

A Study to Assess Basic Food Safety Knowledge among University Students

Muhammad A. Halwani

Department of Medical Microbiology, Faculty of Medicine, Al Baha University, Al Baha, Saudi Arabia

Email: mhalwani@bu.edu.sa

How to cite this paper: Halwani, M.A. (2023) A Study to Assess Basic Food Safety Knowledge among University Students. *Food and Nutrition Sciences*, 14, 526-541. <https://doi.org/10.4236/fns.2023.146035>

Received: May 18, 2023

Accepted: June 25, 2023

Published: June 28, 2023

Copyright © 2023 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Background: University students who visit off-campus university cafeterias during their academic life may lack some basic food safety knowledge. **Study Aim:** To evaluate university students' basic knowledge of food safety in off-campus cafeterias. To explore whether the knowledge reported was influenced by the students' educational backgrounds. **Objects and Methods:** Students from three different universities in Saudi Arabia were included. University A represented medical majors, University B represented a mix of both majors medical and non-medical, and University C represented only non-medical majors. **Data Collection:** An electronic questionnaire was circulated among 500 university students to evaluate their knowledge of food safety. The questionnaire had three main sections covering the cafeteria's location as a food serving area, staff hygiene skills, and food preparation standards. The 5-point Likert scale consists of the following points: yes, maybe, no, it does not matter, I do not know. Only a "yes" answer indicated a positive response and proper awareness of the subject. **Results:** A total of 408 students participated, and the results showed significant differences in student knowledge between the three universities. In fact, University A's students had better overall knowledge than University C's students ($0.001 < P$). However, there was no significant difference between University A's and University B's students. The positive responses for the first part of the questionnaire which focused on off-campus cafeteria location, for 18 statements were from 26% to 90.4%. The positive responses for the second part of the questionnaire that focused on staff skills, for 8 statements were from 54.4% to 87.3%. Finally, the positive responses for the third part of the questionnaire which focused on food preparation, for 9 statements were 54.4% to 87.3%. **Conclusion:** Based on the overall comparison among universities, University A's students have more knowledge in food safety in comparison to University C's. University B's students showed no significant difference with the latter two universities. The overall results suggest that students' educational backgrounds can contribute effectively to the general knowledge of food safety.

Keywords

Food Safety, University Students, Medical Students, Saudi Arabia

1. Introduction

Insufficient education, practice, and knowledge regarding food safety pose significant risks for the transmission of food borne illnesses. Annually, an estimated 76 million individuals fall ill due to food-related diseases, with 325,000 hospitalizations and 5000 deaths occurring in the United States alone [1]. Evidence suggests that the number of foodborne disease outbreaks and concomitant illnesses has increased globally in recent years [2]. Therefore, ensuring food safety is not only crucial for maintaining people's health but also for promoting social stability and better health outcomes. University students are in a prime learning stage where developing good nutritional habits can enhance their educational performances and overall learning. Analyzing university students' food safety knowledge and identifying any factors that may hinder their ability to maintain food quality can be beneficial in reducing the incidence of foodborne illnesses during both early and later stages of life [3]. Furthermore, this information can aid in launching targeted health education campaigns to spread awareness about food safety and influence the population's behavior and attitudes towards it [4]. Ultimately, gaining knowledge about food safety can lead to positive behavior changes, fewer food poisoning incidents, and improve overall quality of life [5]. It is important to note that there is a risk of microbiological contamination during every stage of food preparation and handling, which can lead to infection. Therefore, all consumers, especially youth, play a crucial role in preventing foodborne illnesses by retaining good knowledge of correct preparation, cooking, and storing of food. Studies have shown that university students often lack knowledge of food safety and proper handling practices [6] [7]. In fact, they may have some risky eating behaviors. Several lines of evidence suggest that risky eating habits due to a lack of awareness or busy schedules are common among young university students, such as consuming undercooked animal-sourced foods or engaging in other behaviors that can lead to food contamination [8] [9] [10]. To address this issue, efforts have been made to increase awareness of safe food practices among students, including hand washing, preventing cross-contamination, cooking food thoroughly, and storing it properly [11]. Therefore, it is essential to improve awareness regarding safe food practices among university students to prevent potential outbreaks of foodborne illnesses which might happen at any time [12].

The aim of this research was to evaluate the overall knowledge of food safety preparation among university students from three different universities in Saudi Arabia. This study will cover the overall level of hygiene involved in the locations they visit, cooking, preparing, storing, preserving, and serving food that

they consume outside their homes and on university campuses specifically in cafeterias located outside university premises. Additionally, the study aims to investigate whether students' educational background influenced the way they perceived food safety.

2. Objects and Methods

2.1. Subjects

Out of 500 electronic questionnaires distributed, 408 students responded and joined the study. The students who joined during the spring 2018 were from three different universities: University A represented medical major, University B represented a mix of types of majors including medical and University C represented non-medical majors only. The study sample size was selected using Slovin's Formula: $n = N/(1 + Ne_e)$ where n = sample size, N = population size, e = acceptable margin of error with a precision level of $\pm 5\%$ and a confidence level of 95%. The sum of the enrolled students in the three universities was 155,000 during the study period. Using Slovin's Formula, 399 was the accepted minimum number of students that represented the three universities. The selection criteria of the study population were any undergraduate students between the 2nd to the 4th year from the three universities can voluntarily join. Postgraduate and students from other universities were not invited to join. The approval of the project was obtained through the official routes of university standards. It must be stated that none of the participated students provided any personal information or student ID numbers and they all participated anonymously using the electronic questionnaire that was circulated through a link on their mobile devices.

2.2. Questionnaire Design and Grading Standards

A questionnaire was developed for the study purpose to assess the food safety knowledge of students who frequently visit different off-campus cafeterias. The questionnaire covered basic information such as university name, major, date of birth and gender, but did not request students' identification number or name. This self-administered questionnaire was inspired by the information in the book titled *Modern Nutrition and Food Hygiene* (2016) by Veronica Tuffrey, Published by Scientific Research Publishing. The validity of the study questionnaire was initially tested through a pilot study on a small group of students from University A. The students selected were both medical and non-medical majors. Two versions of the questionnaire were distributed among them, electronic and paper-based. The students who participated in this pilot were then interviewed to ensure that they understood the statements as intended and to provide feedback on them. A comparison was made between the results obtained from the electronic questionnaire and those obtained from the paper-based one to assess concurrent validity. Finally, an epidemiology expert was consulted to assess the concurrent validity of the questionnaire based on the pilot study results. The re-

liability testing of the questionnaire was also conducted by circulating both versions of the questionnaire at different time intervals (two weeks apart) to assess test-retest reliability. High correlation between responses was detected. Overall, this process ensured that the study questionnaire was valid and reliable for use in the subsequent research.

The questionnaire consisted of three parts. The first part had eighteen statements aimed at measuring students' knowledge about cafeteria hygiene regulations, cleanliness, availability and functionality of ventilation fans, use of utensils, proper rubbish collection bags, and cleanliness of preparation benches. The second part had eight statements that assessed cafeteria employees' basic hygiene and food safety skills as food workers. The third part included nine statements designed to evaluate food as preparation, storage, and preservation practices in cafeterias. In all three parts, students were asked to respond to the statement using a five-point Likert scale that consists of the following points: yes, maybe, no, it does not matter, I do not know. The level of knowledge among students was determined based on their responses to the questions. If a higher number of "yes" responses were selected, it was considered an indication of good knowledge regarding a particular statement. Conversely, if "no", "I do not know", or "it does not matter" were selected, it was assumed that the student had poor knowledge in that statements. A medium level of knowledge was inferred when the response "maybe" was selected (See **Appendix 1**: The Study Questionnaire).

The students were able to join the study by clicking on a link that they received on their mobile devices. Students needed to read the study objectives carefully and go through the statements if they agree to join. Prior to the survey, students were not provided with any orientation or instructions regarding the study and questionnaire was distributed among them during their daily university activities.

2.3. Statistical Analysis

All the data were entered into an Excel data sheet and the quality of the data were controlled by the double entry verification. After that, the data were analyzed using (SPSS version 13.0, Inc., Chicago, USA statistical software). Statistical analysis was conducted using the mean and standard deviation (SD) to summarize each student's age and score on nutrition knowledge. Frequency and proportion were calculated to describe gender, majors, degree levels and attitudes towards food safety. An analysis of a variance test (ANOVA) was used as well to compare the overall knowledge of the students between the three universities.

3. Results

3.1. General Information

The questionnaire took an average of 4 minutes for a student to complete, and out of the 500 distributed questionnaires, 408 (82%) were completed. Of the participating students, 297 (72.8%) were females and 108 (26.5%) were males (see

Table 1). The study population had an average age of 20 years old, with 68.6 % falling between the ages of 20 to 22 years old (see **Table 2**). The students represented various majors including arts, sciences, and medicine at different undergraduate levels, between the 2nd and 4th year.

3.2. Students' Overall Knowledge

The overall results did not reveal a significant difference in the knowledge of students of basic food safety across the three universities. However, further analysis indicated that the students in one of the universities had better overall knowledge than the other two. This was established by examining the amount of variation within each sample, relative to the number of variations between the samples using the ANOVA test (see **Table 3**). This was clearly illustrated after multiple comparison methods using Fisher's Least Significant Difference (LSD) to determine the source of the difference between the three universities. University A's students were more knowledgeable in basic food safety than university B's and C's students combined and University C's in particular (Mean difference 3.55,

Table 1. The distribution of gender in the study.

Gender	Frequency	Percentage
Male	108	26.5%
Female	297	72.8%
Missing value	3	0.7%
Total	408	100%

Table 2. Age groups of the study population.

Age	Frequency	Percentage
Less than 20	89	21.8%
From 20 to 22	280	68.6%
More than 22	16	3.9%
Missing value	23	5.6%
Total	408	100%

Table 3. The overall difference of knowledge in the students' between the three universities.

Source of variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	733.304	2	366.652	14.137	<0.001
Within Groups	10296.456	397	25.936		
Total	11029.760	399			

$P < 0.05$) (see **Table 4**). However, no significant differences were observed in the overall knowledge between University A's and University B's students. These findings suggest that University A's students have greater baseline knowledge regarding food safety compared to University C's students. Due to the high proportion of female students in the study, no attempt was made to compare knowledge levels between male and female students.

3.3. Cafeteria Location

In the first part of the questionnaire, which centered on the cafeteria's location and general hygiene standards, 77% (14/18) of the answers were answered "yes". The rest of the answers were directed to the other options. This indicates that students possess a solid foundational understanding of the cafeteria's overall requirements. Only four statements out of the 18 failed to exceed a 48% response rate. The initial query pertained to rubbish bags and their function, characteristics, location, and whether or not they were covered when students were in the cafeteria. In response to this statement, around 47% (193/408) said "yes," indicating that less than half of the students only have some knowledge about rubbish bags and their importance in maintaining overall hygiene in a cafeteria. The second statement focused on student behavior regarding observing the cleanliness of a cafeteria's wall structure and if they are free from cracks and holes. Only 29% (121/408) responded positively to this statement by saying "yes," indicating that only a few of them notice this when they enter a cafeteria. The third statement focused on whether windows were frequently opened to prevent dust and dirt accumulation. Only 26% (106/408) were positively knowledgeable about this. Lastly, ventilation fans and their efficacy in eliminating cooking odors from the cafeteria were addressed as well. The focus was to check if students noticed if fans were clean, functioning properly, and free from dirt or grease. Only 45% (187/408) responded "yes" to this statement (see **Table 5**).

3.4. Employee Practice

As is seen in **Table 6**, university students were aware of the possible influence of employees' performance with food safety. It was noticed that they reported more "yes" than other answers in most of the statements listed in this part of the questionnaire. In specific, more than three statements had response rates that exceeded 90%, one statement had more than 80%, and the four remaining ones had a positive response rate of more than 60%. Those were head cover use,

Table 4. The significant differences between university A and other universities individually.

Comparisons	Mean Difference	P-Value
U-A with U-B	0.88121	0.119
U-C with U-B	-0.88121	0.119
U-A with U-C	3.55197	0.00

Table 5. Statements and answers of university students on the cafeteria location.

Statements	Yes	Maybe	No	It Does Not Matter	I don't know	Missing Value
The location of the cafeteria and the general appearance of it are important for me	294 72.1%	67 16.4%	35 8.6%	8 2%	1 0.2%	3 0.7%
When I enter the Cafeteria, I try to take a quick look to the general hygiene regulations followed in.	267 65.4%	82 20.1%	39 9.6%	7 1.7%	8 2%	5 1.2%
I always look for the rubbish bags and make sure that they are suitable to be used in the cafeteria	193 47.3%	123 30.1%	70 17.2%	13 3.2%	4 1%	5 1.2%
It's very important for me when I entre a cafeteria to make sure that there is a hand washing sink with all the required materials like the hand soap and tissue papers	283 69.4%	79 19.4%	29 7.1%	11 2.7%	3 0.7%	3 0.7%
I always make sure that the chairs and tables are clean	326 79.9%	57 14%	17 4.2%	4 1%	2 0.5%	2 0.5%
I always make sure that the place is free from insects and especially cockroaches or rodents.	329 80.6%	49 12%	21 5.1%	3 0.7%	5 1.2%	1 0.2%
I always observe the floors to make sure that they are clean.	256 62.7%	104 25.5%	31 7.6%	6 1.5%	7 1.7%	4 1.0%
I always observe the cafeteria walls to make sure that they are clean, free from cracks and holes.	121 29.7%	122 29.9%	90 22.1%	53 13%	20 4.9%	2 0.5%
I always check on the cafeteria windows to make sure that they were made in a way that prevent dust accumulation	106 26%	103 25.2%	126 30.9%	37 9.1%	31 7.6%	5 1.2%
The cafeteria has the mosquito – repellant device	271 66.4%	59 14.5%	42 10.3%	18 4.4%	17 4.2%	1 0.2%
The benches that were made for food preparation are made from marble.	258 63.2%	62 15.2%	25 6.1%	22 5.4%	35 8.6%	6 1.5%
The benches that were made for food preparations are clean and free from cracks and fishers	323 79.2%	38 9.3%	22 5.4%	9 2.2%	13 3.2%	3 0.7%
Vent fans are available clean and appear in good condition.	187 45.8%	64 15.7%	99 24.3%	13 3.2%	40 9.8%	5 1.2%
The cafeteria has good ventilation system that prevents smell and steam accumulation	344 84.3%	24 5.9%	13 3.2%	9 2.2%	15 3.7%	3 0.7%
The cooking utensils appear clean and free from corrosion or blackened	369 90.4%	13 3.2%	9 2.2%	1 0.2%	11 2.7%	5 1.2%
The rubbish collection is done by using proper plastic bags, or special containers that are usually covered	369 90.4%	23 5.6%	6 1.5%	5 1.2%	2 0.5%	3 0.7%
All cooking utensils are kept inside proper cupboards.	330 80.9%	35 8.6%	14 3.4%	5 1.2%	19 4.7%	5 1.2%
The structure of the cafeteria is large enough to let the workers move inside it freely	320 78.4%	50 12.3%	8 2%	18 4.4%	8 2%	4 1.0%

Continued

Statements	Yes	Maybe	I don't Know	It doesn't Matter	No	Missing Value
Cafeteria employee's must practice proper hygiene	391 95.8%	0 0%	3 0.7%	1 0.2%	5 1.2%	8 2%
Cafeteria employee's must cover their heads with proper head cover and wear plastic apron	346 84.8%	29 7.1%	3 0.7%	7 1.7%	15 3.7%	8 2%
Cafeteria employee's valid health certificates are hanged on the wall.	272 66.7%	69 16.9%	18 4.4%	17 4.2%	23 5.6%	9 2.2%
It is observed that the cafeteria employee's clean their hands regularly	249 61%	52 12.7%	38 9.3%	2 0.5%	59 14.5%	8 2%
Cafeteria employees must wear clear plastic gloves when they prepare food.	370 90.7%	15 3.7%	3 0.7%	3 0.7%	9 2.2%	8 2%
Cafeteria employee's must be experts in sandwiches preparation	280 68.6%	80 19.6%	7 1.7%	14 3.4%	18 4.4%	9 2.2%
Cafeteria employee's do not touch their hair, noses or faces when they are wearing the clear plastic gloves	372 91.2%	14 3.4%	4 1%	1 0.2%	9 2.2%	8 2%
Cafeteria employee's do not keep the gloves on when they take the money from the students	285 69.9%	45 11%	15 3.7%	13 3.2%	38 9.3%	12 2.9%

Table 6. Statements and answers of university students on employees' performance.

Statements	Yes	Maybe	I don't know	it doesn't matter	No	Missing Value
Fresh food and meat should not be left outside the fridge to avoid contamination	222 54.4%	35 8.6%	40 9.8%	1 0.2%	102 25%	8 2%
Sandwiches contents such as eggs, cheese and tuna are kept in separate containers	343 84.1%	24 5.9%	13 3.2%	6 1.5%	14 3.4%	8 2%
Cooked food is not left outside the fridge for long time	356 87.3%	21 5.1%	9 2.2%	4 1%	10 2.5%	8 2%
The available fridge appears in good condition, and its temperature are monitored and recorded on a special sheet on the outside door	228 55.9%	57 14%	43 10.5%	5 1.2%	65 15.9%	10 2.5%
Fresh meat and chicken are not cut on the same cutting board that other type of food is cut on	333 81.6%	23 5.6%	24 5.9%	6 1.5%	12 2.9%	10 2.5%
Mayonnaise is kept in small containers and not in a large open bowl that expose it to contamination	335 82.1%	24 5.9%	15 3.7%	10 2.5%	15 3.7%	9 2.2%
Food that was freshly prepared is not close by the air condition which might carry dust that lead to contamination	338 82.8%	22 5.4%	17 4.2%	7 1.7%	15 3.7%	9 2.2%
Tuna fish is left in its special cans and only open before using.	341 83.6%	27 6.6%	17 4.2%	3 0.7%	11 2.7%	9 2.2%
There is no mix-up between the freshly cooked food and row food and vegetables	337 82.6%	26 6.4%	16 3.9%	5 1.2%	15 3.7%	9 2.2%

availability of health and safety certificates, proper skills in preparing sandwiches, and wearing clean plastic gloves while preparing food. The least proportion detected in this part of the questionnaire was observing the employees' hand hygiene performance and that was only 61% (249/408).

3.5. Food Practice

In third section of the questionnaire, students had nine statements to select which were about food preparation. Interestingly, seven out of these nine statements received a "yes" with a response rate exceeding 80%. However, two statements had a low response rate. The first one was related to the importance of not leaving fresh food and meat outside the fridge to avoid contamination. Only 54% (222/408) of the students chose "yes," indicating that more than half of the student population were not aware of this crucial aspect of food safety. The other statement with a low response rate was about the availability and the condition of the fridge, and whether its temperature was monitored and recorded on a special sheet on the outside door. The response rate to this statement was 55.9% (228/408) (see **Table 7**).

Table 7. Statements and answers of university students on food preparation.

Statements	Yes	Maybe	I don't know	it doesn't matter	No	Missing Value
Fresh food and meat should not be left outside the fridge to avoid contamination	222 54.4%	35 8.6%	40 9.8%	1 0.2%	102 25%	8 2%
Sandwiches contents such as eggs, cheese and tuna are kept in separate containers	343 84.1%	24 5.9%	13 3.2%	6 1.5%	14 3.4%	8 2%
Cooked food is not left outside the fridge for long time	356 87.3%	21 5.1%	9 2.2%	4 1%	10 2.5%	8 2%
The available fridge appears in good condition, and its temperature are monitored and recorded on a special sheet on the outside door	228 55.9%	57 14%	43 10.5%	5 1.2%	65 15.9%	10 2.5%
Fresh meat and chicken are not cut on the same cutting board that other type of food is cut on	333 81.6%	23 5.6%	24 5.9%	6 1.5%	12 2.9%	10 2.5%
Mayonnaise is kept in small containers and not in a large open bowl that expose it to contamination	335 82.1%	24 5.9%	15 3.7%	10 2.5%	15 3.7%	9 2.2%
Food that was freshly prepared is not close by the air condition which might carry dust that leads to contamination	338 82.8%	22 5.4%	17 4.2%	7 1.7%	15 3.7%	9 2.2%
Tuna fish is left in its special cans and only open before using.	341 83.6%	27 6.6%	17 4.2%	3 0.7%	11 2.7%	9 2.2%
There is no mix-up between the freshly cooked food and row food and vegetables	337 82.6%	26 6.4%	16 3.9%	5 1.2%	15 3.7%	9 2.2%

4. Discussion

The study's aim is to evaluate students' knowledge of basic food safety from three different universities in Saudi Arabia when they visit off-campus cafeterias. Another aim is to investigate whether this knowledge will positively be influenced by their educational background or not using a simple questionnaire. Three universities from different cities were included University A, B and C.

The overall analysis of the data indicated that the results did not show a big difference between the overall knowledge of the students in the three different universities. Though further analysis was done on the same data, it was clear that University A out of the three universities was better than the other two in terms of food safety knowledge. The results, which are similar to other studies, indicate that medical students have better knowledge of food safety than other university students because of the nature of their type of education [13] [14] [15]. However, it was not possible to know if this knowledge will improve their behavior in changing the place they eat in if the hygiene standards are low. Roberts *et al.* state in their study that increased knowledge does not necessarily imply that a change in behavior will take place [16].

When data were analyzed by cafeteria location, 77% of the students responded positively to most of the statements on the list. Nevertheless, the knowledge rate did not exceed 45% in four questions: the cafeteria walls, the cleanness of the ventilation fans, cafeteria windows opening to prevent dust accumulation and the availability of covered rubbish bags. Several factors could explain this finding. Firstly, students usually come in a rush to cafeterias to grab their meals and then go back to their educational activities. Observation of general hygiene is not important to them since cafeteria walls, cleanness of the ventilation fans, the covered rubbish bags and frequent opening of the cafeteria windows have no direct contact with their food [17]. Secondly, not all students, including medically oriented ones, go that far and study this issue in detail. This may be more relevant to food hygiene inspectors who interact with food establishments as health inspectors and monitor these aspects, rather than regular university students who simply grab a bite to eat at cafeterias without paying much attention to their environment. [18] [19].

When the data were analyzed based on employees, which mainly observed their practice skills in the cafeteria during food preparation, the overall response to this section indicated high probable knowledge of the students. However, the response rate of the students to the statement relating to frequent employee hand hygiene application had only 60% response rate, which is considered low compared to other answered questions in this section. This was not surprising, as most employee(s) wear plastic gloves and this, might mislead consumers about the application of frequent hand hygiene in the cafeteria during food preparation. It is important to note that these gloves can be contaminated with different bacteria which may lead to food poisoning if they are not changed frequently [20]. Moreover, one can assume that the importance of hand hygiene

with medical students is associated more with clinical practice than food preparation and that is why they are not concerned. However, this is not always the case. Bakarman *et al.* [21] found that only 46% of 453 medical students who studied the importance of hand hygiene during their studies had proper knowledge about it. It can be suggested then that the importance of hand hygiene with non-medical students can be even poorer. Based on the nature of the population studied, it was not possible to analyze the data by medical students against non-medical students. However, the rate of these answers demonstrates that the knowledge with regards to hand hygiene of the study population is attenuated.

Regarding the third set of questionnaire statements on food, seven out of the nine statements had a response rate that exceeded 80%. One unanticipated result clearly showed that only 54.4% of the study population were positive about fresh food and meat that should not be left outside the fridge to avoid contamination. The remaining results had negative answers which indicated uncertainty about the response to the statements. These results reflected those of [22] [23] respectively, who found that the overall knowledge, practices, and attitudes towards food safety among students (medical and non-medical) were low. It seems possible that this study's results, identified in this section, are due to students' poor knowledge or carelessness of basic food knowledge.

The other statement which has a very close response rate of 59.9% was related to the fridge's appearance in good condition, and if its temperature is monitored and recorded on a special sheet on the outside door of the fridge. The rate of answers obtained to this question is not surprising. This kind of information is usually monitored through a special systematic survey known as Hazard Analysis and Critical Control Points (HACCP), which is run by some specialized agencies in food safety. It must be stated however that nothing was found in the literature that indicates a link between HACCP importance and medical/non-medical students. Only students who study food science as an undergraduate course are introduced to the HACCP program during their academic years [24]. Hence, they are aware that it could prevent food-related risks; however, these students were not included in this study.

The findings of this study demonstrate that there are differences in attitudes toward food safety in university students' responses. Furthermore, the food safety knowledge score of the students in majors other than medicine needs to be improved. This is because this study's results clearly showed that University A's students were better at their food knowledge than the other two universities. This may confirm that one's educational background can interfere with the overall knowledge of the subject. Medical students gave more attention to nutrition and health knowledge because of their major. Besides, they have more opportunities to access that knowledge than other students through their readings, so it could explain their relatively higher scores. This finding comes in agreement with other domestic reports which had similar outcomes that confirmed that non-medical students had poor knowledge of food safety [25]. Therefore, it

is important to strengthen the knowledge of all types of university students, in food safety education, to improve their overall knowledge of the subject and even make them more vigilant to issues linked to food health that could lead to health-related diseases [26] [27].

In conclusion, the main aim of this study was to assess the basic knowledge of food safety among three different university student types in Saudi Arabia beyond the confines of their university cafeterias. Additionally, another aim was to investigate whether students' educational background had a positive impact on this knowledge or not. The findings indicated that medical students who represented one of the universities, exhibited better knowledge compared to students from other majors in the remaining two universities. This suggests that students' academic background may influence their overall response. Furthermore, the study revealed that there is an overall good level of basic knowledge regarding food safety, as evidenced by the high response rates for most of the statements, with only a few statements receiving low response rates. For that reason, students from other majors may still need knowledge about food safety to apply when they use off-campus cafeterias, which may help in controlling food-related illnesses.

Like all research studies, this study has certain limitations. Firstly, it only included three universities, and therefore, the findings may not be representative of the knowledge of all students across the country. Secondly, the study did not differentiate between senior and junior students, which could have impacted the results as senior students may possess more relevant knowledge than juniors. Thirdly, the students' economic status or monthly income was not determined which may interfere with the students' selections of the type of cafeteria they go to. Lastly, due to a significantly higher number of female participants, it was not feasible to analyze data based on gender. This presents an opportunity for future research to explore this topic further. Therefore, it is recommended that future studies consider these limitations and address them accordingly.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

- [1] Mead, P., Slutsker, L., Dietz, V., McCaig, L.F., Bresee, J.S., Shapiro, C., Griffin, P.M. and Tauxe, R.V. (1999) Food-Related Illness and Death in the United States. *Emerging Infectious Diseases*, **5**, 607-625. <https://doi.org/10.3201/eid0505.990502>
- [2] Nyachuba, D.G. (2010) Foodborne Illness: Is It on the Rise? *Nutrition Reviews*, **68**, 257-269. <https://doi.org/10.1111/j.1753-4887.2010.00286.x>
- [3] Medeiros, L.C., Hillers, V.N., Chen, G., Bergmann, V., Kendall, P. and Schroeder, M. (2004) Design and Development of Food Safety Knowledge and Attitude Scales for Consumer Food Safety Education. *Journal of the American Dietetic Association*, **104**, 1671-1677. <https://doi.org/10.1016/j.jada.2004.08.030>

- [4] Asmahan, A.A., Wafa, I.E. and Abd El-Razik, M.M. (2021) Effect of Training Program on Food Safety Knowledge, Behaviour and Practices among Female Students of Qassim University, KSA. *Food Research*, **5**, 297-306. [https://doi.org/10.26656/fr.2017.5\(3\).605](https://doi.org/10.26656/fr.2017.5(3).605)
- [5] Abbot, J.M., Byrd-Bredbenner, C., Schaffner, D., Bruhn, C. and Blalock, L. (2009) Comparison of Food Safety Cognitions and Self-Reported Food-Handling Behaviors with Observed Food Safety Behaviors of Young Adults. *European Journal of Clinical Nutrition*, **63**, 572-579. <https://doi.org/10.1038/sj.ejcn.1602961>
- [6] Lee, H.K., Abdul Halim, H., Thong, K.L. and Chai, L.C. (2017) Assessment of Food Safety Knowledge, Attitude, Self-Reported Practices, and Microbiological Hand Hygiene of Food Handlers. *International Journal of Environmental Research and Public Health*, **14**, Article No. 55. <https://doi.org/10.3390/ijerph14010055>
- [7] Winter, C.K., Fraser, A.M., Gleason, J.B., Hovey, S.K., McCurdy, S.M. and Snider, O.S. (2009) Food Safety Education Using Music Parodies. *Journal of Food Science Education*, **8**, 62-67. <https://doi.org/10.1111/j.1541-4329.2009.00075.x>
- [8] Kowalska, M., Żbikowska, A., Onacik-Gür, S. and Kowalska, D. (2017) Acrylamide in Food Products—Eating Habits and Consumer Awareness among Medical School Students. *Annals of Agricultural and Environmental Medicine: AAEM*, **24**, 570-574. <https://doi.org/10.5604/12321966.1232764>
- [9] Almutairi, K.M., Alonazi, W.B., Vinluan, J.M., Almigbal, T.H., Batais, M.A., Alodhayani, A.A., Alsadhan, N., Tumala, R.B., Moussa, M., Aboshaiqah, A.E. and Alhoqail, R.I. (2018) Health Promoting Lifestyle of University Students in Saudi Arabia: A Cross-Sectional Assessment. *BMC Public Health*, **18**, Article No. 1093. <https://doi.org/10.1186/s12889-018-5999-z>
- [10] Roseman, M. and Deale, C. (2008) An Investigation of University Students' Self-Reported Food Safety Knowledge and Skill Ratings and Actual Food Safety Behaviors and Knowledge. 2008 *International CHRIE Conference*, Atlanta, 30 July-2 August 2008.
- [11] Booth, R., Hernandez, M., Baker, E.L., Grajales, T. and Pribis, P. (2013) Food Safety Attitudes in College Students: A Structural Equation Modeling Analysis of a Conceptual Model. *Nutrients*, **5**, 328-339. <https://doi.org/10.3390/nu5020328>
- [12] Yarrow, L., Remig, V.M. and Higgins, M.M. (2009) Food Safety Educational Intervention Positively Influences College Students' Food Safety Attitudes, Beliefs, Knowledge, and Self-Reported Practices. *Journal of Environmental Health*, **71**, 30-35.
- [13] Al-Mohaithef, M. (2021) Awareness of Foodborne Pathogens among Students: A Cross-Sectional Study in the Kingdom of Saudi Arabia. *International Journal of Food Science*, **2021**, Article ID: 9971748. <https://doi.org/10.1155/2021/9971748>
- [14] Ye, W., Gao, Y., Yin, Z. and Lin, J. (2006) Investigation on Knowledge, Attitude and Practice about Nutrition and Food Safety among University Students in Guangzhou. *Chinese Journal of School Health*, **27**, 847-848. (In Chinese)
- [15] Mshelia, A.B., Osman, M. and Binti Misni, N. (2022) A Cross-Sectional Study Design to Determine the Prevalence of Knowledge, Attitude, and the Preventive Practice of Food Poisoning and Its Factors among Postgraduate Students in a Public University in Selangor, Malaysia. *PLOS ONE*, **17**, e0262313. <https://doi.org/10.1371/journal.pone.0262313>
- [16] Roberts, K.R., Barrett, B.B., Howells, A.D., Shanklin, C.W., Pilling, V. and Brannon, L. (2008) Food Safety Training and Foodservice Employees' Knowledge and Behavior. *Food Protection Trends*, **28**, 252-260.

- [17] Dehghan, P., Pournaghi-Azar, F., Azami-Aghdash, S., Sohrabi, Y., Dadkhah, H. and Mohammadzadeh-Aghdash, H. (2017) Knowledge and Attitude towards Health and Food Safety among Students of Tabriz University of Medical Sciences, Tabriz, Iran. *Journal of Analytical Research in Clinical Medicine*, **5**, 62-68.
<https://doi.org/10.15171/jarcm.2017.012>
- [18] Osaili, T.M., Al-Nabulsi, A.A. and Taybeh, A.O. (2021) Food Safety Knowledge, Attitudes, and Practices among Jordan Universities Students during the COVID-19 Pandemic. *Frontiers in Public Health*, **9**, Article 729816.
<https://doi.org/10.3389/fpubh.2021.729816>
- [19] Pervaiz, M., Amed, F., Yasir, I. and Akbar, A. (2018) Knowledge and Perception on Food Safety among Medical Students of Isra University, Al-Nafees Medical College: A Descriptive Cross-Sectional Study. *Isra Medical Journal*, **10**, 74-77.
- [20] Yoon, Y., Kim, S.-R., Kang, D.-H., Shim, W.-B., Seo, E. and Chung, D.-H. (2008) Microbial Assessment in School Foodservices and Recommendations for Food Safety Improvement. *Journal of Food Science*, **73**, M304-M313.
<https://doi.org/10.1111/j.1750-3841.2008.00828.x>
- [21] Bakarman, M.A., Baig, M., Malik, A.A., Gazzaz, Z.J., Mostafa, M.M., Zayed, M.A., Balubaid, A.S. and Alzahrani, A.K. (2019) Hand Hygiene Knowledge and Attitude of Medical Students in Western Saudi Arabia. *PeerJ*, **7**, e6823.
<https://doi.org/10.7717/peerj.6823>
- [22] Azanaw, J., Dagne, H., Andualem, Z. and Adane, T. (2021) Food Safety Knowledge, Attitude, and Practice of College Students, Ethiopia, 2019: A Cross-Sectional Study. *BioMed Research International*, **2021**, Article ID: 6686392.
<https://doi.org/10.1155/2021/6686392>
- [23] Miri, A., Poursadeghiyan, M., Baneshi, M.M., Biglari, H., Yari, A.R. and Khammar, A. (2017) Study on Attitudes of Students of Islamic Azad University Tehran Medical Branch toward Food Safety, 2016. *Electronic Physician*, **9**, 4289-4295.
<https://doi.org/10.19082/4289>
- [24] Angelillo, I.F., Viggiani, N.M., Greco, R.M. and Rito, D. (2001) HACCP and Food Hygiene in Hospitals Knowledge, Attitudes, and Practices of Food-Services Staff in Calabria, Italy. *Infection Control and Hospital Epidemiology*, **22**, 363-369.
<https://doi.org/10.1086/501914>
- [25] Yin, J., Ran, X., Wang, Q., Wu, S. and Jiang, S. (2010) Survey on Food Safety Knowledge, Attitude and Practice of 852 University Students in Kunming. *Practical Preventive Medicine*, **17**, 699-701. (In Chinese)
- [26] Alzahrani, S.H., Saeedi, A.A., Baamer, M.K., Shalabi, A.F. and Alzahrani, A.M. (2020) Eating Habits among Medical Students at King Abdulaziz University, Jeddah, Saudi Arabia. *International Journal of General Medicine*, **13**, 77-88.
<https://doi.org/10.2147/IJGM.S246296>
- [27] Courtney, S.M., Majowicz, S.E. and Dubin, J.A. (2016) Food Safety Knowledge of Undergraduate Students at a Canadian University: Results of an Online Survey. *BMC Public Health*, **16**, Article No. 1147.
<https://doi.org/10.1186/s12889-016-3818-y>

Appendix 1: The Study Questionnaire

Y = Yes, M = Maybe, N = No, D = does not matter, I = I do not know, F = missing value.

statement/Location	Y	M	N	D	I	F
The location of the cafeteria and the general appearance of it are important for me						
When I enter the Cafeteria, I try to take a quick look to the general hygiene regulations followed in.						
I always look for the rubbish bags and make sure that they are suitable to be used in the cafeteria						
It's very important for me when I entre a cafeteria to make sure that there is a hand washing sink with all the required materials like the hand soap and tissue papers						
I always make sure that the chairs and tables are clean						
I always make sure that the place is free from insects and especially cockroaches or rodents.						
I always observe the floors to make sure that they are clean.						
I always observe the cafeteria walls to make sure that they are clean, free from cracks and holes.						
I always check on the cafeteria windows to make sure that they were made in a way that prevent dust accumulation						
The cafeteria has the mosquito – repellent device						
The benches that were made for food preparation are made from marble.						
The benches that were made for food preparations are clean and free from cracks and fishers						
Vent fans are available clean and appear in good condition.						
The cafeteria has good ventilation system that prevents smell and steam accumulation						
The cooking utensils appear clean and free from corrosion or blackened						
The rubbish collection is done by using proper plastic bags, or special containers that are usually covered						
All cooking utensils are kept inside proper cupboards.						
The structure of the cafeteria is large enough to let the workers move inside it freely						
statements/employees	Y	M	N	D	I	F
Cafeteria employee's must practice proper hygiene						
Cafeteria employee's must cover their heads with proper head cover and wear plastic apron						
Cafeteria employee's valid health certificates are hung on the wall.						
It is observed that the cafeteria employee's clean their hands regularly						
Cafeteria employee's must wear clear plastic gloves when they prepare food.						
Cafeteria employee's must be experts in sandwiches preparation						
Cafeteria employee's do not touch their hair, noses or faces when they are wearing the clear plastic gloves						
Cafeteria employee's do not keep the gloves on when they take the money from the students						

Continued

statement/Food	Y	M	N	D	I	F
Fresh food and meat should not be left outside the fridge to avoid contamination						
Sandwiches contents such as eggs, cheese and tuna are kept in separate containers						
Cooked food is not left outside the fridge for long time						
The available fridge appears in good condition, and its temperature are monitored and recorded on a special sheet on the outside door						
Fresh meat and chicken are not cut on the same cutting board that other type of food is cut on						
Mayonnaise is kept in small containers and not in a large open bowl that expose it to contamination						
Food that was freshly prepared is not close by the air condition which might carry dust that lead to contamination						
Tuna fish is left in its special cans and only open before using.						
There is no mix-up between the freshly cooked food and row food and vegetables						