Journal of Pioneering Medical Sciences
Received: February 17, 2025 | Accepted: March 20, 2025 | Published: June 05, 2025
Volume 14, Issue 05, Pages 55-62

DOI https://doi.org/10.47310/jpms2025140510

Knowledge, Attitude and Practice of University Students on Food Poisoning: A Cross-Sectional Study in Saudi Arabia

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Abstract **Background:** Improved customer awareness of food safety information is necessary to provide safer food with the lowest possible risk of food illness. **Objective:** To assess Saudi Arabian university students' knowledge, attitudes and practices about Food Poisoning (FP). **Methods:** An online cross-sectional survey study was conducted in Saudi Arabia between March and December 2024. Multiple logistic regression was performed to assess the factors associated with better FP knowledge. **Results:** A total of 606 students participated in this study. The total mean of knowledge score was (15.90±4.14). Single students reported a significant higher knowledge score mean (16.46±4.69) compared to married (14.99±2.06) (p = 0.0001). Students in medicine faculty reported a significant higher knowledge score mean (20.46± 6.06) compared to students in College of Languages and Translation (14.35±3.00) (p = 0.0001). A total of 301 students (49.5%) had a good knowledge score and 307 students (50.5%) had poor knowledge. Married students had significantly lower odds of good knowledge compared to others (odds ratio (OR) = 0.5,95% CI = 0.31-0.78, p = 0.003). Students at college of Medicine had significantly higher odds of good knowledge (OR = 3.33,95% CI = 1.23-9.03, p = 0.018). **Conclusion:** University students demonstrated a deficiency in understanding or application of food safety in their day-to-day activities. Since education is a powerful instrument for influencing attitudes and behavior, it is very simple to increase students' knowledge and awareness of food safety in educational and research institutions. To enhance students' understanding, awareness and practices of food safety, appropriate training and awareness initiatives should be created and implemented.

Key Words Attitude, Food Poisoning, Knowledge, Students

INTRODUCTION

Consuming food tainted with bacteria, viruses, parasites, or other toxins results in Foodborne Illness (FBI), often known as Food Poisoning (FP) [1,2]. Food poisoning has become a major global public health concern in recent decades, affecting both wealthy and poor nations [3,4]. Every year, 48 million people worldwide contract a foodborne illness, 128,000 are admitted to hospitals and 3,000 pass away [5]. Even though developing nations account for the majority of FP incidence and fatalities [6]. Multiple factors contribute for food consumption and poisoning like unsanitary food intake, pesticide residues in food or water and improper food storage conditions [7,8]. However, because of the growing need for inexpensive food and the inability to give the best care possible in hygienic circumstances when cooking and storing food, FP is not common in these countries alone; it also becomes common in rich nations [7,9].

Food safety is the act of handling, preparing and storing food in a way that keeps it from becoming contaminated by harmful substances or microorganisms

that could cause food-borne illness [10]. Food safety refers to the essential procedures and guidelines that must be followed when producing, preparing, processing, storing and distributing food attest to its safety and suitability for human ingestion [11]. A lack of understanding about food safety and handling is one of the many factors that contribute to the rise in foodborne illnesses and poisoning [12,13].

Knowledge is the ability to acquire, retain and apply information; it is a confluence of talent, experience, comprehension and sound judgment. The term "attitude" describes the propensity or readiness to react favorably to particular situations, to perceive and understand events in light of particular predispositions, or to arrange thoughts or beliefs into coherent, interconnected frameworks. The application of guidelines and information that results in action is called practice. An ethically accomplished art form that contributes to the growth of knowledge and applied science is considered a good practice [14]. Improved customer awareness of food safety information is also necessary to provide safer food with the lowest possible risk of food illness. There are limited studies that examined this area in the Middle east and specifically in Saudi Arabia. Furthermore, previous studies focused on specifical populations such as parents or specific bacteria [15,16]. Previous study by Alqahtani *et al.* [16] found that majority of parents showed good Knowledge, Attitudes and Practices (KAP) regarding brucellosis. Besides, they identified that education and gender were significant determinants of satisfactory awareness. Moreover, another study by Shati *et al.* [15] found that parents' KAP concerning FP is limited. Thus, the primary goal of this study was to assess Saudi Arabian university students' knowledge, attitudes and practices about FP.

METHODS

Study Design and Participants

An online cross-sectional survey study was conducted in Saudi Arabia between March and December 2024. University students in Saudi Arabia formed the study population for this research. The inclusion criteria were university students who currently studying in Saudi Arabia. We did not exclude participants based on their field of study, gender, or socioeconomic status. The minimum required sample size was 385 students using Cochran's Formula, with a 95% confidence, 5% level of significance, 5% margin of error and an expected response distribution of 50%.

Procedures

The questionnaire tool was distributed through social media platforms such as X, Snapchat and Facebook. The convenience sampling technique was utilized to recruit the study participants. Participants who meet the inclusion criteria were invited to participate in the study. The inclusion criteria were mentioned in the study invitation letter. No incentive was provided for the participants.

Data Collection Instruments

The questionnaire for this study was adopted from previous research in Saudi Arabia [17]. The questionnaire tool examined students' demographic data (Nationality, College, Academic Level, Age, Gender and Marital status) and KAP towards FP. Knowledge, attitude and practice section comprised of 50 core questions or statements: 15 for knowledge, 15 for attitude and 20 for practice on FP. Based on the original questionnaire [17], participants' responses were restricted to five multiple-choice questions. The scale of response measurement was a 4-point Likert scale (0-4). In dichotomous classification, a score of less than 3 is considered a negative response (answering incorrectly), whereas scores of 3 and 4 are considered a positive response (answering the correct question). The final version of the questionnaire was disseminated to students after it was peer reviewed and underwent a pilot study. For the knowledge questionnaire (1-15), the response scale (a-e) ranged from 4 to 0. For questions 1-11 of the attitude questionnaire, the scale ranged from 0 to 4 and for questions 12-15, it reversed direction from 4 to 0. The direction of the score for the practice questionnaire was 4-0 for questions 1-6 and it moved from 0 to 4 for questions 7-20 [17]. The questionnaire tool is available in the Supplementary file.

The validity of the original data collection instrument was checked by three experts panel from the medical college of King Khalid University. Moreover, the reliability was assessed using a pilot study of 25 participants (with a reliability coefficient (α-Cronbach's) of 0.73) [15].

Data Analysis

The Statistical Package for Social Science (SPSS) version 29 was used to analysis the data for this study. Descriptive statistics such as the frequency and percentage presented the categorical variables, while the mean and the Standard Deviation (SD) presented the continuous variables. The normality of the data was checked using histogram, skewness and kurtosis measures. The Analysis of Variance (ANOVA) test and the independent t-test were performed to examine the difference in continuous variables. Multiple logistic regression was performed to assess the factors associated with good knowledge and presented as Odds Ratios (OR) with 95% Confidence Intervals (CI). The level of significance was defined as $\alpha = 0.05$. The median knowledge score for the study sample was used as the cutoff point to define good knowledge (dummy variable).

Ethical Considerations

Ethical approval for this research was obtained from the Institutional Review Board (IRB) in Al-Imam Muhammad Ibn Saud Islamic University (project number 609/2024; approval date: 20-03-2024). Informed consent was obtained

Table 1: The demographic characteristics of the students

Variable		Frequency	Percentage
Nationality	Non-Saudi	10	1.7
	Saudi	596	98.3
College	College of Shari'ah	21	3.5
	College of Fundamentals of Religion	28	4.6
	College of Arabic Language	42	6.9
	College of Languages and Translation	40	6.6
	College of Computer and Information Sciences	40	6.6
	College of Economics and Administrative Sciences	63	10.4
	College of Social Sciences	53	8.7
	College of Education	38	6.3
	College of Science	29	4.8
	College of Medicine	95	15.7
	College of Engineering	23	3.8
	College of Media and Communication	32	5.3
	College of Applied Science	20	3.3
	College of Human Sciences in Huraymila	32	5.3
	Applied College in Huraymila	32	5.3
	College of Nursing	18	3.0
Academic level	1st year	84	13.9
	2nd year	107	17.7
	3rd year	162	26.7
	4th year	154	25.4
	5th year	74	12.2
	6th year	25	4.1
Age (years)	Less than 18	29	4.8
	18-20	214	35.3
	21-25	302	49.8
	Above 25	61	10.1
Gender	Male	304	50.2
	Female	302	49.8
Marital state	Single	399	65.8
	Married	185	30.5
	Divorced	20	3.3
	Widowed	2	0.3

from all subjects involved in the study. All methods were carried out in accordance with the principles of the Declaration of Helsinki.

RESULTS

The reliability of the questionnaire tool was deemed high (with a reliability coefficient (α-Cronbach's) of 0.85). A total of 606 students participated in the analysis. The majority were Saudi (n = 596, 98.3%). The most common age group was 21-25 years, accounting for 302 participants (49.8%), followed by 18-20 years, accounting for 214 students (35.3%). Most students were single (n = 399, 65.8%), followed by married students (n = 185, 30.5%). Most students enrolled in the analysis were from medicine faculty (n = 95, 15.7%), followed by College of Computer and Information Sciences (n = 63,10.4%). Additional details about demographic characteristics of the participants are provided in Table 1.

A total of 470 students (78.1%) reported FP is caused by pathogenic microbes and 412 students (68.4%) agreed that some toxins produced by microbes and cause FP are resistant to heating temperature of food. Notably, 87.4% (n = 526) recognized drinking raw milk as highly risky for FP. Similarly, 84.6% (n = 509) understood that eating raw eggs poses a significant risk, while 80.9% (n = 487) and 81.6% (n = 491) acknowledged the risks of consuming raw, unwashed vege`s and unwashed, not peeled fruits, respectively. Moreover, 81.4% (n = 490) were aware that unhygienic practices among food handlers could lead to microbial contamination and 80.6% (n = 485) identified eating uncovered cooked food kept at room temperature for 12-24 hours as risky. Additional details about knowledge items responses are provided in Supplementary material Table 1.

Among respondents, 46.2% (n = 278) reported always washing their hands with soap and water before preparing food, demonstrating the highest adherence to hygiene in this category. Additionally, 41.7% (n = 251) always washed their hands after using the toilet, while 41.9% (n = 252) most of the time washed fresh vegetables and fruits in tap water before eating. However, among respondents, 37.4% (n = 225) always consuming raw milk of she-camel and 35.4% (n = 213) most of the time eating cooked food left at room temperature for over six hours without sufficient heating. Additional details about the practice of FP are provided in Table 2.

The total mean of knowledge score was (15.90±4.14). As the table shown, single students reported a significant higher knowledge score mean (16.46±4.69) compared to married (14.99±2.06) (p = 0.0001). Students in medicine faculty reported a significant higher knowledge score mean

Table 2: The knowledge score stratified by the demographic characteristics

Variable		Knowledge score		p-value
		Mean	SD	
Nationality	Non-Saudi	14.30	6.58	0.19
	Saudi	15.98	4.00	
College	College of Shari'ah	16.10	3.30	0.0001
	College of Fundamentals of Religion	15.25	2.27	
	College of Arabic Language	14.50	2.53	
	College of Languages and Translation	14.35	3.00	
	College of Computer and Information Sciences	14.72	3.67	
	College of Economics and Administrative Sciences	15.35	2.46	
	College of Social Sciences	15.23	3.48	
	College of Education	14.79	2.94	
	College of Science	15.93	1.91	
	College of Medicine	20.46	6.06	
	College of Engineering	16.00	2.43	
	College of Media and Communication	15.28	3.69	
	College of Applied Science	15.25	1.65	
	College of Human Sciences in Huraymila	15.12	2.03	
	Applied College in Huraymila	14.84	3.08	
	College of Nursing	15.00	2.63	
Academic level	1st year	16.57	5.63	0.35
	2nd year	15.72	4.13	
	3rd year	15.89	3.99	
	4th year	15.75	2.94	
	5th year	16.51	3.72	
	6th year	15.00	4.51	
Age (years)	Less than 18	15.69	2.71	0.75
	18-20	16.13	4.56	
	21-25	15.95	4.09	
	Above 25	15.52	1.97	
Gender	Male	15.82	3.60	0.38
	Female	16.10	4.45	
Marital state	Single	16.46	4.69	0.0001
	Married	14.99	2.06	
	Divorced	15.00	1.95	
	Widowed	14.50	3.54	

(20.46± 6.06) compared to students in College of Languages and Translation (14.35±3.00) (p = 0.0001). Additional details about knowledge score stratified by the demographics are provided in Table 2.

A total of 301 students (49.5%) had a good knowledge score and 307 students (50.5%) had poor knowledge. A multiple logistic regression model was obtained to assess the factors affected the knowledge level. Married students had significantly lower odds of good knowledge compared to others (OR = 0.5,95% CI = 0.31-0.78, p = 0.003). Students at college of Medicine had significantly higher odds of good knowledge (OR = 3.33,95% CI = 1.23-9.03, p = 0.018), Table 3.

DISCUSSION

The main findings of this study are as the following: (1) Students in medicine faculty reported a significant higher knowledge score mean (20.46± 6.06) compared to students in College of Languages and Translation (14.35±3.00) (p = 0.0001), (3) A total of 301 students (49.5%) had a good knowledge score and 307 students (50.5%) had poor knowledge, (4) Married students had significantly lower odds of good knowledge compared to others (OR = 0.5,95% CI = 0.31-0.78, p = 0.003). Besides, students at college of Medicine had significantly higher odds of good knowledge (OR = 3.33,95% CI = 1.23-9.03, p = 0.018).

In this study, around 78.1% of the participants reported that FP is caused by pathogenic microbes and 68.4% agreed that some toxins produced by microbes and cause FP are resistant to heating temperature of food [18]. In fact, bacteria account for 66% of foodborne illness cases, followed by chemicals (26%), parasites (4%) and viruses (4%) [18]. Among foodborne ailments, infection and intoxication are the most prevalent [18]. The most prevalent pathogens that are spread by food are viruses; in the US, viruses are responsible for 66.6% of food-related diseases [19]. Besides, Norwalk-like viruses were responsible for over 80% of gastroenteritis cases recorded in the Netherlands' local health services. Notably, in this study, 87.4% recognized drinking raw milk as highly risky for FP, which is much higher than the result of a large descriptive cross-sectional study conducted on 3011 parents in the Aseer region in the southwest region of Saudi Arabia, which showed that almost 60% of participants were not aware that there is no risk of FP while drinking pasteurized milk [15]. Similarly, in this study, 84.6% understood that eating raw eggs poses a significant risk, while 80.9% and 81.6% acknowledged the risks of consuming raw, unwashed vegetables and

Table 3: Logistic regression analysis of demographic characteristics and knowledge level

Variable		OR (95% CI)	p-value
Nationality	Non-Saudi	Reference	
	Saudi	0.65 (0.17-2.45)	0.529
Academic level	1st year	Reference	
	2nd year	1.05 (0.52-2.15)	0.886
	3rd year	1.29 (0.61-2.69)	0.504
	4th year	1.27 (0.54-3.01)	0.583
	5th year	1.2 (0.44-3.24)	0.720
	6th year	0.43 (0.11-1.72)	0.236
Age (years)	Less than 18	Reference	
	18-20	0.78 (0.3-2.03)	0.606
	21-25	0.62 (0.21-1.83)	0.384
	Above 25	1.62 (0.42-6.3)	0.483
Gender	Female	1.13 (0.79-1.62)	0.512
Marital status	Single	Reference	
	Married	0.5 (0.31-0.78)	0.003
	Divorced	0.4 (0.12-1.32)	0.132
	Widowed	0.92 (0.05-18.86)	0.959
College	College of Shari'ah	Reference	
	College of Fundamentals of Religion	0.62 (0.19-2)	0.424
	College of Arabic Language	0.54 (0.18-1.6)	0.264
	College of Languages and Translation	0.56 (0.19-1.71)	0.312
	College of Computer and Information Sciences	0.68 (0.23-2.02)	0.490
	College of Economics and Administrative Sciences	1.11 (0.4-3.05)	0.841
	College of Social Sciences	1.14 (0.4-3.22)	0.808
	College of Education	0.93 (0.31-2.78)	0.893
	College of Science	1.59 (0.5-5.1)	0.433
	College of Medicine	3.33 (1.23-9.03)	0.018
	College of Engineering	1.65 (0.48-5.71)	0.431
	College of Media and Communication	0.77 (0.25-2.38)	0.654
	College of Applied Science	0.52 (0.14-1.92)	0.327
	College of Human Sciences in Huraymila	0.95 (0.31-2.96)	0.931
	Applied College in Huraymila	0.76 (0.24-2.39)	0.640
	College of Nursing	0.54 (0.14-2.07)	0.370

unwashed, not pealed fruits, respectively. Moreover, 81.4% were aware that unhygienic practices among food handlers could lead to microbial contamination and 80.6% identified eating uncovered cooked food kept at room temperature for 12-24 hours as risky. Fruits, nuts and vegetables from vine stalks were the two primary commodities linked to the majority of outbreak-related diseases that came from plant-based foods, according to the US Centers for Disease Control and Prevention's (CDC) 2008 report on surveillance for food-borne disease outbreaks [20]. One Norovirus was the primary pathogen-commodity combination that caused the majority of outbreaks in leafy greens. The majority of the infections linked to the outbreak were caused by pathogen-commodity combinations, including *Salmonella* spp. in fruits and nuts and *Salmonella* spp. in vegetables with vine stalks [21].

In this study, a total of 301 students (49.5%) had a good knowledge score and 307 students (50.5%) had poor knowledge. Besides, the knowledge mean score of our study sample was 74.95% overall. Given the correlation between education level and food-borne disease knowledge [22]. Therefore, the average knowledge score at the community level in Saudi Arabia is believed to be significantly lower. Moreover, in a large study done in Taif University students, Saudi Arabia, 2008 to evaluate the KAP on FP of Taif University students, Saudi Arabia which included 1020 students showed that students have little understanding of a few crucial aspects of FP. Besides, more than half of the students, for instance, are unaware that consuming raw eggs and raw cheese made from unpasteurized. Milk poses an extremely high risk of FP. It is also unknown to more than half of the pupils that certain bacterial toxins are resistant to food heating temperatures [17].

Numerous research has demonstrated that a wide range of factors influence people's knowledge, attitudes, behaviors, perceptions and practices regarding food safety. The most significant factors were age, gender, education, socioeconomic status and work status [23-25]. In our study, we found that married students had significantly lower odds of knowledge compared to others (OR = 0.5,95% CI = 0.31-0.78, p = 0.003). This lack of knowledge is probably due to their ignorance of the potential food hazards that might arise from high-risk foods, viral origins and FP consequences, which puts married respondents at risk for FP. The results of this study contradict the findings of previous research [26]. However, the results of our study were compatible with a cross-sectional study among postgraduate students in a public university in Selangor, Malaysia [27].

In our study, students at college of medicine had significantly higher odds of knowledge (OR = 3.33, 95% CI = 1.23-9.03, p = 0.018). The findings of our study appear to be in line with those of earlier studies that identified

a strong correlation between knowledge score and educational attainment. Higher knowledge scores were reported by respondents with more schooling than by those with less. Women reported higher scores than men and it has been shown that knowledge of food safety increases with age [28].

Numerous food safety management practices have been thoroughly studied in the past, such as the significance of complete handwashing [29,30], proper food storage [31,32], appropriate cooking methods [32,33] and the need of preserving hygienic conditions and avoiding cross-contamination [31]. In this study, around 46.2% reported always washing their hands with soap and water before preparing food, demonstrating the highest adherence to hygiene in this category. Additionally, 41.7% always washed their hands after using the toilet, while 41.9% reported that most of the time washed fresh vegetables and fruits in tap water before eating. Besides, the vast majority of participants stated that they wash their hands with soap and water before eating, after using the restroom and after handling raw, unwashed vegetables. Before eating fresh fruits and vegetables, a sizable portion of participants said they wash them with tap water. It was less typical, though, to wash your hands with soap and water before handling food. Only a small percentage of the participants (37.4%) reported always consuming raw milk of she-camel. Recent research has shown that similar behaviors and attitudes are still common across the Middle East and North Africa, despite recent evidence linking the consumption of raw milk as the most common source of exposure among brucellosis patients [34,35]. Traditional beliefs have a significant impact on attitudes and behaviors surrounding food. The idea that local, fresh produce is healthier and more advantageous, as well as the false perception that boiling milk destroys its nutrients, are examples of this impact [35]. The research community was predominantly nomadic and agrarian until a few decades ago and eating habits like drinking raw milk were widespread. These views reflect persistent cultural impacts in that population. Numerous studies show that attempts to stop FP have not been successful [36,37]. In addition to a lack of prevention and handling training and a lack of a specific strategy for FP outbreaks, the cause is the poor involvement of health workers in monitoring and assessment because of a lack of human resources. Only when health professionals and caterers work together to add a shared commitment to food safety can this prevention be put into practice. Therefore, it is essential to conduct thorough coaching and supervision activities [38].

Strength and Limitation

This study has the advantages of being among the first few studies to examine KAP towards FP among universities students. At the same time, this study has limitations. The online cross-sectional survey study design using convenience sampling technique restricted the generatability of the study findings, the ability to examine causality among the study variables and introduce selection bias. Moreover, this study is prone to reporting bias and social desirability as it utilized self-administered questionnaire. Besides, due to the use of online survey study design, we were not able to estimate the number of participants who were invited to participate; therefore, we cannot estimate the number of respondents or the response rate for this study, which increase the possibility of non-response bias. Moreover, the long data collection period might introduce temporal bias.

In conclusion, the results of this study showed that university students demonstrated a deficiency in understanding or application of food safety in their day-to-day activities. Since education is a powerful instrument for influencing attitudes and behavior, it is very simple to increase students' knowledge and awareness of food safety in educational and research institutions. To enhance students' understanding, awareness and practices of food safety, appropriate training and awareness initiatives should be created and implemented. The dissemination of food safety principles and practices among students, especially international students, might be greatly aided by the government. Future studies designing and implementing appropriate educational intervention should be conducted to enhance students KAP towards FP.

Declarations

Ethical Approval and Consent to Participate

Ethical approval for this research was obtained from the Institutional Review Board (IRB) in Al-Imam Muhammad Ibn Saud Islamic University (project number 609/2024; approval date: 20-03-2024). Informed consent was obtained from all subjects involved in the study. All methods were carried out in accordance with the principles of the Declaration of Helsinki.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare no conflict of interest.

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