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Perceptions and perspectives towards safe food handling and its practices: a case study at Jahangirnagar University

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Abstract

Background Foodborne illness is a significant public health concern, particularly in developing countries like Bangladesh. Young adults, aged 18–26 (including undergraduates and recent graduates), are especially vulnerable to the onset of unhealthy eating habits and nutritional imbalances as they begin living independently, often away from their families. This research aims to identify the risk factors associated with the knowledge, attitudes, and practices related to safe food handling among residential university students. By understanding these factors, the study seeks to inform strategies to improve food safety behaviors in this at-risk population.

Methods A standardized questionnaire was administered through a simple random sampling survey of 250 students at Jahangirnagar University to collect primary data on food safety practices, attitudes, and knowledge. Descriptive statistics and the chi-square test were used to examine associations between the responses and predictor variables. To further assess the statistical significance and strength of these relationships, logistic regression analyses were performed. These methods provided a comprehensive evaluation of the factors influencing safe food handling behaviors among the students.

Results The survey found that most participants were from rural areas (44.4%) and female students (65.2%). Multicollinearity issues were not detected, and predictor factors explained 53.8% (Nagelkerke R-square: 0.538) of the variation in food poisoning incidents. Overall, 57.6% of students reported being prone to food poisoning. Risk factors for food poisoning included being in the third year of study (OR: 3.493, CI: 0.394–30.972), consuming food during a blackout based on its appearance or scent (OR: 4.824, CI: 0.690–33.715), and believing food should be refrigerated for five to seven days (OR: 2.309, CI: 0.318–16.778). Conversely, students who stored raw meat or fish on the middle shelf (OR: 0.078, CI: 0.012–0.511) and those who thought leftover food should be kept in the fridge for more than seven days (OR: 0.034, CI: 0.002–0.626) were less likely to experience food poisoning. These findings highlight behaviors that influence foodborne illness risk among students.

Conclusions This study found that while students in Bangladesh demonstrate a strong understanding of food handling, there has been insufficient focus on food safety education in the country. Based on these findings, the authors recommend enhancing awareness of key food safety risks and integrating this knowledge into both short- and long-term initiatives. To ensure lasting improvements in food safety, sustained and effective interventions are essential.

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These efforts will accelerate progress toward achieving the sustainable development goals related to public health in Bangladesh.

Keywords Food safety, Foodborne diseases, Jahangirnagar University, Bangladesh

Introduction

In Bangladesh, food safety has emerged as a critical concern, surpassing many other pressing issues [23]. This is due, in part, to a significant gap between the knowledge of food safety practices and their actual implementation. As a result, the population is increasingly susceptible to foodborne diseases, making it more difficult to effectively prevent these health risks. One of the primary contributors to this situation is the rising consumption of unsafe food, which complicates efforts to accurately gauge the global prevalence of food-related diseases. Ensuring that food is safely purchased, stored, prepared, and handled at home is essential for reducing the incidence of foodborne illnesses [12]. According to the World Health Organization (WHO), unsafe food, which can harbor harmful bacteria, viruses, parasites, or chemicals, is responsible for more than 200 diseases, ranging from foodborne infections to chronic conditions like cancer. It is estimated that unsafe food causes 600 million illnesses annually, leading to 33 million years of healthy life lost (DALYs) and 420,000 deaths worldwide [4]. These statistics highlight the critical importance of safe food handling practices to prevent diseases and promote public health. Food safety is also of vital importance to businesses, as it protects consumers from foodborne illnesses and food poisoning. Food poisoning occurs when harmful microorganisms such as bacteria, viruses, and parasites contaminate food, causing illness in those who consume it [6, 29]. Common causes of foodborne illness include serving contaminated raw food, undercooking or inadequately heating food, allowing sick individuals to handle food, and failing to maintain proper cleanliness and hygiene standards [2, 29].

Foodborne infections in Bangladesh are often underestimated due to challenges in reporting, as data is typically only collected from individuals who seek medical care. It is estimated that 30 million people are affected by foodborne diseases caused by harmful bacteria each year [4, 32]. The prevalence of foodborne illnesses among students has also been documented [4], with young adults aged 18–27 being especially vulnerable to poor dietary habits and nutritional imbalances as they transition to independent living and are exposed to new foods. A study on food safety practices among university food handlers found that only 31.5% demonstrated good knowledge, and 28.4% followed proper safety practices, with many lacking awareness of foodborne pathogens and hand hygiene [24]. However, the lack of comprehensive epidemiological research makes it difficult to identify the main sources of foodborne diseases, which may come from contaminated food, water, animals, or environmental factors. This challenge is exacerbated in low- and middle-income countries (LMICs) like Bangladesh, where limited resources and underreporting hinder food safety improvements. Additionally, weak enforcement and a shortage of inspectors reduce the effectiveness of food safety regulations [13]. Addressing these gaps through a robust framework for food safety regulation and education is essential for improving public health and reducing foodborne diseases in Bangladesh.

Incorrect food handling practices can significantly harm public health and trigger outbreaks of foodborne illnesses, making food safety a critical concern. In Bangladesh, university students' living arrangements vary widely, influenced by factors such as geographic location, family background, and financial resources. While many students in larger cities like Dhaka live away from home in dormitories, rented apartments, or shared accommodations, others, particularly those attending public universities or from nearby areas, continue to live with their families. This diversity in living situations impacts students' food handling practices and overall food safety awareness. Unlike in Europe, where students in countries like Italy or Spain often live with their families, or the US, where many move to university campuses, the decision to live away from home in Bangladesh is shaped by practical considerations such as university proximity and financial constraints. Given that approximately 4 million students are enrolled in higher education institutions in Bangladesh (BANBEIS), the variation in living conditions presents a unique challenge for addressing food safety and highlights the need for targeted interventions in this large and diverse student demographic. Students, in particular, are more vulnerable to food safety risks than other age groups, as they often consume food that may present safety issues both at home and outside of it. The student phase represents a crucial opportunity to educate individuals on the importance of food safety, equipping them with the knowledge, skills, and awareness needed to address current challenges in food handling [4]. Furthermore, many students play an active

role in food preparation, either by helping their parents or preparing meals independently [26]. Unfortunately, some of these students engage in unsafe practices, such as preparing food with unclean hands, storing cooked and uncooked food together, or keeping food at improper temperatures—all of which can lead to cross-contamination [19]. To prevent foodborne outbreaks, it is essential to follow basic food safety practices, including regular and proper handwashing, cleaning kitchen surfaces thoroughly, storing food at the correct temperature, and keeping raw and cooked foods separate [21]. Given their susceptibility to risky eating behaviors, university students are particularly prone to foodborne illnesses. Moreover, as future parents and food preparers, their behavior could have long-term implications for food safety in their households. Despite these risks, there is currently no systematic study assessing the food safety knowledge, attitudes, and practices of Bangladeshi students. To bridge this gap, this study aims to evaluate the level of understanding, attitudes, and behaviors regarding safe food handling among Bangladeshi students. By doing so, it will provide valuable insights to enhance food safety education and improve practices in this vulnerable population.

Methods and materials

Data source

A survey questionnaire was developed as the primary research instrument to help achieve the objectives of the study. The questionnaire consisted of 36 questions designed to assess the frequency with which students practice safe food handling behaviors and attitudes, as well as to gather demographic information, including gender and other relevant characteristics. The data collection took place between June and July 2023, with the study sample drawn from students at Jahangirnagar University.

Participants

Using Cochran's sample size estimation formula [7], the required number of samples was calculated as follows:

$$n = \frac{z^2 p(1-p)}{d^2}$$

To ensure the maximum sample size, a sample proportion of 0.5 was selected [30]. The parameters used were: z = 1.96 for a 95% confidence level, d = 0.07 for a 7% margin of error, and p = 0.5 for the estimated proportion. The calculation resulted in a required sample size of 196. However, to increase the robustness of the study, a total of 250 samples were collected using a simple random sampling technique, and these samples were used for the final analysis.

Research design

A cross-sectional study approach was used to assess students' perceptions, attitudes, and practices related to food safety, focusing on their actions in various contexts and situations that may pose food safety risks. Simple random sampling was employed to select a total of 250 students from Jahangirnagar University. The sample was collected from a total of 17,212 students from 27 departments across six faculties: Faculty of Mathematics and Physical Science, Faculty of Arts and Humanities, Faculty of Biological Science, Faculty of Social Science, Faculty of Business Studies, and Faculty of Law. Participants were instructed to respond to the questionnaire honestly, and the completed questionnaires were collected for analysis. While a few minor discrepancies and blank areas were noted, the level of bias was considered negligible and did not significantly affect the study's conclusions.

Data collection and research instrument

Data was collected following the guidelines for scientific and professional articles, using a standardized questionnaire developed by adapting questions from existing, reliable, and valid instruments in previous research [12]. The 36-item survey was divided into three sections: demographic information, food handling practices, and food safety knowledge. The first section included 14 questions about personal, family, and home details. The second section contained 14 questions related to food management practices, such as cooking habits, food storage and reheating, handwashing before cooking, washing fruits and vegetables, and the habit of washing hands after handling other items during food preparation. The final section consisted of 8 questions assessing the participants' knowledge of food safety, including their understanding of foodborne diseases, the risks of consuming expired foods, proper handwashing practices before meal preparation, and the recommended duration for storing food in the refrigerator. The questionnaire was distributed in both paper-based and online formats. Due to limited reach with the paper-based version, data was initially collected from approximately 200 students using this method. For those who could not be reached through the paper-based version, a Google Form with the same set of questions was created and distributed. The remaining responses were then collected through this online format.

Reliability of instrument

The pilot testing of the instrument involved students with varying levels of intellectual capacity from different departments. Approximately 30 student's responses were collected during pilot testing. The questionnaire was distributed in paper-based format which helped us to finalize our study's questions and data collection method. This diverse group helped ensure the questionnaire's applicability across a broad range of academic backgrounds. As a result, the instrument demonstrated a high level of reliability, with a Cronbach's alpha coefficient of 0.88, indicating excellent internal consistency and dependability.

Study variables and measurements

The outcome variable in this study, whether a person has ever experienced food poisoning, was treated as a binary variable, with responses coded as "Yes" (1) and "No" (2). Various predictor variables were used in the analysis, including age (grouped in 3-year intervals), gender (male or female), type of residence (rural, suburban, or urban), educational background (undergraduate years 1–4 and post-graduation), faculty, and department. Additionally, family type (nuclear, coded as 2, and joint, coded as 1), living arrangements (living with family, coded as Yes [1] and No [2]), family monthly income, total monthly spending, and monthly spending on nutrition and medical care were considered as explanatory variables. Other key factors included whether the respondents frequently bought food from outside (categorized as often, occasionally, infrequently, or never), and whether they cooked at home (always, occasionally, infrequently, or never). By examining these variables, we can better understand the respondents' food handling practices, attitudes, and awareness of food safety, shedding light on the methods they use to manage and prepare food.

Statistical analysis

In this study, descriptive statistics were used to determine the frequency and percentage of both the independent and outcome variables. Chi-square test were used to examine associations between the responses and predictor variables. To further assess the statistical significance and strength of these relationships, logistic regression analyses were performed. Data analysis was performed using R, Microsoft Excel, and the Statistical Package for Social Sciences (SPSS) version 23. A significance level of 5% was applied to all statistical tests.

Results

The primary goal of this research was to evaluate the food safety practices, attitudes, and knowledge of Jahangirnagar University students. Table 1 presents the distribution of participants based on their background characteristics, including age, gender, place of residence, education level, faculty, family type, income, living arrangements (with or without family), average number of study hours per week, and history of food poisoning. The majority of respondents (65.2%) were female, aligning with studies from Kampala and Indonesia, which also reported a higher proportion of female participants. Additionally, 80.4% of the respondents indicated that their families were nuclear, and 44.4% reported living in rural areas. Of the participants, 53.6% did not live with their family. Importantly, 57.6% of students reported having experienced food poisoning. Figure 1 shows the students' perceptions of the age groups most at risk of food poisoning, with children, adolescents, adults, and the elderly identified as vulnerable. A small number of respondents selected the "Don't know" option, indicating uncertainty.

Table 2 evaluates the food handling attitudes and practices of the students, while Table 3 assesses their food safety knowledge. The findings revealed that 9.2% of students cook regularly, 42.8% cook occasionally, 34.8% cook rarely, and 13.2% never cook. When it comes to food safety practices, 52.8% of students reported washing knives with water after cutting raw meat or fish, 60.0% always check food expiration dates, and 32.4% store raw meat or fish on the top shelf of the refrigerator. Additionally, 63.2% of students heat leftover food until it boils, and 54.8% wash their hands for 10 to 20 s or longer using soap. However, 32.4% of students reported touching food while having a hand wound covered with a bandage, and 42.4% generally avoid handling food under such circumstances. These results provide insights into students' food safety practices, highlighting areas of strength and potential risks.

The study findings reveal several important insights about food safety practices among Jahangirnagar University students. For example, 54.8% of students reported checking how food smells or looks before deciding what to do in the event of a power outage. In terms of food storage, 34% of students indicated that they store food in the refrigerator if someone is late for a meal and then reheat it later. Additionally, 39.2% of students determine whether food is properly cooked by tasting it or assessing its color, while 30.4% rely on cooking time. When it comes to handwashing before food preparation or eating, 63.2% use soap and wash with cold water, while 32.8% use only cold water.

Table 3 of the study highlights that, while Jahangirnagar University students generally possess a sufficient level of food safety knowledge, there is a clear need to further educate them on key topics such as aseptic practices, proper temperature control, preventing cross-contamination, and proper cooking techniques. Proper

Table 1 Demographic characteristics along with their categorization

Variables names	Descriptions	Categorization	Percentage (%)
Age	Age in 3-year groups	18–20	24.0
		21–23	44.8
		24–26	30.4
		27–29	0.8
Gender	Sex of respondents	Male	34.8
		Female	65.2
Residence	Type of place of residence	Urban	42.4
		Rural	44.4
		Suburb	12.4
		No answer	0.8
education level	Highest educational level of respondent	1st year	41.6
		2nd year	6.0
		3rd year	15.6
		4th year	23.2
		Post-graduation	13.6
Family type	Respondent's family type	Joint	19.6
		Nuclear	80.4
Family income	Respondent's monthly family income	< 20,000	37.6
		20,000–30000	26.8
		30,001–40000	18.0
		> 40,000	17.6
Live with family	Respondents living with their family	Yes	46.4
		No	53.6
Average study hour	Respondent's average study hour per week	0–30	88.0
		31–60	9.2
		61–90	2.4
		121–150	0.4
Food poisoning	Respondent's ever suffering from food poisoning	Yes	57.6
		No	42.4

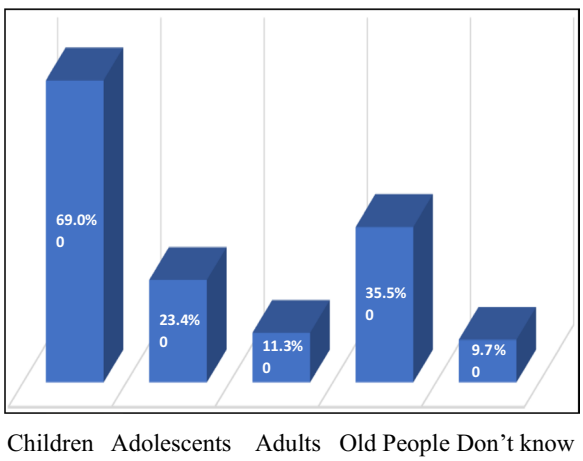

Fig. 1 Frequencies of the individuals most likely to get food poisoning

handwashing is emphasized as a critical practice, given that improper food handling is a major cause of many foodborne illnesses.

Children Adolescents Adults Old People Don't know.

The study also found that students' food safety behaviors correlate with their risk of food poisoning. Among the respondents, 25.6% of students who occasionally cook their own meals reported experiencing food poisoning, compared to just 5.6% of students who always cook or never cook. This suggests that students who cook occasionally may have lower awareness of food safety practices, making them more susceptible to foodborne illnesses. On the other hand, students who do not cook at all may rely on cafeteria food, which may offer different risks or food safety standards.

The study revealed that 46% of students living in nuclear families experienced food poisoning, compared to just 11.6% of those from joint families. This suggests that students in nuclear families may be more vulnerable

Table 2 Evaluation of food handling attitude and practices of food handlers

Variable names	Categorization	Percentage (%)
Self-Cooking habit	Cooks all the time	9.2
	Sometimes	42.8
	Rarely	34.8
	Never	13.2
Using knife after cutting raw meat or fish	Use the knife as it is	5.6
	Wash the knife with water	52.8
	Wipe the knife with a cloth/paper-towel	3.6
	Wash the knife with soap and water	25.6
	Not applicable	12.4
Checking date of expiration	Yes, all the time	60.0
	Most of the time	27.2
	Sometimes	10.0
	Rarely	2.4
	Never	0.4
Placing raw meat or fish in the refridgerator	Top shelf	32.4
	Middle shelf	9.2
	Bottom shelf	33.2
	Does not matter	11.2
	Not applicable	14
Time of washing hands with soap	< 10 s	20.8
	10–20 s	54.8
	20–30 s	24.4
Time of heating leftover food	Untill they are boiling hot	63.2
	Heat it to the temperature I prefer	20
	Just until they are at least at room temperature or 25 degree celsius	6.4
	Reheating is not necessary	3.2
	Not applicable	7.2
Handle food if have a wound on hand	Yes, as long as a bandage is applied to the wound	32.4
	Yes, provided that the wound is not infected	17.2
	Yes, provided that gloves are worn	4.4
	Handle the food with the wound as it is	3.6
	Not at all	42.4
Checking sufficiently cooked food	By checking the color or by taking the taste	39.2
	Juice content density or food concentration	18.8
	By checking the central temperature of the cooking pot	3.2
	By measuring the cooking time	30.4
	Not applicable	8.4
Washing hands after touching	Face	33.2
	Nose	48.8
	Dirty cooking utensils	73.2
	Clean utensils	8.4
	None of the above	8.4
Taking of jewelry while prepare foods	Yes	32.8
	No	16.4
	Sometimes	12
	Not applicable	38.8

Table 2 (continued)

Variable names	Categorization	Percentage (%)
Approaches during blackout if food is thawed or warm	Throw them right away	6.8
	Cook them right away	12.8
	See how they smell or look before deciding what to do	54.8
	Immediately re-fridge until future consumption	6.4
	Not applicable	19.2
Handling food if late for a meal	Store it in the refrigerator and reheat it when the person is ready to eat it	34
	Store it in anywhere until the person is ready to eat it	24.8
	Store it in a warm oven until the person is ready to eat it and not reheat again	4.4
	Store it in a cool oven and reheat it when the person is ready to eat	14.8
	Don't know	22.0
Washing fruits and vegetables using	Water and soap	6.0
	Hot water	5.2
	Water only	88.0
	Don't wash at all	0.8
Cleaning hands before preparing food or eating	Cold water	32.8
	Soap or hand-wash and cold water	63.2
	Wipe using towel or dishcloth	3.2
	Don't clean them at all	0.8

to food safety risks, possibly due to differences in food handling practices or family dynamics.

The study also found that 29.2% of students who smelled or inspected food before taking action during a blackout experienced food poisoning, the highest incidence. In contrast, only 4.4% of students who discarded the food immediately reported food poisoning, indicating that immediate disposal may reduce the risk.

Food poisoning was more prevalent among students who believed food should be refrigerated for just 1–2 days (29.2%) compared to those who thought it should be stored for 5–7 days (2.0%). This discrepancy may reflect a gap between students' knowledge of food safety and their actual food handling behaviors. Notably, students who stored raw meat or fish on the top shelf of the refrigerator were significantly more likely to suffer from food poisoning (22.4%) compared to those who stored it on the middle shelf (5.4%). Age also played a significant role in food poisoning risk. The 21–23 age group had the highest incidence of food poisoning (24.8%), while the 27–29 age group had the lowest (0.8%).

Bivariate analysis, shown in Table 4, revealed significant associations between predictors and food poisoning status. A Nagelkerke R-square value of 0.538 indicates that the predictors explain 53.8% of the variation in food poisoning incidence. The analysis found no significant multicollinearity issues, which would otherwise affect the accuracy of the results. Key predictors of food poisoning included the respondent's education level, knowledge of safe food storage practices, handling of thawed food during blackouts, and understanding of how long leftovers should be refrigerated. Logistic regression revealed that second- and third-year students were 3.47 and 3.49 times more likely to experience food poisoning, respectively, compared to first-year students, suggesting that food safety awareness may decline as students' progress through their studies.

Furthermore, from the results presented in Table 5, students who stored raw meat or fish on the bottom or middle shelves of the refrigerator, or who believed food could be stored anywhere in the fridge, were less likely to experience food poisoning (OR values between 0.078 and 0.336). Conversely, students who smelled or inspected food during a blackout (OR: 4.824) or refroze food (OR: 1.227) were more likely to suffer from foodborne illness. Finally, students who knew food should be refrigerated for 5–7 days (OR: 2.309) were more likely to experience food poisoning compared to those who believed food should be stored for only a day or two. Interestingly, those who answered "Don't know" to the question of how long food should be refrigerated may not refrigerate food at all, potentially leading them to consume fresher, less-contaminated food. These findings emphasize the importance of education on proper food handling to promote healthier lifestyles and reduce foodborne illness.

Table 3 Evaluation of food handling knowledge of food handlers

Variable names	Categorization	Percentage (%)
Micro-organisms that cause most foodborne diseases	Bacteria	68.0
	Fungi	12.4
	Viruses	1.6
	Parasites	2.0
	Don't know	16.0
Individuals are most likely to get food poisoning	Children	69.0
	Adolescents	23.4
	Adults	11.3
	Old people	35.5
	Don't know	9.7
Get food poisoning from	Foods taken out of the fridge immediately	23.2
	Raw or under-cooked meat	66.0
	None of the above	8.8
	Don't know	17.6
People with syndrome should not cook for others	Diarrhoea	52.8
	Headache	4.8
	AIDS	21.2
	Skin disease	49.2
	Don't know	11.2
Healthiest lifestyle	Eat more and sleep more	4.0
	Exercise	45.2
	Balanced diet	84.8
	Control body weight	39.6
	Don't know	4.0
True for expired food	It can be eaten as long as it appears good	4.4
	Expired food can be eaten after heating and boiling	4.8
	Expired food can't be eaten	82.8
	Do not know	8.0
Individuals should wash their hands before cooking and eating	With water	14.4
	With soap and water	81.2
	No need to wash hands	1.2
	Don't know	3.2
Leftover food should be stored in the refrigerator	1–2 days	53.2
	3–4 days	18.8
	5–7 days	5.6
	More than 7 days	7.2
	Don't know	15.2

Discussions

The primary goal of this research was to assess the food safety practices, attitudes, and knowledge among students at Jahangirnagar University. In our cross-sectional study, the respondents' answers revealed that, according to their knowledge, children are particularly vulnerable to food poisoning. This aligns with the findings of other studies. Individuals generally possess good knowledge of handwashing practices before cooking and eating. Many students in this study reported consistently washing their hands, a behavior that is similarly observed in studies by Naina et al. [18] and Ahmed et al. [3], where a large proportion of respondents followed proper hand hygiene before food preparation [12]. Abu Bakar & Abdullah [1] also found that 97.8% of students in public universities recognize handwashing as a key component of food safety practices, further supporting the importance of this behavior in preventing foodborne illness.

The study also found that students living in nuclear families experienced food poisoning more frequently

Table 4 Relationship between variables and food poisoning

Variable name	Categorization	Food poisoning (%)		Total (%)	*P* value
		Yes	No		
Self cooking	All the time	14 (5.6)	9 (3.6)	23 (9.2)	0.309
	Sometimes	64 (25.6)	43 (17.2)	107 (42.8)	
	Rarely	52 (20.8)	35 (14.0)	87 (34.8)	
	Never	14 (5.6)	19 (7.6)	33 (13.2)	
Family type	Joint	29 (11.6)	20 (8.0)	49 (19.6)	0.873
	Nuclear	115 (46.0)	86 (34.4)	201 (80.4)	
Food Handling Practice during Blackout	Throw them away	11 (4.4)	6 (2.4)	17 (6.8)	0.028
	Cook them right away	16 (6.4)	16 (6.4)	32 (12.8)	
	See how their scent or appearance before taking any action	73 (29.2)	64 (25.6)	137 (54.8)	
	Immediately refreeze until future consumption	15 (6.0)	1 (0.4)	16 (6.4)	
	Not applicable	29 (11.6)	19 (7.6)	48 (19.2)	
Time of leftover food should be in refrigerator	1–2 days	73 (29.2)	60 (24.0)	133 (53.2)	0.029
	3–4 days	29 (11.6)	18 (7.2)	47 (18.8)	
	5–7 days	5 (2.0)	9 (3.6)	14 (5.6)	
	More than 7 days	16 (6.4)	2 (0.8)	18 (7.2)	
	Don't know	21 (8.4)	17 (6.8)	38 (15.2)	
Shelf of refrigerator for placing raw meat or fish	Top Shelf	56 (22.4)	25 (10.0)	81 (32.4)	0.012
	Middle Shelf	13 (5.2)	10 (4.0)	23 (9.2)	
	Bottom Shelf	37 (14.8)	46 (18.4)	83 (33.2)	
	Does not matter	20 (8.0)	8 (3.2)	28 (11.2)	
	Not applicable	18 (7.2)	17 (6.8)	35 (14.0)	
Age	18–20	29 (11.6)	31 (12.4)	60 (24.0)	0.085
	21–23	62 (24.8)	50 (20.0)	112 (44.8)	
	24–26	51 (20.4)	25 (10.0)	76 (30.4)	
	27–29	2 (0.8)	0 (0.0)	2 (0.8)	

compared to those from joint families. This could be attributed to several factors, including differences in food handling practices and family dynamics. In nuclear families, where parents may both be working or the household size is smaller, students may have more individual responsibility for food preparation and consumption. This independence in food handling could lead to lapses in hygiene or food safety, despite a general awareness of food safety practices. In contrast, joint families often have a larger support network with multiple people involved in food preparation, which may lead to more shared responsibility, better oversight, and potentially better food handling practices. Furthermore, joint families may have more experience with traditional food preparation methods that emphasize food safety and hygiene. Our findings revealed that students who stored raw meat and fish on the top shelf of the refrigerator had a significantly higher risk of food poisoning (22.4%), compared to those who placed it on the middle shelf (5.4%). This discrepancy may be explained by temperature variations within the refrigerator. As recommended by food safety guidelines [12], raw meats should be stored on the bottom shelf of the refrigerator to prevent cross-contamination, as the bottom shelf tends to be the coldest part of the fridge. However, our study found a lower incidence of food poisoning among those who stored raw meat on the middle shelf. This could be due to several factors: students may not have been following recommended storage practices, possibly due to a lack of awareness or negligence, or they may have placed raw meat on the middle shelf out of convenience or space constraints, inadvertently avoiding contamination from drips that can occur when meat is stored higher up in the fridge. Furthermore, it is possible that the refrigerators in students' households had limited items or storage space, leading to fewer raw meats being stored on the bottom shelf. This, in turn, may explain the unusual pattern observed in our study. More research is needed to further explore the relationship between shelf

Table 5 Result of Logistic Regression of respondents ever suffered from food poisoning among the independent variables

Variable	Odds ratio	95% CI of OR		*P*-value
		Lower limit	Upper limit	
Education level				
1st year	0[a]			
2nd year	3.470	0.677	17.799	0.136
3rd year	3.493	0.394	30.972	0.261
4th year	1.719	0.264	11.191	0.571
Post-graduation	1.856	0.318	10.834	0.492
Self-cooking habit				
Cooks all the time	0[a]			
Sometimes	0.431	0.033	5.672	0.522
Rarely	0.137	0.021	0.892	0.038***
Never	0.245	0.042	1.416	0.116
Using knife after cutting raw meat or fish				
Use the knife as it is	0[a]			
Wash the knife with water	44.813	1.762	1139.537	0.021***
Wipe the knife with a cloth/paper-towel	5.504	0.825	36.723	0.078
Wash the knife with soap and water	28.350	0.593	1354.500	0.090
Not applicable	5.862	0.902	38.096	0.064
Shelf of refrigerator placing raw meat/fish				
Top shelf	0[a]			
Middle shelf	0.078	0.012	0.511	0.008***
Bottom shelf	0.110	0.013	0.955	0.045***
Does not matter	0.336	0.063	1.784	0.200
Not applicable	0.103	0.014	0.781	0.028***
Handle food if have a wound in hand				
Yes, as long as a bandage is applied to the wound	0[a]			
Yes, provided that the wound is not infected	1.987	0.708	5.579	0.192
Yes, provided that gloves are worn	0.925	0.247	3.455	0.907
Handle the food with the wound as it is	0.117	0.010	1.330	0.084
Not at all	0.904	0.073	11.193	0.937
Checking sufficiently cooked food				
By checking the color or by taking the taste	0[a]			
Juice content density or food concentration	11.681	1.116	122.290	0.040***
By checking the central				
Temperature of the cooking pot	9.269	0.818	105.061	0.072
By measuring the cooking time	14.718	0.372	582.434	0.152
Not applicable	26.23	2.200	312.670	0.010***
Time of heating leftover food				
Until they're blazingly hot	0[a]			
Heat it to the preferred temperature	0.116	0.010	1.309	0.082
Just until they are at room temperature or 25degree Celsius	0.141	0.011	1.827	0.134
Reheating is not necessary	0.175	0.010	3.151	0.237
Not applicable	0.026	0.000	1.621	0.083
Time of washing hands with soap				
< 10 s	0[a]			
10–20 s	0.685	0.164	2.861	0.604
20–30 s	0.706	0.240	2.070	0.525
Taking off jewellery while preparing foods				
Yes	0[a]			
No	1.120	0.359	3.495	0.845
Sometimes	1.197	0.259	5.521	0.818

Table 5 (continued)

Variable	Odds ratio	95% CI of OR		*P*-value
		Lower limit	Upper limit	
Not applicable	1.177	0.295	4.691	0.817
Approaches during blackout if food is thawed or warm				
Throw them away	0[a]			
Cook them right away	0.284	0.035	2.303	0.239
See how their scent or appearance before taking any action	4.824	0.690	33.715	0.113
Immediately refreeze until future consumption	1.227	0.301	4.996	0.775
Not applicable	0.163	0.007	3.760	0.258
Handling food if several hours late for a meal				
Store it in the refrigerator and reheat it when the person is ready to eat it	0[a]			
Store it in anywhere until the person is ready to eat it	1.324	0.339	5.182	0.686
Store it in a warm oven until the person is ready to eat it and not reheat again	0.785	0.192	3.214	0.737
Store it in a cool oven and reheat it when the person is ready to eat	34.360	0.977	1208.220	0.052
Don't know	1.982	0.413	9.519	0.393
Cleaning hands before preparing food or eating				
Cold water	0[a]			
Soap or hand-wash and cold water	1.331	0.005	366.150	0.920
Wipe using towel or dishcloth	1.418	0.005	420.424	0.904
Don't clean them at all	0.361	0.000	511.822	0.783
Washing fruits and vegetables using				
Water and soap	0[a]			
Hot water	0.806	0.072	9.033	0.861
Water only	1.055	0.116	9.562	0.962
Don't wash at all	1.349	0.426	4.273	0.611
Micro-organisms that cause most foodborne diseases according to food handlers knowledge				
Bacteria	0[a]			
Fungi	1.602	0.282	9.091	0.595
Viruses	0.276	0.025	3.109	0.298
Parasites	0.617	0.009	42.797	0.823
Don't know	1.250	0.043	35.942	0.896
True for expired food				
It can be eaten as long as it appears good	0[a]			
Expi red food can be eaten after heating and boiling	0.041	0.001	2.665	0.134
Expired food can't be eaten	0.779	0.014	42.172	0.902
Do not know	0.267	0.012	6.153	0.409
Individuals should wash their hands before cooking and eating				
With water	0[a]			
With soap and water	14.857	0.097	2276.763	0.293
No need to wash hands	11.654	0.085	1595.399	0.328
Don't know	9.480	0.011	8462.508	0.516
Time of leftover food should be in refrigerator				
1–2 days	0[a]			
3–4 days	0.513	0.109	2.416	0.399
5–7 days	2.309	0.318	16.778	0.408
More than 7 days	0.034	0.002	0.626	0.023***
Don't know	0.996	0.233	4.265	0.996

[a] Set to zero because it is reference category (ref) and ***represents statistical significance at 5%

storage, temperature regulation, and food safety in student households.

Improper food storage contributes to the risk of cross-contamination and foodborne illness. Furthermore, during blackouts, students who chose to smell or examine the food before deciding whether to eat it had the highest incidence of food poisoning (29.2%), whereas those who discarded the food immediately had the lowest incidence (4.4%). This underscores the importance of immediate food safety actions, such as discarding potentially spoiled food, rather than relying on sensory cues like smell or appearance, which may not accurately indicate whether food is safe to consume. The study also revealed that students who occasionally cook for themselves had the highest incidence of food poisoning, compared to those who cook regularly or never cook. This finding suggests that students who cook infrequently may be less knowledgeable or less consistent about food safety practices, which makes them more susceptible to foodborne illness. On the other hand, students who do not cook at all may be relying on cafeteria food, which is typically prepared under more controlled and regulated conditions. This aligns with the findings from Borneff et al. [5], which showed that food prepared at home is three times more likely to cause foodborne illness compared to food served in cafeterias. The World Health Organization [28] also reported that approximately 40% of foodborne outbreaks occur at home, which could explain the lower rates of food poisoning among students who eat at cafeterias. The study also found that students who believed food should only be refrigerated for 1–2 days (29.2%) were more likely to experience food poisoning, while those who believed food could safely be stored for 5–7 days (2.0%) had a lower incidence of foodborne illness. This discrepancy suggests that, although these students are aware of food safety guidelines, there may be a disconnect between their knowledge and actual food handling behaviors. This aligns with findings from previous studies, which have shown that individuals may understand food safety principles but fail to consistently apply them in practice [9, 22, 29].

Our analysis also revealed that second- and third-year students were more likely to experience food poisoning compared to first-year students. This suggests that as students progress in their academic careers, they may become more vulnerable to foodborne illnesses. One possible explanation is that these students may have greater autonomy over their food choices and preparation, leading to inconsistent food handling practices. As students approach graduation and eventually take on the role of food preparers for their own families, the risk of foodborne illness may increase. Educational institutions could play a crucial role in promoting food safety awareness and practices to reduce this risk [11]. In our study, food poisoning was significantly more common among younger students aged 21–23 (24.8%) compared to those aged 27–29 (0.8%), which stands in contrast to the findings of Mshelia et al. [16] and Zyoud et al. [32], both of which reported no significant association between age and food poisoning. There are several possible reasons for this discrepancy. First, contextual differences between the study populations may account for the contrasting results. Our study focused on university students in Bangladesh, where factors such as living conditions, food safety education, and cultural practices may differ from those in the populations studied by Mshelia et al. [16] and Zyoud et al. [32], which were conducted in different geographic and socioeconomic settings. For example, in Bangladesh, younger students, particularly those living away from home for the first time, may have less experience with food handling and hygiene since in-home mothers are responsible for cooking food and maintaining food hygiene like in Pakistan, which could lead to a higher incidence of foodborne illnesses Ullah et al. [27]. In contrast, the students in the other studies may have had more exposure to food safety practices through formal education or community initiatives Mullan et al. [17].

Second, our study found that younger students (21–23) are more likely to rely on convenience foods and eating out due to busy schedules or limited cooking skills, which increases the likelihood of food contamination. This behavioral pattern, combined with limited food safety awareness, could explain the higher rates of food poisoning among this age group. On the other hand, older students (27–29), with more life experience and cooking skills, may be more cautious and better equipped to handle food safely Mullan et al. [17]. Finally, peer influence and living arrangements may play a significant role. Younger students are more likely to live in shared accommodation or dormitories, where food handling practices can vary widely, and unsafe practices can spread among peers. This social factor may increase the risk of foodborne illness [14]. Older students, with more established living arrangements and possibly more responsibility for food safety, may exhibit safer practices, contributing to the lower incidence of food poisoning.

Students who believed food should be stored in the refrigerator for 5–7 days were more likely to experience food poisoning, suggesting a misunderstanding of the risks associated with long-term refrigeration (Ohio State University Extension, n.d. [20]). This highlights the need for clearer food safety education. Additionally, those who answered "Don't know" about refrigeration times may avoid refrigeration altogether, possibly consuming fresher food with shorter shelf lives, which could reduce

food poisoning risk. Students without refrigerators, who buy fresh food more often, also had lower rates of food poisoning, indicating that lack of refrigeration may limit foodborne illness by reducing bacterial growth [15]. Positive behaviors such as good hand hygiene, proper food storage, and immediate disposal during power outages are key to preventing foodborne illness. Educational institutions can play a vital role by promoting food safety awareness, benefiting students' health and their future roles as food handlers.

Conclusions

Overall, this research provides valuable insights into the food safety knowledge, attitudes, and practices of students at Jahangirnagar University in Bangladesh. The study revealed a significant gap between students' food safety knowledge and their actual food handling practices. Over half (57.6%) of students reported being prone to food poisoning, with key risk factors including being in the third year of study, consuming food during a blackout based on its appearance or smell, and believing food should be refrigerated for 5–7 days. Conversely, students who stored raw meat or fish on the middle shelf and those who believed leftover food should be kept in the fridge for more than seven days were less likely to experience food poisoning. This knowledge-practice gap underscores the need for interventions that not only enhance knowledge but also encourage behavior change. These findings suggest that certain food safety misconceptions and behaviors, such as improper food storage and consuming questionable food, increase the risk, while safer practices like proper refrigeration reduce it. Based on our findings, we recommend integrating food safety education into the curriculum, especially for students in health-related fields, and including practical workshops on safe food handling. Universities should also organize awareness campaigns via social media and peer-led programs to reinforce food safety practices. Improving campus facilities, such as food storage and kitchen hygiene in dormitories, is essential for supporting safer food handling. Additionally, universities should collaborate with food vendors and cafeterias to ensure compliance with food safety standards through regular training and monitoring. Future research should focus on longitudinal studies to track how food safety knowledge and practices change over time, particularly as students gain more independence. This would help identify causal relationships and long-term trends. Additionally, evaluating the effectiveness of interventions such as education programs and awareness campaigns will be crucial in refining strategies to improve food safety behaviors. Finally, studies should explore how demographic factors like socioeconomic status, educational background, and regional differences impact food safety knowledge and practices among students in different parts of Bangladesh.

Recommendations

To improve food safety among students, the education system in Bangladesh should integrate food safety into the curriculum, especially in health, nutrition, and hospitality courses. This would equip students with foundational knowledge on safe food handling. Awareness campaigns through social media, posters, and seminars can help inform students about the risks of unsafe food practices. Peer education programs, where trained students mentor their peers, can also promote safe food practices on campus. Universities should provide access to proper cooking equipment, food storage, and educational materials to support safe handling.

Moreover, specific agencies like the Bangladesh Food Safety Authority (BFSA) and local health departments must establish and enforce clear food safety protocols for food handlers, particularly in university cafeterias and student-run food outlets. These agencies should regularly monitor compliance with hygiene standards, ensuring that food service staff are properly trained. The Department of Public Health should also collaborate with educational institutions to create and enforce food safety training programs for food handlers. Further, food vendors and cafeteria operators must comply with these protocols to prevent foodborne illnesses. Research, particularly longitudinal studies, should be conducted to explore food safety behaviors across various demographic groups in Bangladesh, which will help refine food safety education programs and policies, ultimately reducing foodborne diseases.

Strength and limitations of study

Strengths

This study offers valuable insights into food safety practices among students, with a particular focus on comparing those from nuclear versus joint families. A key strength of this study is its broad participant pool, which enhances the representativeness of the sample. Additionally, the focus on practical, everyday behaviors, such as food storage and handling, provides direct, actionable data for improving food safety practices among student populations.

Limitations

However, there are some limitations to the study. First, the research is cross-sectional, meaning it captures data at a single point in time, limiting the ability to establish causality between food handling practices and foodborne illness. Second, the reliance on self-reported data may lead to recall or response bias, as participants

may not accurately report their food handling behaviors. Third, while the study provides valuable insights, the sample size may not be large enough to account for all demographic and cultural variations in food handling practices, which could affect the generalizability of the findings. Lastly, we did not control for certain confounding variables such as participants' access to food safety education or their personal health history, which might also influence their risk of food poisoning.

We believe these strengths make the study informative, but the limitations should be kept in mind when interpreting the results. Further research using longitudinal designs and more diverse samples would be helpful in confirming these findings and providing a clearer understanding of the factors that contribute to foodborne illness among students.

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Author contribution
SA: data collection, data curation, formal analysis, writing original draft, editing, supervision. NS: conceptualization and design, methodology, data collection, editing, supervision. SY: editing and writing original draft. STP: data collection, writing original draft. SS: data collection, editing, supervision. MKMA: editing, supervision.

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Availability of data and materials
The data will always be accessible upon request.

Declarations

Ethics approval and consent to participate
This study utilized primary data, and participants were fully informed about the study's objectives and significance before the survey administration. They were assured that all information provided would remain confidential. To ensure informed consent, the survey included basic Yes/No agreement questions to obtain the participants' verbal consent. Ethical guidelines, including those set out in the Helsinki Declaration, were followed throughout the study to address the ethical considerations of using human subjects.

Consent for publication
Not applicable.

Competing interest
There are no conflicting interests for authors.
The authors declare no competing interests.

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