




## Research

# Knowledge, attitude, and food safety practices among university students in Kilimanjaro region, northern Tanzania

Geni-theresia T. Masiku<sup>1</sup>  · Kelvin F. Mwijage<sup>1</sup> · Nyakorema L. Ryoba<sup>1</sup> · Noel J. Ngulinzila<sup>1</sup> · Neema T. Mgimba<sup>1</sup> · Maria M. Njambilo<sup>1</sup> · Laura J. Shirima<sup>3</sup>  · Innocent B. Mboya<sup>4</sup>  · Rehema A. Mavura<sup>2</sup>

Received: 20 May 2024 / Accepted: 1 October 2024

Published online: 14 October 2024

© The Author(s) 2024 [OPEN](#)

## Abstract

Food safety is a public health concern worldwide due to an increased morbidity and mortality risk associated with the outbreak of food-borne diseases. This study aimed to assess knowledge, attitude, and food safety practices (KAP) among university students in northern Tanzania. This is interesting because it allows data to be collected for creating awareness on safety, sanitation, and quality of food available within and outside the university environments. We conducted a cross-sectional study among 407 university students in Kilimanjaro region and all authors participated equally. Participants completed an online, self-administered questionnaire. Data was analyzed using SPSS version 25 and summarized using descriptive statistics. The Chi-squared test compared the proportion of KAP by participant characteristics and the multiple logistic regression model used to determine the associated factors. Participants had a mean age (standard deviation) of 23.2 (2.6) years, 51.4% were males, and 83% were < 25 years. The overall proportion of good knowledge, attitude, and food safety practices were 82.6, 78.4, and 31.9%, respectively. Higher odds of knowledge and attitude on food safety were students from KCMUCo (OR = 2.36; 95% CI 1.33–4.17) and (OR = 4.80; 95% CI 2.67–8.63). Also higher odds of food safety practice were students with good knowledge (OR = 1.80; 95% CI 1.03–3.13). Good food safety knowledge but not attitudes was associated with good food safety practices. This shows the need to introduce practical food safety within college environments to help students improve food hygiene and safety practices.

**Keywords** Food safety · Foodborne diseases · Knowledge · Attitude · Practices

## Abbreviations

KAP	Knowledge attitude and practice
KCMUCo	Kilimanjaro Christian Medical University College
MOCU	Moshi Co-operative University
SDG	Sustainable development goal
WHO	World Health Organization

---

✉ Geni-theresia T. Masiku, gentmacq@gmail.com | <sup>1</sup>Department of Health Laboratory Sciences, Kilimanjaro Christian Medical University College, Moshi, Tanzania. <sup>2</sup>Community Health Department, Institute of Public Health, Kilimanjaro Christian Medical University College, Moshi, Tanzania. <sup>3</sup>Department of Epidemiology and Biostatistics, Institute of Public Health, Kilimanjaro Christian Medical University College, Moshi, Tanzania. <sup>4</sup>Department of Translational Medicine, Lund University, Malmö, Sweden.



## 1 Introduction

Food safety refers to the procedures used in handling, preparing, and storing food in a way that prevents contamination and food-borne diseases [1]. Food safety is one of the key areas of the 2030 Agenda for Sustainable Development Goals (SDG) [2] and a public health concern worldwide due to an increased morbidity and mortality risk associated with the outbreak of food-borne diseases [3, 4]. Improper handling of food increases the risk of contamination with bacteria, viruses, parasitic organisms, or chemical toxins [5]. The most common agents in low- and middle-income countries (LMIC) are enterotoxigenic *Escherichia coli* and Rotavirus, *Cryptosporidium*, *Shigella* species, *salmonella* species, and *campylobacter* species [6]. Toxins like aflatoxin induce illness and death [7]. Foodborne diseases account for 33 million disability-adjusted life years and 420,000 diarrhea-related deaths [4], cholera [8], and other food-borne diseases [4]. LMIC and particularly African countries are disproportionately affected where 92 million people fall ill from consuming contaminated foods, resulting in 130,000 deaths each year [9].

Food safety among students and the university/college environment is affected by a lack of knowledge, unfavorable attitudes [4], and inappropriate food handling practices, eventually affecting the health status of students [10]. 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/college premises [11]. Consequently, food borne diseases among university students may lead to poor class attendance, low concentration, and poor academic performance [12]. There is still limited information on the knowledge, attitude, and practice on food safety among university students in Tanzania. Such data are essential for creating awareness on safety, sanitation, and quality of food available within and outside the university environments. The study aimed to determine the knowledge, attitude, and practice on food safety among university students in Kilimanjaro region, Northern Tanzania.

## 2 Materials and methods

### 2.1 Research design and population

We conducted a cross-sectional study in June and July 2022 among undergraduate university students in the Kilimanjaro Christian Medical University College (KCMUCo), a private medical college and Moshi Co-operative University (MoCU), a public non-medical university, which are located in Moshi municipality on the slopes of snow-capped Mount Kilimanjaro, Tanzania. KCMUCo enrolls approximately 400 undergraduate students each year and has about 1700 students in total [13] with three faculties as Faculty of Medicine, Faculty of rehabilitation on Medicine, Faculty of Nursing, and three directorates as Directorate of post graduate studies, Directorate of Research and consultancies and Institute of Public Health, while MoCU enrolls approximately 3500 undergraduate students and has about 9700 students in total with two faculties as Faculty of Co-operative and Community Development (FCCD) and Faculty of Business and Informational Sciences (FBIS) and one Directorate [14].

### 2.2 Sampling and sample size

The sample size was divided equally among the two universities, three faculties from KCMUCo and two from MoCU, then divided equally to the undergraduate courses taken. Systematic random sampling technique using probability proportional to size was used to sample students from their respective classes. From KCMUCo we selected, 72 students from Faculty of Medicines, Faculty of rehabilitation 71 students were taken, Faculty of Nursing 71 students were selected while in MoCU for both FCCD and FBIS faculties 108 students were selected.

The study population constituted undergraduate students from KCMUCo and MoCu who consented to participate. The minimum sample size was calculated by using Cochran Formula;

$$N = \frac{Z^2 * P(1 - P)}{d^2}$$

where  $N$ -Minimum sample size,  $P$ -Estimate the proportion of university students who will take part in the study which is 50% [4],  $Z$ - Critical value corresponding to 95% Confidence Interval (1.96),  $d$ -Margin of error (5%).

$$N = \frac{(1.96)^2 * 0.5(1 - 0.5)}{0.05^2}$$

$$N = 384$$

10% of the calculated sample size will be added to minimize sampling error which is for non-respondent subjects. Now, by adding the 10%

$$N = 384 + 38$$

$$N = 422$$

Therefore, total of 422 students were recruited but 407 students were only included in the study, who are adults. But 15 students were excluded due to misinformation on Knowledge, Attitude and Food Safety Practices.

### 2.3 Data collection procedures and measures

Self-administered online structured questionnaire was used to assess the knowledge, attitude, and food safety practice which were uploaded in Google Form. Questions were both in English and Swahili language to give the students a privilege to use a language that they preferred the most.

The dependent variables in this study were knowledge, attitude, and food safety practices, assessed using similar tool used in Ethiopia [4]. As stated in Bloom's Cut-off points, the KAP among study participants was grouped into three levels, 80.0–100.0%, 60.0–79.9%, and < 60.0%. Cronbach's alpha statistics assessed the internal consistency of the KAP items, which were 73, 85, and 71%, respectively [4].

**Food safety knowledge** was assessed using six questions requiring binary responses. From these questions, a knowledge score was generated as categorical variable then categorized as: 5–6 scores "good", 3–4 scores "fair", and 0–2 scores "poor" but during analysis "fair", and "poor" scores were considered as "poor". And therefore remained with Good and Poor Knowledge.

**Food safety attitudes** were assessed using nine Likert scale questions, with three-response choices from "agree" to "disagree". Questions in derogatory sentences were reversed in the order of the ratings. The responses were categorized into three levels, which are 7–9 positive attitude, 4–6 neutral attitude, and < 3 negative in food safety attitude. But during analysis neutral attitude and negative attitude were considered as negative attitude. Hence remaining with Positive and Negative attitude.

**Food safety practices** were assessed using eight questions in a 5-point Likert scale with choices ranging from "never" to "always". Total practice data was graded as good for 80–100 points, moderate for 60 to 79 scores, and poor for less than 60 scores. And again during analysis moderate and poor scores were considered as poor, as a result two scores were originated as Good and Poor food safety practices.

**The independent variables** included participants' socio-demographic characteristics including gender (male, female), age (18–24, 25–29, > 30), university (KCMUCo, MoCU), course, year of study, and residence (campus/hostel, off-campus).

### 2.4 Data Analysis

Data was analyzed by using Statistical Package for Social Sciences (SPSS version 25). Descriptive statistics summarized the data. Differences in the proportion of food safety KAP across participant characteristics were compared using the Chi-squared test at an alpha level of < 0.05. Cronbach's alpha statistics assessed the internal consistency of the KAP items, which were 73, 85, and 71%, respectively. This shows that all items were internally consistent and reliable [4]. Binary Logistic regression was used to show the association between variables.

### 2.5 Ethical considerations

The ethical approval for the study was obtained from Kilimanjaro Christian Medical University College Research and Ethics Review Committee (KCMU-CRERC) in Kilimanjaro Tanzania with ethical approval number UG 13/2022 and the study adhered to the Declaration of Helsinki. Permission to conduct the study was obtained from KCMUCo and MoCU administration. The study participants were informed about the aim of the study and confidentiality was maintained in data collection. All study participants were told about the study before enrolment and informed consents were obtained from all participants. Participants had the freedom to withdraw from the study without coercion. No individual information

was shared to any other third person who was not involved in the study since they were protected by password accounts that were only known to the investigator.

### 3 Results

#### 3.1 Participant background characteristics

The mean age (SD) of 407 university students was 23.2 (2.6) years, 51.4% were males, 51% and were from MoCU. The highest proportion of participants (42.3%) were in the second year of study (Table 1).

#### 3.2 Food safety knowledge

Our study revealed that 82.6% of study participants had good knowledge on food safety. Most respondents were aware that there is cross contamination between cooked and uncooked foods (94.3%); contamination of foodstuffs cannot be detected by using sense organs (67.3%); washing hands properly reduce the chance of contamination (97.1%); and washing food utensils before preparing food reduce the chance of contamination (97.3%). Also, 73.2% knew that using the same knife to cut vegetables and meat expose to food borne diseases and 90.4% recognized that frequent food contact surface cleaning can prevent food contamination (Table 2).

#### 3.3 Food safety attitudes

Regarding attitudes on food safety, 78.4% of study participants had positive attitudes on food safety. Most (88%) of the respondents agreed that covering mouth during coughing and sneezing avoids food contamination; 96.3% agreed that food handlers should wash their hands after touching some parts of their bodies before rendering food; 85.5% agreed that raw food should be processed separately from cooked food; and 87.5% agreed that long painted fingernails contaminate foodstuffs with illnesses. Participants also agreed that pathogens can be sourced from food utensils (78.6%); o food handlers with cuts on hands should not prepare food (65.6%); to control foodborne diseases, it is necessary to maintain food hygiene (93.9%); hands are where most bacteria and microorganisms originate (66.3%); and it is unsafe to leave food without covering (93.9%) (Table 3).

**Table 1** Social demographic characteristics of university students in Kilimanjaro region (N = 407)

Characteristics	Number	Percentage
Sex		
Male	209	51.4
Female	198	48.6
Age (years)		
Mean (S.D)	23.15 (2.55)	
18–24	340	83.5
25+	67	16.5
University		
KCMUCo	200	49.1
MOCU	105	25.8
Year of study		
1st year	95	23.3
2nd year	172	42.3
3rd year +	140	34.4
Residence		
Campus/ hostel	51	12.5
Off-campus	356	87.5

**Table 2** Knowledge on food safety among University students in Kilimanjaro (N=407)

Variables	Number	Percentage
Contact between cooked and uncooked food causes cross contamination		
Yes	384	94.3
No	23	5.7
Contamination of foodstuffs cannot be detected by using sense organs		
Yes	274	67.3
No	133	32.7
Washing hands properly reduces chances of food contamination		
Yes	395	97.1
No	12	2.9
Washing food utensils before preparing food reduces chances of contamination		
Yes	396	97.3
No	11	2.7
Use of the same knife to cut vegetables and meat expose to foodborne diseases		
Yes	298	73.2
No	109	26.8
Frequent food contact surface cleaning can prevent contamination of food		
Yes	368	90.4
No	39	9.6
Overall knowledge		
Good	336	82.6
Poor	71	17.4

### 3.4 Food safety practices

Overall, only 31.9% of study participants had good food safety practices. This was in regards to, among others, always washing hands with soap and water before handling and cooking food (35.1%), always reheating food leftovers (36.1%), and never leaving food leftovers on the table to be used the next day (60.9%) (Table 4).

### 3.5 Association between food safety KAP with participant characteristics

Results indicate notable differences in the proportion of good knowledge and positive attitudes by age of respondents, university, and year of study of respondents; with the highest proportions among the young individuals 18–24 years, from KCMUCo, and the first years' students. Female students had good food safety practices (38.4%) than males (25.8%) and no significant differences were observed by participant knowledge and attitudes (Table 5).

Logistic regression results adjusted for other factors (Table 6) shows the association between knowledge, attitude and food safety Practices with participants' characteristics. The odds of university students from KCMUCo for good knowledge were 2.36 (95% CI 1.33–4.17) times higher than MOCu students, but gender, age and year of study of the students was not significant to knowledge on food safety.

With positive attitude students' aged 18–24 had odds of 2.60 (95% CI 1.41–4.75) times higher than the university students age 25+, students from KCMUCo had odds of 4.80 (95% CI 2.67–8.63) times higher than the students from MOCu.

Lower odds of good food safety practices were among males (OR 0.52, 95% CI 0.34–0.81) than females and those with good knowledge had higher odds (OR 1.80, 95% CI 1.03–3.13) than students with poor food safety knowledge whereas age, type of university and food safety attitude was not statistically significant to food safety practices.

**Table 3** Attitude on food safety among university students in Kilimanjaro Region (N=407)

Variables	Number	Percentage
Covering mouth during coughing and sneezing avoids contamination of food		
Agree	358	88.0
Disagree	49	12
After touching some parts of your body, food handlers should wash his/her hands		
Agree	392	96.3
Disagree	15	3.7
Raw food should be processed separately from cooked food		
Agree	348	85.5
Disagree	59	14.9
Long painted fingernails contaminate foodstuffs with illnesses		
Agree	356	87.5
Disagree	51	12.5
Pathogens can be sourced from food utensils		
Agree	320	78.6
Disagree	87	21.4
Food handlers with abrasions/cuts on hands should not prepare food		
Agree	267	65.6
Disagree	140	34.4
To control foodborne diseases, it is necessary to maintain food hygiene		
Agree	382	93.9
Disagree	25	6.1
Hands are where most bacteria and microorganisms originate		
Agree	270	66.3
Disagree	137	33.7
Leaving cooked food without covering is unsafe		
Agree	382	93.9
Disagree	25	6.1
Overall attitude		
Positive	319	78.4
Negative	88	21.6

## 4 Discussion

In this cross-sectional survey of food safety KAP among university students in Kilimanjaro region, northern Tanzania, overall, 82.6% had good knowledge, 78.4% had positive attitudes, and 31.9% had good food safety practices. Many college students, particularly those preparing their own meals for the first time, engage in risky behaviors hence have poor food safety practices [15].

Food safety knowledge in this study was higher than other related studies done in Canada [16], United States of America (USA) [17], Ethiopia [4], nearly twice lower than studies in Kenya [18] but comparable to that in Bulgaria [19]. The difference in knowledge level in the studies was due to the use of different tools, where different questions were used in different studies in assessing knowledge. On the other hand, 78.4% of study participants had a positive attitude toward food safety, which is similar to estimates in other settings [18, 20] but much higher than 29.1% reported in Ethiopia [4]. In this study, good food safety knowledge and positive attitudes were high among the younger students from the medical college (KCMUCo), because the connection between food safety knowledge and science-focused programs is logical, as these programs often include essential courses like nutrition, food science, or microbiology and influence the student's ability to have more knowledge and positive attitude on food safety [16]. These findings are consistent with previous studies [15]. There was a significant association of year of study and good food safety knowledge and positive attitude where students from first year had higher likelihood on good food safety knowledge and positive attitude on food safety, because a young person at college is more exposed to media

**Table 4** Food safety Practices among university students in Kilimanjaro region (N=407)

Variables	Number	Percentage
Do you wash your hands before handling and cooking food with soap and water		
Never	34	8.3
Sometimes	98	24.1
Most of the time	132	32.4
Always	143	35.1
Do you reheat food leftovers		
Never	46	11.3
Sometimes	114	28.0
Most of the time	100	24.6
Always	147	36.1
Do you leave food leftovers on the table to be used the next day		
Never	248	60.9
Sometimes	108	26.5
Most of the time	40	9.8
Always	11	2.7
After 3–4 days, leftovers are discarded		
Never	51	12.5
Sometimes	53	13.0
Most of the time	56	13.8
Always	247	60.7
Do you wash your hands before washing the food utensils		
Never	120	29.5
Sometimes	81	19.9
Most of the time	71	17.4
Always	135	33.2
Do you wash your hands after visiting toilets		
Never	9	2.2
Sometimes	16	3.9
Most of the time	48	11.8
Always	334	82.1
After counting money, do you wash hands		
Never	215	52.9
Sometimes	108	26.5
Most of the time	37	9.1
Always	47	11.5
After handling dirt things, do you wash hands		
Never	15	3.7
Sometimes	42	10.3
Most of the time	62	15.2
Always	288	70.8
Food safety practice		
Good	130	31.9
Poor	277	68.1

and hence have high knowledge and food safety attitude than the older students [4]. The findings were different in studies [15, 21].

The positive attitude towards food safety among university students coupled with adequate knowledge is crucial to inform proper food handling practices in this population [17]. The majority of university students have a general knowledge on food safety and know nothing about the principles of food safety, hence they have poor practices on food safety [14, 22]. Also poor

**Table 5** Correlation between knowledge, attitudes, and food safety practices with socio-demographic characteristics among university students in Kilimanjaro region (N = 407)

Characteristics	Total	Good knowledge		Positive attitude		Good practices	
		n (%)	P-value	n (%)	P-value	n (%)	P-value
Gender			0.35		0.60		0.01
Male	209	169 (80.9)		166 (79.4)		54 (25.8)	
Female	198	167 (84.3)		153 (77.3)		76 (38.4)	
Age (years)			0.24		<0.001		0.50
18–24	340	284 (83.5)		279 (82.1)		111 (32.6)	
25+	56	52 (77.6)		31 (59.7)		19 (19.6)	
University			0.001		<0.001		0.38
KCMUCo	200	178 (89.0)		182 (91.0)		68 (34.0)	
MoCU	207	158 (76.3)		137 (66.2)		62 (30.0)	
Year of study			0.07		0.004		0.10
1st year	95	84 (88.4)		85 (89.5)		31 (32.6)	
2nd year	172	144 (83.7)		134 (77.9)		55 (32.0)	
3rd year +	140	108 (77.1)		100 (71.4)		44 (31.4)	
Residence			0.41		0.71		0.23
Campus/hostel	51	40 (78.4)		41 (80.4)		20 (39.2)	
Off-campus	356	296 (83.1)		278 (78.1)		110 (30.9)	
Food safety knowledge					0.002		0.14
Good	336			273 (81.2)		102 (30.4)	
Poor	71			46 (64.8)		28 (39.4)	
Food safety attitudes			0.002				0.07
Positive	319	273 (85.6)				109 (34.2)	
Negative	88	63 (71.6)				21 (23.9)	
Food safety practices			0.14		0.07		
Good	130	102 (78.5)		109 (83.8)			
Poor	277	234 (84.5)		210 (75.8)			

food safety practices among university students may be caused by the absence in proper catering and kitchen facilities like refrigerators for most university students lead them to prepare food in unsuitable environments, such as hostel rooms and cause the students to perform unsafe methods, such as improper cooking temperatures or inadequate food storage [11]. However, the opposite was true in this study where only 32% of all students had good food safety practices as also reported in Ethiopia [4]. Much higher proportions were reported in other settings [19, 21]. In addition, females were more likely to have good food safety practices than males as also reported in Kenya [15], this is due to higher levels of food safety knowledge and awareness to women which leads to better practices in handling food safely than in males [23].

The study had several limitations. First, the study was conducted on only two universities in the Kilimanjaro region, which might affect generalizability to other colleges and universities in the region and the whole country, secondly the study did not comprise the qualitative component. Lastly, self-reporting of food safety knowledge, attitude, and practice may not reflect students' actual food safety knowledge, attitude, and practices due to non-response and social desirability bias. The strength of this study is that we were able to exhaust knowledge, attitude on food safety among university students with medical and non-medical perspective in Kilimanjaro Northern Tanzania.

## 5 Conclusion

The study found high knowledge (82.6%) and attitude (78.4%) but low food safety practices (31.9%). Then there was a significant association between knowledge and practice while knowledge was independent of food safety attitude, but the overall score on food safety practice among the university was bad. These findings demonstrate the need to introduce practical food safety education to university students through their student departments to



**Table 6** Association between knowledge, attitudes, and food safety practices with socio-demographic characteristics among university students in Kilimanjaro region (N= 407)

Characteristic	Good knowledge		Positive attitude		Good practice	
	AOR (95% CI)	P-value	AOR(95% CI)	P-value	AOR (95% CI)	P-value
Gender						
Male	0.78 (0.45–1.33)	0.36	–	–	0.52 (0.34–0.81)	0.04*
Female	1		–	–	1	
Age (Years)						
18–24	1.13 (0.58–2.23)	0.71	2.60 (1.41–4.75)	0.002*	0.94 (0.51–1.74)	0.85
25+	1		1		1	
University						
KCMUCo	2.36 (1.33–4.17)	0.003*	4.80 (2.67–8.63)	<0.001*	1.21 (0.77–1.90)	0.41
MoCU	1		1		1	
Year of study						
1st Year	1.75 (0.81–3.78)	0.15	2.19 (0.99–4.82)	0.052	–	–
2nd Year	1.21 (0.67–2.20)	0.52	0.87 (0.50–1.54)	0.64	–	–
3rd Year+	1		1			
Residence						
Campus	–	–	–	–	–	–
Off-Campus	–	–	–	–	–	–
Food safety knowledge						
Good	–	–	–	–	1.80 (1.03–3.13)	0.04*
Poor	–	–	–	–	1	
Food safety attitude						
Positive	–	–	–	–	0.57 (0.32–1.02)	0.06
Negative	–	–	–	–	1	
Food safety practice						
Good	–	–	–	–	–	–
Poor	–	–	–	–	–	–

help improve their food safety practices, the knowledge will equip the university students to reduce the incidence of foodborne diseases, which is a major public health concern globally. But also the government should assign the cafeterias in universities in the country to sell food with affordable price to prohibit the hostel students to cook food under unsuitable environment [15].

**Acknowledgements** The authors are grateful for all the university students' who accepted to participate in our studies.

**Author contributions** Conceptualization: GM, KM, NR, NN, NM, MN. Data curation: GM, KM, NR, NN, NM, MN. Formal analysis: GM, LS, IM. Investigation: GM, KM, NR, NN, NM, MN. Methodology: GM, KM, NR, NN, NM, MN. Project administration: GM, KM, NR, NM. Resources: GM, KM, NR, NN, NM, MN, LS, IM, RM. Supervision: LS, IM, RM. Validation: GM, LS, IM, RM. Visualization: GM, LS, IM, RM. All authors read and approved the final manuscript. Formal analysis: GM, LS, IM. Investigation: GM, KM, NR, NN, NM, MN. Methodology: GM, KM, NR, NN, NM, MN. Project administration: GM, KM, NR, NM. Resources: GM, KM, NR, NN, NM, MN, LS, IM, RM. Supervision: LS, IM, RM. Validation: GM, LS, IM, RM. Visualization: GM, LS, IM, RM. All authors read and approved the final manuscript.

**Funding** The authors received no financial support for the research, authorship, and/or publication of this article.

**Data availability** Data set underlying the findings are publicly available [24].

## Declarations

**Ethics approval and consent to participate** The ethical approval for the study was obtained from Kilimanjaro Christian Medical University College Research and Ethics Review Committee (KCMU-CRERC) in Kilimanjaro Tanzania with ethical approval number UG 13/2022. All study participants were told about the study before enrolment and informed consents were obtained from all participants.

**Competing interests** The authors declare no competing interests.

**Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

## References

1. Ashkanani F, Husain W, Dwairji MAAI. Assessment of food safety and food handling practice knowledge among college of basic education students, Kuwait. *J Food Quality*. 2021. <https://doi.org/10.1155/2021/5534034>.
2. FAO. The State of Food and Agriculture 2021. 2021. <https://doi.org/10.4060/cb4476en>.
3. Negri S. Food Safety and Global Health: An International Law Perspective, global health governance. 2009; 3(1). <http://www.ghgj.org>.
4. Azanaw J, Dagne H, Andualem Z, Adane T. Food safety knowledge, attitude, and practice of college students, Ethiopia, 2019: a cross-sectional study. *Biomed Res Int*. 2021. <https://doi.org/10.1155/2021/6686392>.
5. WHO. WHO estimates of the global burden of foodborne diseases: foodborne disease burden epidemiology reference group. Geneva: World Health Organization; 2015. p. 2007–15.
6. Girmay AM, Gari SR, Alemu BM, Evans MR, Gebremariam AG. Diarrheal disease and associated behavioral factors among food handlers in Addis Ababa, Ethiopia. *AIMS Public Health*. 2020;7(1):100–13. <https://doi.org/10.3934/publichealth.2020010>.
7. Kumar P, Mahato DK, Kamle M, Mohanta TK, Kang SG. Aflatoxins: a global concern for food safety, human health and their management. *Front Microbiol*. 2017. <https://doi.org/10.3389/fmicb.2016.02170>.
8. Focus Adriano L, Nazir A, Uwishema O. The devastating effect of cyclone Freddy amidst the deadliest cholera outbreak in Malawi: a double burden for an already weak healthcare system—short communication. *Ann Med Surg*. 2023;85(7):3761–3. <https://doi.org/10.1097/ms9.0000000000000961>.
9. Bisholo KZ, Ghuman S, Haffejee F. Food-borne disease prevalence in rural villages in the Eastern Cape, South Africa. *Afr J Primary Health Care Family Med*. 2018;10(1):5.
10. Luo X, Xianglong X, Chen H, Bai R, Zhang Y, Hou X, Zhang F, Zhang Y, Sharma M, Zeng H, Zhao Y. Food safety related knowledge, attitudes, and practices (KAP) among the students from nursing, education and medical college in Chongqing, China. *Food Control*. 2019;95:181–8. <https://doi.org/10.1016/j.foodcont.2018.07.042>.
11. Obande D, Young I. Safe food refrigeration knowledge, attitudes, and practices of university students. *Br Food J*. 2020;122(4):1085–98. <https://doi.org/10.1108/BFJ-05-2019-0327>.
12. Whatnall MC, Hutchesson MJ, Patterson AJ. Predictors of food insecurity among Australian university students: a cross-sectional study. *Int J Environ Res Public Health*. 2020. <https://doi.org/10.3390/ijerph17010060>.
13. .Kcmuco. Kilimanjaro Christian Medical University College. 2023. <https://kcmuco.ac.tz/>
14. MoCU. Moshi Co-operative University (MOCU) Prospectus 2023/2024. *Applscholars*. 2022. <https://appliescholars.com/moshi-co-operative-university-mocuprospectus>.
15. Serrem K, Illés CB, Serrem C, Atubukha B, Dunay A. Food safety and sanitation challenges of public university students in a developing country. *Food Sci Nutr*. 2021;9(8):4287–97. <https://doi.org/10.1002/fsn3.2399>.
16. Courtney SM, Majowicz SE, Dubin JA. Food safety knowledge of undergraduate students at a Canadian university: results of an online survey. *BMC Public Health*. 2016;16(1):1–16. <https://doi.org/10.1186/s12889-016-3818-y>.
17. Booth R, Hernandez M, Baker ER, Tevni Grajales T, Pribis P. Food safety attitudes in college students: a structural equation modeling analysis of a conceptual model. *Nutrients*. 2013;5(2):328–39. <https://doi.org/10.3390/nu5020328>.
18. Imathiu S. Assessment of food safety knowledge, beliefs and attitudes of undergraduate students at a Kenyan university: results of an online survey. *Food Agric Organ UN EJFOOD*. 2020;2(4):85. <https://doi.org/10.2401/ejfood.2020.2.4.85>.
19. Stratev D, Odeyemi OA, Pavlova A, Kyuchukovaa R, Fatehi F, Bamidele FA. Food safety knowledge and hygiene practices among veterinary medicine students at Trakia University, Bulgaria. *J Infect Public Health*. 2017;10(6):778–82. <https://doi.org/10.1016/j.jiph.2016.12.001>.
20. Abolhassani M, Negin Eftekhari N, Basirinezhad MH, Adnan Karimi K, Shamsizadeh M. Knowledge and attitude of students in Shahroud university of medical sciences on health and food safety. *J Clin Basic Res (JCBR)*. 2018;2(3):50–4. <https://doi.org/10.2925/jcbr.2.3.50>.
21. Ali MT, Sultan Mahmud M, Mohsin AU, Mian AI, Ahmed FF. Heliyon knowledge, attitude, and practices toward food safety among students in Bangladesh: a cross-sectional web-based study. *Heliyon*. 2023;9(4):e14762. <https://doi.org/10.1016/j.heliyon.2023.e14762>.
22. Farrish JR et al. Work Experience and Education: Their effect on food safety practices of university students. *scholarworks.umass.edu/collections*. 2009. <https://hdl.handle.net/20.500.14394/42597>.
23. Sanlier N. Food safety knowledge and the safe food handling behaviours of female and male consumers. *Pak J Med Sci*. 2010;26(3):653–8.
24. MasikuGT, Mwijage, KF, Ryoba NL, Ngulinzila NJ, Mgimba NT, Njambilo MM, Shirima LJ, Mboya IB, Mavura RA. Knowledge, attitude, and food safety practices among university students in Kilimanjaro region, northern Tanzania. 2024. <https://data.mendeley.com/datasets/v99zfx2ssv/1>

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.