Food Safety Concerns and Practices Among Palestinian University Students: A Cross-Sectional Study

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Abstract
University students constitute a target for risk-reduction interventions regarding food poisoning as they are among those with higher exposure to problematic food. This is particularly important since young adults’ knowledge regarding measures to prevent foodborne illnesses was found to be inadequate. Therefore, the objectives of this study were to assess knowledge, attitudes, and practices regarding food safety and food poisoning among An-Najah National University Students and to investigate the correlation of their knowledge, attitudes, and practices with various socio-demographic characteristics and academic variables. The cross-sectional design was used, and the study occurred at An-Najah National University in Nablus. Data was collected using a native Arabic language face-to-face questionnaire. Verbal consent was obtained before initiation. The questionnaire has four parts that address students’ demographic data, knowledge, attitudes, and practice. A sample of 450 students was invited to complete the questionnaire. Half the respondents were aged 17 to 20, and more than half (57.1%) were females. The median knowledge score was 10.00 [8.75–12.0]. A significant correlation was found between the food poisoning knowledge and attitude scores of students (r = .339, p < .001), a significant correlation between food poisoning knowledge and attitude scores (r = .285, p < .001), and a significant correlation between attitude and practice scores (r = .429, p < .001). The current study found significant correlations between knowledge, attitude, and practices of university students regarding food safety. Female respondents also had better attitudes and more hygienic food practices. The results can help students prepare effective methods to understand food poisoning better and improve their knowledge and awareness. The study also indicates that more comprehensive and focused education regarding food safety is required for this population.

Keywords
food safety, hygiene, university students, Palestine, knowledge, attitude, practice

Introduction
Food can transmit disease-causing agents as well as their performed toxins that cause foodborne diseases, which are becoming a global concern (Bintsis, 2017). The emergence of novel and traditional foodborne diseases has been linked to many factors, including changes in human demographics, food choices, food production, and distribution changes, lack of support for public health resources, microbial adaptation, and increasing travel (Smith & Fratamico, 2018). Stages that food passes through before reaching the consumer include farming, harvesting, processing, storage, transport, and distribution. Contamination from contaminated water, soil, or air can potentially occur at any of these stages (World Health Organization [WHO], 2022). As a result, millions of people get sick and thousands die from foodborne diseases annually (WHO, 2022). More than 200 foodborne illnesses have been described, including viral, bacterial, and parasitic illnesses and illnesses caused by chemicals and radioactive substances, among others (Bintsis, 2017).

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Food poisoning manifestations are related to the microbe ingested. Symptoms can take hours, days, or even weeks to appear after food is ingested, including diarrhea, nausea, vomiting, abdominal pain, fever, and, to a lesser extent, neurological symptoms (Acheson, 2015a; WHO, 2014). Everyone is at risk of contracting food poisoning, but some groups are far more likely to be affected and to develop a serious illness with long-term sequelae if affected, including the elderly, infants and young children, pregnant women, immune-suppressed patients, cancer patients, and patients with other chronic illness such as diabetes and kidney disease (Home Food Safety, 2021). Improper food handling, cooking, storage, and reheating also increase the chance of developing food poisoning (Acheson, 2015b).

Achieving food safety is a multidisciplinary responsibility, requiring expertise from toxicologists, microbiologists, parasitologists, health economists, nutritionists, and human and veterinary physicians. Local communities and the education system also have a vital role in ensuring food safety (WHO, 2015). A 2021 study from Jordan, a neighboring country, assessed food safety knowledge among university students and found it insufficient (Osaili et al., 2021). A similar study in Saudi Arabia reported fair knowledge regarding food poisoning among university students (Al-Mohaithef et al., 2020). Another study from Kuwait revealed poor food safety knowledge among university students (Ashkanani et al., 2021). Similar studies from other parts of the world reported more or less consistent knowledge gaps regarding this topic (Ali et al., 2018; Dagne et al., 2021; Mshelia et al., 2022; Zhang et al., 2020). These findings are worrying, considering that knowledge, attitudes, and practices regarding food safety greatly affect food poisoning incidence. It seems that this issue is problematic in Arabic nations and other countries. The Palestinian society has a distinct character as it is considered closed, and the Palestinians have difficulties in moving between countries will affect in sharing of the experiences of developed countries. Therefore, it is better to study Palestinians’ experiences in food safety and poisoning.

Furthermore, to the best of our knowledge, only one study was conducted to assess food safety perceptions and practices followed in Palestine among a cohort of parents (Zyoud et al., 2019). This study urged the public’s need for awareness campaigns and educational programs. However, no studies have assessed university students’ practices and knowledge regarding food poisoning. Therefore, this study assesses An-Najah National University students’ food poisoning knowledge, attitudes, and practices. The relationship between socio-demographic factors and knowledge, attitudes, and practices regarding food poisoning was also explored. This study’s results will help direct education decisions to decrease the incidence of foodborne diseases. Additionally, the data generated in this study provides an important basis that can guide further research that aims to improve food safety in the country.

**Methods**

**Study Design**

A cross-sectional study design was implemented to evaluate knowledge, practices, and attitudes regarding food poisoning using a self-administered survey instrument.

**Study Setting and Population**

The study was conducted at An-Najah National University in Nablus, Palestine. The target population was An-Najah National University students from different faculties.

**Sample Size and Sampling Procedure**

Raosoft sample size calculator (http://www.raosoft.com/samplesize.html) was used to calculate the sample size needed for this study. The total population of the university is approximately 23,000 students. The predetermined margin of error was 5% and the confidence level was 95%. The approximated sample size was 377 students. The target sample size was increased to 450 to minimize erroneous results and increase study reliability. The inclusion criterion was being a university student who lived in dorms or in his or her home.

**Data Collection Form**

A self-administered native Arabic language questionnaire was used. We adopted the questionnaire from a previous study concerning the same topic and received permission to use it in this study (Sharif & Al-Malki, 2010). The questionnaire consisted of four parts (50 core questions or statements):

1. The first section consisted of questions concerned with demographic and other background data (age, gender, school year, faculty, type of residency, marital status, the person responsible for food preparation in their household, and the number of meals consumed).
2. The second section contained questions concerned with food poisoning knowledge (15 questions).
3. The third section contained questions concerned with food poisoning attitudes (15 questions).
4. In the fourth section, students were asked about food poisoning practices (20 questions).

**Data Collection Procedure**

Data collection was done by interviewing students face-to-face. A convenient selection of the participants was used. Participants read a consent form that explains the research purpose and assures them about the confidential nature of the data collected. Afterward, they were offered a free, voluntary choice between accepting and refusing to participate.
**Pilot Study**

To ensure the significance and simplicity of the study questions, the questionnaire was sent to specialists, including toxicologists and academic researchers. A pilot study on 15 participants was conducted to validate the questionnaire and test the simplicity of the questions, in addition to determining the duration of the interview. Cronbach’s alpha for all tested domains (knowledge, attitude, and practice) was more than .7, indicating acceptable reliability.

**Ethical Consideration**

This study was Institutional Review Board (IRB) authorization. Additionally, verbal consent was obtained from students before initiation. The collected data was used only for research purposes and was accessed only by the researchers.

**Data Statistical Analysis**

SPSS version 22 was used for data analysis. Descriptive statistics were calculated for demographic data to show the respondents’ characteristics. Descriptive statistics were calculated for students’ responses to knowledge and attitudes. Frequencies and percentages were calculated for each of the 30 questions that measured knowledge and attitudes after the responses were recorded from the five categories of the Likert scale (strongly agree, agree, not sure, disagree, and strongly disagree) into three categories wherein strongly agree and agree were combined as agree, and strongly disagree and disagree were combined in to disagree. Descriptive statistics were calculated for students’ practice. The frequencies and percentages of answers were calculated for each of the 20 questions that measured the students’ practice after recoding the responses from the five categories—always yes, most of the time, sometimes, rarely, always no—into yes/no answers were yes including those who always answered yes, sometimes, and most of the time sometimes whereas no included those who answered rarely and always no. Responses were translated into dichotomous (binary) variables for analysis. Previous studies have shown that the Likert scale’s consolidation to binary format does not affect the results (Rogith et al., 2014; Zyoud et al., 2019). The responses of students were recorded as either wrong or correct, where a wrong answer received no points, whereas a correct one was given 1 point, then the sum of points that were calculated for each of the knowledge items was named “total knowledge,” and that of the attitude items was named “total attitude,” and that of the practice items was named “total practice.” The association between total knowledge, total attitude, total practice, and binary (two categories) demographic variables was tested using the Mann–Whitney U test when normality was violated. Variables not normally distributed were expressed as medians (lower–upper quartiles), and normally distributed ones were expressed as mean ± standard deviation (SD). The association of total knowledge, total attitudes, and total practice with polytomous (more than two categories) demographic variables was tested using the Kruskal–Wallis H test when normality was violated. Calculation of the Pearson correlation coefficient was done to determine the correlation of continuous variables, including knowledge score, attitude scores, and practice score. *p*-Value <.05 was considered statistically significant.

**Results**

**Socio-Demographic Data**

A sample of 450 respondents was invited to fill the questionnaire, and Table 1 describes the respondents’ characteristics in detail. Almost half of the respondents (50.6%) were aged between 17 and 20 years, while the other half (48.9%) were aged between 21 and 30. Female respondents were slightly more than half (57.1%). When distributed in terms of the study year, 29.1% wherein their fourth year, which is the study year with the highest percentage of students. A majority of 61.1% reported that they lived with their families, and 49.8% of the respondents were coming from cities. The great majority (95.1%) were single in terms of marital status. Most of the students (73.3%) said that their mothers prepared their food. Regarding the number of meals consumed at home, only a minority (11.8%) reported that as an everyday routine.

**Knowledge**

Regarding Students’ knowledge, the rate of correct answers varied between 57.8% and 93.8%. “Eating uncovered leftover cooked food, kept at room temperature for 12 to 24 hours, is at high risk to cause food poisoning” was answered correctly by only 57.8% of the students. Table 2 summarizes student’s knowledge responses in detail.

**Attitude**

Only 5 of the 15 questions in this section were answered positively by more than 60% of the students: “Ingestion of raw meat of young animals possesses no risk of disease,” with which 66.2% of students disagreed; “Handling of food by individuals with no clinical symptoms can result in contamination of food with microbes and can subsequently cause food poisoning” with which 72.9% of students agreed; “It is necessary to wash hands with water and soap prior to ingestion of food to prevent for the occurrence of food poisoning” with which 86.7% of them agreed; “cleaning hands with soap and water can prevent food poisoning” with which 85.8% of the students agreed; and “It is necessary to wash hands with soap and water before preparing food to prevent food poisoning” with which 85.6% of the students agreed. Table 3 presents students’ responses to attitude items.
Only 4 practices out of 20 were answered positively by less than 60% of the respondents: “Do you get fresh vegetables and fruits to be washed?” (53% said they did not), “Do you eat fresh vegetables and fruits just after having them wiped?” (43.6% said they did), “When you go on a trip, do you eat herbs or vegetables that you pick without having them washed?” (50.6% said they did not), and “Do you eat cooked food that was left at room temperature for more than 6 hours without sufficiently heated?” (41.1% said they did not). Table 4 shows students’ responses to the practice items.

**Description of Total Knowledge, Total Attitude, and Total Practice**

The mean knowledge score was 10.37 and its standard deviation was 2.80. The median, on the other hand, was 10.00, with lower and upper percentiles of 8.75 and 12.0, respectively. There was a significant correlation between students’ food poisoning knowledge score and attitude score ($r = .339$, $p < .001$). There was also a significant correlation between students’ food poisoning knowledge score and practice score ($r = .285$, $p < .001$). Attitude and practice score correlation was also found to be significant ($r = .429$, $p < .001$).

**Association of Socio-Demographic Factors With Food Poisoning Knowledge**

There was a significant association between the knowledge scores and four of the demographic variables: Age group ($p = .009$), scholastic year ($p = .005$), faculty ($p < .001$), and the number of meals outside the home ($p = .002$). Table 5 presents the association of socio-demographic factors with food poisoning knowledge.

**Association of Socio-Demographic Factors With Attitudes Toward Food Poisoning**

Table 6 shows the association of socio-demographic factors with attitudes toward food poisoning. The results have shown an association between the attitude score and five demographic variables: age group ($p < .001$), gender ($p = .045$), scholastic year ($p < .001$), faculty ($p < .001$), and the number of meals outside the home ($p = .04$).

**Association of Socio-Demographic Factors With Food Poisoning-Related Practices**

Table 7 shows the association of practice scores with the socio-demographic variables. The results have shown an association between practice scores and only two socio-demographic variables: gender ($p < .001$) and the number of meals away from home ($p = .039$).
Table 2. Rates of Participating Students’ Responses to Knowledge Items.

| Question statement | Agree | Not sure | Disagree |
|--------------------|-------|----------|-----------|
| 1. Pathogenic microbes are the cause of food poisoning. | 421 (93.8) | 21 (4.7) | 7 (1.6) |
| 2. Some microbe’s toxins which cause food poisoning could resist the heating temperature of food. | 268 (59.8) | 106 (23.7) | 74 (16.5) |
| 3. Drinking Raw milk is considered as a risk factor for food poisoning. | 331 (73.7) | 85 (18.9) | 33 (7.3) |
| 4. Eating Raw poultry products is considered as a risk factor for food poisoning. | 260 (58.6) | 99 (22.3) | 85 (19.1) |
| 5. Eating undercooked meat is considered as a risk factor for food poisoning. | 373 (84.0) | 43 (9.7) | 28 (6.3) |
| 6. Eating unwashed vegetables possesses a risk for food poisoning. | 343 (76.7) | 55 (12.3) | 49 (11.0) |
| 7. Eating unpeeled, unwashed fruits is considered as a risk factor for food poisoning. | 308 (68.9) | 68 (15.2) | 71 (15.9) |
| 8. Unhygienic Practices might be the source of food contamination with microbes that could cause food poisoning. | 381 (85.0) | 47 (10.5) | 20 (4.5) |
| 9. Well-cooking could kill the microbes that could cause food poisoning. | 305 (69.0) | 72 (16.3) | 65 (14.7) |
| 10. Eating well-cooked, uncovered food, and preserved for more than 12 to 14 hours at room temperature, is considered as a risk factor for food poisoning. | 257 (57.8) | 133 (29.9) | 55 (12.4) |
| 11. Uncooked/raw white cheese is considered as a risk factor for food poisoning. | 261 (58.8) | 103 (23.2) | 80 (18.0) |
| 12. Pasteurized milk is not considered as a risk factor for food poisoning. | 268 (60.9) | 113 (25.7) | 59 (13.4) |
| 13. Refrigerator temperature is enough to stop microbial growth and prevent food poisoning. | 337 (76.1) | 79 (17.8) | 27 (6.1) |
| 14. Drinking untreated water, such as lakes and rivers, is considered as a risk factor for food poisoning. | 287 (64.3) | 98 (22.0) | 61 (13.7) |
| 15. Eating cooked food, preserved in refrigerator for 2–3 days, is not considered a risk factor for food poisoning. | 265 (60.2) | 111 (25.2) | 64 (14.5) |

*Correct answers are in bold.*

Discussion

This study was designed to evaluate knowledge, attitudes, and practices regarding food poisoning among An-Najah National University students. To our best knowledge, this is the first study of its kind to be conducted in Palestine.

Food safety KAP was evaluated among different groups in different Arab countries. For example, a study in Saudi Arabia reported fair knowledge regarding foodborne diseases among electronic university students (Al-Mohaithef et al., 2020). However, a similar study from Kuwait revealed poor food safety knowledge (Ashkanani et al., 2021). In another Arabic country like Lebanon, a study found low food safety knowledge and poor practices among food handlers and recommended continuous education for this group (Hassan et al., 2018). Food safety KAP was also assessed during the COVID-19 pandemic in Jordan and showed insufficient scores among university students (Osaili et al., 2021). These results showed a gap in knowledge and practices regarding food safety in Arab countries in different groups, which necessitates greater attention to this significant issue.

The responsibilities of the families living in the eastern side of the world in terms of household and preparing food are carried out almost by females. In this study, findings supported that most respondents reported that their mothers are the ones responsible for food preparation. This is consistent with other studies reporting that mothers’ contribution to cooking is more than that of other family members (Ashkanani et al., 2021; Mb et al., 2017; Shati et al., 2021; Zyoud et al., 2019). Individuals responsible for preparing food to consider that food prepared outside the home renders them susceptible to food poisoning compared with that prepared inside the home (Meyenburg et al., 2014; Sudershnan et al., 2008). In fact, a large percentage of foodborne illnesses occur due to improper handling and preparing the food at home (WHO, 2020). Although, a study found that Saudi women had improved knowledge regarding buying and storing of food as compared with food preparation, almost half of the sample had poor knowledge of food preparation safety (Arfaoui et al., 2021).

It should be noted that using clean and hygienic equipment during preparation prevents food contamination (Marriott et al., 2006). On the other hand, food handling, under-cooking, storing at inadequate temperature, and many other factors may contribute to causing food poisoning (Alsayeqh, 2015). In many episodes, foodborne outbreaks were associated with improper handling of food at home (Yeman & Tamene, 2022). However, recently, women tend to work and rely less on home food (Lange, 2017). Many studies published on food poisoning showed that many factors influence food safety knowledge, attitudes, and practice, including age, gender, residency, and education (Mekonnen et al., 2021; Mshelia et al., 2022; Shati et al., 2021; Yeman & Tamene, 2022). Older age, along with an increased length of practice, is associated with increased knowledge. Moreover, a previous study found that females...
had higher knowledge scores than males (Green & Knechtges, 2015). Another study also concluded that females are better informed regarding appropriate food handling compared to males (Zeeshan et al., 2017), which was also supported by another published paper that was conducted looking at university students’ knowledge of food poisoning (Osaili et al.,

| Table 3. Rates of Participating Students’ Responses to Attitude Items. |
|---------------------------|-------------------|-------------------|-------------------|
| Question statement | Agree | Not sure | Disagree |
| 1. Raw dairy products are healthier than boiled/pasteurized products. | 132 (30.1) | 109 (24.8) | 198 (45.1) |
| 2. Drinking raw dairy products is not considered as a risk factor for food poisoning. | 109 (24.8) | 102 (23.2) | 229 (52.0) |
| 3. Drinking raw camel’s milk is not considered as a risk factor for food poisoning. | 107 (24.5) | 124 (28.4) | 206 (47.1) |
| 4. Eating raw poultry products is healthier than cooked poultry products. | 100 (23.4) | 114 (26.7) | 213 (49.9) |
| 5. Eating raw poultry products is not considered as a risk factor for food poisoning. | 108 (25.2) | 108 (25.2) | 212 (49.5) |
| 6. Eating young animal’s meat is not considered as a risk factor for food poisoning. | 66 (15.2) | 81 (18.6) | 288 (66.2) |
| 7. Wiping fruits or vegetables only, is enough to eat them safely, and considered as a way to prevent food poisoning | 107 (24.4) | 94 (21.5) | 237 (54.1) |
| 8. Cooked food preserved for 1 day at room temperature, is not considered as a risk factor for food poisoning. | 185 (42.1) | 147 (33.5) | 107 (24.4) |
| 9. Eating unwashed vegetables/herbs collected from the plants right away is not considered as a risk factor for food poisoning. | 122 (27.9) | 81 (18.5) | 235 (53.7) |
| 10. Pathogenic microbes are not existed in healthy baby feces. | 85 (20.0) | 130 (30.5) | 211 (49.5) |
| 11. Drinking untreated rain water from its reservoirs is safe. | 135 (31.3) | 108 (25.0) | 189 (43.8) |
| 12. Pathogenic microbes, capable of causing food poisoning, have the ability to be transmitted by asymptomatic food handlers. | 320 (72.9) | 57 (13.0) | 62 (14.1) |

| Table 4. Rates of Participating Students’ Responses to Practice Items. |
|---------------------------|-------------------|-------------------|
| Question statement | Yes | No |
| 1. Do you rinse vegetables/fruits with water prior to eating? | 429 (97.1) | 13 (2.9) |
| 2. Do you have your hands cleaned with water and soap prior to eating? | 427 (97.0) | 13 (3.0) |
| 3. Do you have your hands cleaned with water and soap prior to preparing food? | 418 (95.0) | 22 (5.0) |
| 4. Do you have your hands cleaned with soap and water after holding unwashed vegetables? | 346 (78.6) | 94 (21.4) |
| 5. Do you have your hands cleaned with water and soap after using the bathroom? | 430 (97.9) | 9 (2.1) |
| 6. Do you clean your hands after touching any animal? | 420 (95.7) | 19 (4.3) |
| 7. Do you eat unwashed fruits/vegetables? | 202 (46.1) | 236 (53.9) |
| 8. Are you satisfied with only wiping vegetables/fruits prior to eat them? | 246 (56.4) | 190 (43.6) |
| 9. When you travel somewhere, Do you eat unwashed vegetables/herbs collected directly from the plants? | 217 (49.4) | 222 (50.6) |
| 10. Do you eat raw poultry products? | 71 (16.2) | 367 (83.8) |
| 11. Do you eat under-cooked poultry products? | 160 (36.8) | 275 (63.2) |
| 12. Do you eat uncooked meat? | 65 (14.9) | 370 (85.1) |
| 13. Do you under-cooked meat? | 91 (20.9) | 345 (79.1) |
| 14. Do you eat raw dairy products? | 78 (17.7) | 362 (82.3) |
| 15. Do you drink unpasteurized camel’s milk? | 66 (15.1) | 371 (84.9) |
| 16. Do you eat raw cheese obtained from unpasteurized milk? | 159 (36.1) | 281 (63.9) |
| 17. Do you eat cooked food preserved for more than 6 hours at room temperature? | 261 (58.9) | 182 (41.1) |
| 18. Do you eat anything from restaurants, even if it doesn’t look good? | 86 (19.7) | 351 (80.3) |
| 19. Do you drink untreated rain water directly from its reservoir? | 136 (30.7) | 307 (69.3) |
| 20. Do you eat food from big shared plates? | 120 (27.1) | 323 (72.9) |

aCorrect answers are in bold.
Table 5. Association Between Socio-Demographic Characteristics of Participants and Food Poisoning Knowledge Score.

| Variables             | Median (Q1–Q3) | p-Value* |
|-----------------------|----------------|----------|
| Age (years)           |                |          |
| 17–20                 | 10.0 (8.0–12.0) | .009a    |
| 21–30                 | 11.0 (9.0–13.0) |          |
| 31 or more            | 14.0 (14.0–14.0)|          |
| Gender                |                |          |
| Male                  | 10.0 (8.0–12.25)| .088b    |
| Female                | 11.0 (9.0–12.0)|          |
| Scholastic year       |                |          |
| 1                     | 10.0 (8.0–12.0) | .005a    |
| 2                     | 10.0 (8.5–12.0)|          |
| 3                     | 10.0 (8.0–12.0)|          |
| 4                     | 11.0 (8.0–13.0)|          |
| 5                     | 10.0 (8.0–12.0)|          |
| 6                     | 13.5 (11.25–15.0)|        |
| Faculty               |                |          |
| Literature            | 10.0 (8.0–13.0) | <.001a   |
| Journalism            | 9.5 (6.75–11.0)|          |
| Commerce              | 10.0 (8.0–12.0)|          |
| Sciences              | 10.0 (8.0–12.0)|          |
| IT and engineering    | 10.0 (8.0–12.0)|          |
| Law                   | 10.0 (8.0–12.0)|          |
| Medicine              | 12.0 (10.0–13.0)|        |
| Pharmacy              | 10.0 (7.5–13.5)|          |
| Physical sciences     | 10.0 (9.0–11.75)|        |
| Other                 | 12.0 (9.0–15.0)|          |
| Type of housing       |                |          |
| Students dorm         | 10.0 (9.0–12.0) | .586b    |
| Family home           | 10.0 (8.0–12.0)|          |
| Residency             |                |          |
| City                  | 10.0 (8.0–12.0) | .339a    |
| Village               | 11.0 (8.0–12.0)|          |
| Palestinian refugee camps | 11.5 (9.75–14.0)|  |
| Marital status        |                |          |
| Single                | 10.0 (8.0–12.0) | .231b    |
| Married               | 11.0 (9.75–13.25)|        |
| Children              |                |          |
| Have children         | 11.0 (11.0–14.5)| .496b    |
| Does not have children | 11.0 (9.0–13.0)|          |
| Food prepared by      |                |          |
| Mother                | 11.0 (9.0–12.0) | .428a    |
| Father                | 11.5 (8.0–13.25)|        |
| Grandmother           | 7.0 (2.0–7.0)  |          |
| Other                 | 10.0 (8.0–12.0)|          |
| Meals consumed outside home |        |          |
| Never                 | 10.0 (8.0–13.0) | .002a    |
| 1–3 meals per month   | 11.0 (10.0–13.0)|        |
| 1–2 meals per week    | 11.0 (9.0–12.0)|          |
| More than 2 meals per meal | 10.0 (8.0–12.0)|        |
| Everyday              | 10.0 (8.0–11.0)|          |

*Statistical significance has been measured using Kruskal–Wallis H test
bStatistical significance has been measured using Mann–Whitney U test.
*p-Value in bold are below the significance level of .05.

Table 6. Association Between Socio-Demographic Characteristics of Participants and Food Poisoning Attitude Score.

| Variables             | Median (Q1–Q3) | p-Value* |
|-----------------------|----------------|----------|
| Age (years)           |                |          |
| 17–20                 | 8.0 (5.0–10.0) | <.001a   |
| 21–30                 | 10.0 (6.0–13.0)|          |
| 31 or more            | 11.5 (10.0–11.5)|       |
| Gender                |                |          |
| Male                  | 8.0 (4.0–11.0) | .045b    |
| Female                | 9.0 (6.0–12.0)|          |
| Scholastic year       |                |          |
| 1                     | 8.0 (4.0–10.0) | <.001a   |
| 2                     | 8.0 (5.0–11.0)|          |
| 3                     | 7.0 (5.5–10.0)|          |
| 4                     | 10.0 (6.0–12.0)|        |
| 5                     | 9.0 (5.5–12.5)|          |
| 6                     | 12.5 (7.75–14.0)|       |
| Faculty               |                |          |
| Literature            | 6.0 (5.0–10.0) | <.001a   |
| Journalism            | 7.0 (4.75–9.25)|        |
| Commerce              | 6.0 (4.0–9.5) |          |
| Sciences              | 10.0 (4.0–12.0)|        |
| IT and engineering    | 9.0 (6.0–11.0)|          |
| Law                   | 8.0 (3.0–10.0)|          |
| Medicine              | 11.0 (9.0–13.0)|        |
| Pharmacy              | 10.0 (4.0–11.5)|        |
| Physical Sciences     | 8.0 (5.25–11.75)|        |
| Other                 | 10.0 (4.0–11.0)|        |
| Type of housing       |                |          |
| Students dorm         | 10.0 (6.5–12.0) | .062b   |
| Family home           | 9.0 (6.0–11.0)|          |
| Residency             |                |          |
| City                  | 8.5 (5.0–11.0) | .421a   |
| Village               | 8.0 (4.0–11.0)|          |
| Palestinian refugee camps | 9.5 (7.25–11.0)|    |
| Marital status        |                |          |
| Single                | 9.0 (5.0–11.0) | .552b   |
| Married               | 10.5 (4.0–13.0)|        |
| Children              |                |          |
| Have children         | 12.0 (5.0–13.0) | .710b   |
| Does not have children | 9.0 (4.0–13.0)|          |
| Food prepared by      |                |          |
| Mother                | 9.0 (6.0–11.0) | .467a   |
| Father                | 5.0 (3.75–9.25)|          |
| Grandmother           | 6.5 (1.0–6.5) |          |
| Other                 | 9.0 (5.0–12.0)|          |
| Meals consumed outside home |        |          |
| Never                 | 8.0 (4.0–11.0) | .040a   |
| 1–3 meals per month   | 9.0 (6.0–12.0)|          |
| 1–2 meals per week    | 9.0 (6.0–11.5)|          |
| More than 2 meals per week | 8.0 (5.0–12.0)|        |
| Everyday              | 7.0 (5.0–10.0)|          |

*Statistical significance has been measured using Kruskal–Wallis H test
bStatistical significance has been measured using Mann–Whitney U test.
*p-Value in bold are below the significance level of .05.
In contrast to this, some studies reported better knowledge regarding food poisoning in males (Ashkanani et al., 2021; Shati et al., 2021). Risky food-related attitudes are more common among people with low education levels and low-income (Farahat et al., 2015; Zyoud et al., 2019). The lack of food safety courses in schools and universities could explain the inadequate knowledge regarding food poisoning (Byrd-Bredbenner et al., 2007). Individuals with higher education levels, such as university graduates and undergraduates, and those working in the nutrition field were found to have higher levels of knowledge compared to those with high school graduates (Meyenburg et al., 2014). However, one study found that individuals with university education had more risky practices than those without higher education, despite having better knowledge (Patil et al., 2005). Another study also found that persons with higher socioeconomic status were less worried about food safety as well (Al-Sakkaf, 2015). This inconsistency may be due to lack of experience with handling and preparing food.

On the other hand, the current study shows a significant association between the educational level of students and their knowledge score, wherein those with higher levels of education had higher knowledge scores. Students in the higher academic year also scored higher than those in more junior years on the knowledge score, as well as on the attitude score. In addition, students with increasing numbers of meals consumed outside the home scored lower than those mainly consuming meals at home, not only on the knowledge score, but also on attitude and practice scores. These findings could be linked to the improper handling of food at restaurants or university cafeterias. Gender, however, did not affect knowledge in the current study, supporting the results of a previous Palestinian study (Zyoud et al., 2019), but opposing other studies (Ashkanani et al., 2021; Green & Knechtges, 2015). This inconsistency may be due to lack of experience with handling and preparing food.

Concerning highly risky foods, more than 67% of students knew that raw eggs, raw milk, raw or undercooked meat, raw or unwashed fruits, and vegetables are major sources of food poisoning. More than 64% did not eat undercooked or raw eggs, drink raw milk, or eat undercooked or raw meat. The striking finding was that 36% of students reported eating raw white cheese prepared from raw, unpasteurized milk and that 59% of students reported eating cooked food left at room temperature for over 6 hours.

### Table 7. Association Between Socio-Demographic Characteristics of Participants and Food Poisoning Practice Scores.

| Variables                              | Median (Q1–Q3) | p-Value* |
|----------------------------------------|----------------|----------|
| Age (years)                            |                |          |
| 17–20                                  | 16.0 (12.0–18.0)| .894a    |
| 21–30                                  | 16.0 (13.0–18.0)|        |
| 31 or more                             | 16.5 (16.0–16.5)|        |
| Gender                                 |                |          |
| Male                                   | 14.5 (11.0–17.0)| <.001b   |
| Female                                 | 17.0 (15.0–18.5)|        |
| Scholastic year                        |                |          |
| 1                                      | 16.0 (11.0–18.0)| .087a    |
| 2                                      | 16.0 (14.0–18.0)|        |
| 3                                      | 16.0 (12.0–18.0)|        |
| 4                                      | 15.0 (13.0–17.0)|        |
| 5                                      | 15.0 (12.0–17.0)|        |
| 6                                      | 17.0 (16.25–19.0)|       |
| Faculty                                |                |          |
| Literature                             | 16.0 (11.0–18.0)| .535a    |
| Journalism                             | 16.0 (12.5–18.75)|        |
| Commerce                               | 16.0 (11.0–18.0)|        |
| Sciences                               | 17.0 (15.0–18.0)|        |
| IT and engineering                     | 16.0 (12.0–18.0)|        |
| Law                                    | 16.0 (16.5–16.75)|        |
| Medicine                               | 16.0 (14.0–18.0)|        |
| Pharmacy                               | 15.5 (9.0–18.0) |        |
| Physical sciences                      | 15.0 (13.25–16.0)|        |
| Other                                  | 16.0 (12.0–18.5) |        |
| Type of housing                        |                |          |
| Students dorm                          | 16.0 (14.0–18.0)| .534b    |
| Family home                            | 16.0 (13.0–18.0)|        |
| Residency                              |                |          |
| City                                   | 16.0 (12.0–18.0)| .144a    |
| Village                                | 16.0 (12.0–17.0)|        |
| Palestinian refugee camps              | 15.0 (12.25–17.5)|       |
| Marital status                         |                |          |
| Single                                 | 16.0 (13.0–18.0)| .576b    |
| Married                                | 16.0 (11.0–17.0)|        |
| Children                               |                |          |
| Have children                          | 16.0 (12.0–17.0)| .331b    |
| Does not have children                 | 15.0 (10.0–17.0)|        |
| Food prepared by                       |                |          |
| Mother                                 | 16.0 (13.0–18.0)| .511a    |
| Father                                 | 12.5 (7.75–17.75)|        |
| Grandmother                            | 12.0 (8.0–12.0) |        |
| Other                                  | 16.0 (13.0–18.0) |        |
| Meals consumed outside home            |                |          |
| Never                                  | 16.0 (10.0–19.0)| .038c    |
| 1–3 meals per month                    | 16.0 (13.0–18.0)|        |
| 1–2 meals per week                     | 16.0 (14.0–18.0)|        |
| More than 2 meals per week             | 16.0 (13.0–18.0)|        |
| Everyday                               | 15.0 (10.0–17.0)|        |

*Statistical significance has been measured using Kruskal–Wallis H test
*Statistical significance has been measured using Mann–Whitney U test.
*p-Value in bold are below the significance level of .05.
Most students knew that eating unwashed vegetables and fruits possesses a high risk for food poisoning. It is necessary to wash vegetables and fruits to prevent food poisoning properly. Raw vegetables and fruits may be contaminated with soil or dust and contain microbes resulting in food poisoning when ingested without washing (Macieira et al., 2021). Foodborne diseases, especially diarrhea, can be reduced by 30% through hand-washing promotion (Ejemot-Nwadiaro et al., 2021). Food handlers’ hands are among the main source of food contamination with bacterial or viral pathogens and are considered a major public issue (Ghartey & Antwi, 2019; Kariuki et al., 2017). A satisfying finding was that up to 50% of the students disagreed with an item that stated that baby feces contain no pathogenic agents if they have no disease. This is important because cross-contamination may occur if hands are not properly washed after diaper changing.

Our study shows that most students knew that eating uncovered cooked food left at room temperature for about 12 to 24 hours possesses a high risk for food poisoning. Microbial growth can be slowed down and suppressed by low temperatures in refrigerators. However, 58.9% of them reported eating cooked preserved for more than 6 hours at room temperature without heating. This could be explained by the lack of proper food handling practices attributed to low knowledge (Meyenburg et al., 2014). Moreover, about 60% of students agreed with an item that stated that eating left-over cooked food preserved in the refrigerator for 2 to 3 days carries no risk for food poisoning. A previously reported that 43.3% of university students were not knowledgeable about the maximum temperature a refrigerator should be set at to prevent growth of microbes (Obande & Young, 2020). Another striking finding was that more than 25% of the students reported drinking from untreated rain-water. However, 64.3% of them knew that surface water, like water from rivers and streams collected in reservoirs, possessed a high risk of poisoning when drunk without boiling or chlorination.

Having a good attitude and behavior was not necessarily associated with having good knowledge, consistent with previous articles (Dagne et al., 2021; Tuglo et al., 2021). Although individuals may have good food safety knowledge, their knowledge is not linked to appropriate behaviors of food handling, unlike what was found in other previous studies (Al-Kandari et al., 2019; da Vitória et al., 2021). This study showed that knowledge was strongly correlated with attitude, as well as practice. The correlation between attitude and practice was found to be strong as well, which is in agreement with findings from another similar study (Al-Shabib et al., 2016).

The current study has major implications for future research, practices, and local policies. It will help the researcher focuses on this issue and make an appropriate intervention accordingly. This study aids the responsible authorities across the country in implementing educational programs targeting students at school and the public and implementing policies about food safety in each organization and institution.

The strengths of this study include its large sample size. This was also the first study to evaluate Palestinian university students’ knowledge, attitudes, and practices regarding food safety. Moreover, this study could serve as a reference point for additional studies at other Palestinian universities in the future. The limitations of this study include its sampling technique and its unicentric setting. In addition, a causality relationship cannot be assured since the study is a cross-sectional design. Furthermore, although the used scales had an acceptable Cronbach’s alpha, the reliability and validity of the used scales were not assessed in previous studies using the Arabic language.

Conclusions

Our primary goal was to examine An-Najah National University students’ levels of knowledge, attitudes, and practices regarding food safety and food poisoning. The current study found significant correlations between students’ knowledge, attitudes, and practices regarding food safety. This study also revealed that the correlation between food poisoning knowledge, attitudes, and practice was significant in that students with higher educational levels, especially medical students, had better knowledge and attitudes. Moreover, students with higher educational levels had better attitudes and practices. Female respondents had better attitudes and more hygienic practices when handling food.

Based on the results of this study, we recommend conducting this study on a different population segment. We also recommend that Palestinian universities provide training courses for first-year students to raise their awareness regarding the direct effects of food poisoning on their health and implement educational programs and seminars to improve their knowledge, attitudes, and hygienic behaviors regarding food handling and preparation.

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Authors Contributions

AAH, AHA, and AAA collected data, performed the analyses, conducted the literature search, and drafted the manuscript. AS contributed to the analysis and interpretation of data and drafted the manuscript. AA provided logistical support, coordinated, supervised, participated in the field study, and in the development of the final version of the manuscript. LS developed the study design and methodology and helped to interpret and analyze the data. AAK participated in manuscript writing and reviewed the literature to
provide more recent references and data. SHZ conceptualized and designed the study; coordinated, supervised, and analyzed the data; critically reviewed the manuscript; interpreted the results; and assisted in writing the final manuscript. All authors read and approved the final manuscript.

Availability of Data and Materials
The datasets used for the current study are available from the corresponding author upon request.

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Ethical Approval and Consent to Participate
The IRB at An-Najah National University approved this study (Archived number: MED7Dec2018). Verbal informed consent was taken from each participant before the interviews were started. The study protocol was approved (including the verbal consent process) by the IRB and did not require written consent. All participants were informed that their information would be coded and anonymised.

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