university students. The p-values for all variables were above the usual significance threshold of 0.05, indicating a lack of significant association, as described in **Table 4**. Consequently, binary logistic regression was not further tested, as the absence of significant relationships suggests that these predictors may not effectively explain variations in levels of food safety knowledge among students.

Table 4: Bivariate analysis of factors associated with levels of food safety knowledge among university students (N = 660)

Predictor variables	Level of knowledge		Chi-square	P-value
	Adequate	Inadequate		
Age				
Under 18 years	3 (0.5)	0 (0.0)		
18-22 years	238 (36.1)	6 (0.9)		
23-27 years	333 (50.5)	13 (2.0)	2.809	0.59
28-32 years	48 (7.3)	0 (0.0)		
33 years and above	18 (2.7)	1 (0.2)		
Gender				
Male	263 (39.8)	9 (1.4)	0.122	0.727
Female	377 (57.1)	11 (1.7)		
Education level				
Undergraduate student	547 (82.9)	18 (2.7)	0.323	0.57
Postgraduate student	93 (14.1)	2 (0.3)		
Year of study				
First year	144 (21.8)	2 (0.3)		
Second year	264 (40.0)	5 (0.8)	7.635	0.054
Third year	225 (34.1)	13 (2.0)		
Fourth year and above	7 (1.1)	0 (0.0)		
Type of university				
Public	163 (24.7)	7 (1.1)	0.921	0.337
Private	477 (72.3)	13 (2.0)		
Residency status				
On-campus	167 (25.3)	6 (0.9)	0.153	0.696
Off-campus	473 (71.7)	14 (2.1)		
Monthly allowance (Tsh)				
Less than 100,000	325 (49.2)	11 (1.7)		
100,000 - 200,000	193 (29.2)	4 (0.6)	1.302	0.729
200,001 - 300,000	60 (9.1)	2 (0.3)		
More than 300,000	62 (9.4)	3 (0.5)		
Preferred source of food				
On-campus cafeteria	172 (26.1)	4 (0.6)		
Off-campus cafeteria	184 (27.9)	5 (0.8)	1.655	0.647
Street vendors	82 (12.4)	2 (0.3)		
Self-cooked meals	202 (30.6)	9 (1.4)		
Program of study				
Health-related program	315 (47.7)	6 (0.9)	2.867	0.09
Non-health-related program	325 (49.2)	14 (2.1)		

P<0.05 is statistically significant

DISCUSSION

This current study reported a mean score of 82.47%, indicating a generally adequate level of knowledge among university students on food safety knowledge, and 97% of students possess adequate knowledge, while only 3% have inadequate knowledge. The findings of this study align with a related investigation conducted by Masiku et al. in the Kilimanjaro region of Tanzania, which revealed that 82.6% of the evaluated students demonstrated a commendable understanding of food safety (**Masiku et al., 2024**). These results exhibit a close resemblance to findings from other nations. For instance, a study in Pakistan indicated that most university students had adequate knowledge of food safety (**Ullah et al., 2020**). Additionally, a recent examination conducted in Ghana found that most participants achieved scores ranging from 80% to 100% on food safety knowledge assessments, highlighting a relatively high level of awareness among students in that region (**Lawal, 2023**).

In contrast, food safety knowledge appears to be notably lower in certain Arab countries. A study conducted among Palestinian university students indicated insufficient food safety knowledge, with many participants exhibiting inadequate practices (**Hussien et al., 2022**). In Lebanon, university students achieved an average score of 53.6% on food safety knowledge assessments, highlighting a significant deficiency in their understanding of food safety principles (**Hassan et al., 2018**). This pattern is further reflected in Jordan, where university students demonstrated low levels of food safety knowledge during the COVID-19 pandemic (**Hussien et al., 2022**). Additionally, research in Ethiopia revealed that only 35.7% of college students possessed a good understanding of food safety, underscoring the necessity for improved educational initiatives (**Azanaw et al., 2021**). In Kuwait, a study reported an even lower overall food safety knowledge score of 35.5%, indicating widespread gaps in understanding among students (**Ashkanani et al., 2021**).

This study found that an impressive 649 (98.3%) students accurately identified common symptoms associated with foodborne illnesses, demonstrating a strong awareness of food safety's health implications. In contrast, a study conducted in Pakistan found that only 55.2% of university students were knowledgeable about the symptoms of foodborne diseases (**Ullah et al., 2020**). Moreover, a study in China revealed that while students had a good understanding of food safety practices, their knowledge of foodborne pathogens was significantly lower, suggesting that awareness of symptoms does not always correlate with overall food safety knowledge (**Ma et al., 2019**).

In response to the inquiry regarding the primary reason for washing hands prior to food consumption, 95.5% of students provided correct answers. Similarly, a study conducted in Malaysia revealed that 92.5% of respondents acknowledged the importance of handwashing before engaging in food handling, reflecting a robust awareness of hygiene practices among students (**Ramli, 2024**). This finding is consistent with research conducted in Saudi Arabia, where approximately 95% of students recognized the critical role of hand hygiene in preventing disease transmission (**Almoslem et al., 2021**).

About 38.8% of students answered correctly on the potential health risks of consuming raw fish, indicating a substantial lack of awareness regarding the specific dangers linked to such food items. In a similar context, a study conducted among university students in Canada revealed that only 49% of participants recognized the risks associated with consuming raw or undercooked foods, including fish (**Courtney et al., 2016**). This finding underscores the widespread gaps in knowledge regarding food safety among students, particularly concerning high-risk foods.

Additionally, a survey of students at the University of Maine indicated that less than 30% of participants correctly identified several high-risk foods, including raw fish, which further emphasizes the need for targeted education (**Ferk et al., 2015**). Furthermore, a study in Ethiopia indicated that only 25% of students were aware of the health risks associated with consuming raw fish, highlighting significant gaps in food safety knowledge in that region (**Azanaw et al., 2021**). This disparity emphasizes the variability in food safety awareness among students from different geographical and educational backgrounds.

Conversely, a study in Saudi Arabia found that 62.5% of students were aware of the risks associated with consuming raw fish and other high-risk foods (**Al-Mohaithef, 2021**). Furthermore, a study among veterinary medicine students in Bulgaria revealed that 85.06% of participants had a high level of food safety knowledge, which included awareness of the risks associated with consuming raw fish (**Sharma et al., 2018**). This suggests that students in specialized programs may have better knowledge due to the nature of their studies, reinforcing the need for comprehensive food safety education across disciplines.

The investigation into the relationship between various predictor variables and food safety knowledge among university students has yielded mixed results across different studies. In this current study, all factors, including age, gender, education level, year of study, type of university, residency status, monthly allowance, and preferred food source, had no significant associations with food safety knowledge levels among university students. This finding aligns with a study by Ncube et al., which found that the level of food safety knowledge was not significantly influenced by socio-demographic factors, including age and gender, in a lower-middle-income country (**Ncube et al., 2020**).

Conversely, some studies have reported contrasting findings, suggesting that certain socio-demographic factors can indeed influence food safety knowledge. For example, Vuksanović et al. noted differences in food safety knowledge among students from different universities, implying that educational environment and institutional factors may shape students' knowledge (**Vuksanović et al., 2022**). Additionally, Moy et al. found that students who received formal education in food safety exhibited significantly higher levels of knowledge about food safety compared to those who did not (**Moy et al., 2018**). This suggests that while demographic factors may not be significant, educational interventions could enhance food safety knowledge among students.

Furthermore, this study revealed that while both groups achieved an adequate level of knowledge, health-related program students scored a mean of 84.35%, slightly above the overall mean, compared to non-health-related program students who scored 80.69%, below the overall mean. The results contrast with the study of Cumhur which found that students specializing in health and food-related fields had an average food safety knowledge score of 78.46%, while those from non-health disciplines scored significantly lower at 59.91% (**Cumhur, 2021**). However, this study also highlights that despite the apparent advantage for health-related students, the gap may not be as pronounced as expected, indicating that non-health students may also acquire substantial food safety knowledge through other means, such as personal interest or informal education.

Moreover, Ullah et al. found that health-related students reported significantly higher food safety knowledge scores than their non-health counterparts, which aligns with the expectation that health education would enhance knowledge in this area (**Ullah et al., 2020**). However, this study also points out that the curriculum's effectiveness in translating knowledge into practice remains a critical area for improvement, as many students, regardless of their field of study, exhibited gaps in practical food safety behaviors.

CONCLUSION

The study concludes that university students generally display a commendable level of knowledge regarding food safety, as evidenced by high rates of correct responses to key questions. Specifically, a remarkable 98.3% of students identified common symptoms of foodborne illnesses, while 95.5% understood the importance of handwashing before meals. However, there are notable gaps in knowledge, particularly concerning the health risks associated with consuming raw fish, where only 38.8% of students answered correctly.

Overall, the mean knowledge score of 82.47% indicates an adequate understanding of food safety among participants, with health-related program students achieving slightly higher scores than their peers in non-health-related programs. Despite the generally high levels of knowledge, the study found no significant relationships between all demographic factors and food safety knowledge. While university students exhibit a solid foundation of knowledge in food safety, there are critical areas that require further attention to bolster their understanding and awareness, especially concerning the potential hazards of consuming raw food products. Addressing these gaps is important for improving overall food safety knowledge within this demographic.

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