Food safety knowledge and practices among college female students in north of Jordan

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Abstract
Young adults have inadequate knowledge about measures needed to prevent foodborne illnesses. The objectives of this study were to assess the level of food safety knowledge and to investigate the association between the level of food safety knowledge and the socio-demographic and academic variables among college female students staying at dorms in north of Jordan. Information concerning socio-demographic and academic characteristics and food safety knowledge were collected using self-administered questionnaire. Food safety questions included 5 major scales that covered key food safety concepts. A total of 867 female students participated in the study (mean age = 20.07 ± 1.81 years). The overall passing percentage of food safety knowledge was 33.9%. Students were most knowledgeable about prevention of cross contamination and disinfection procedures and had the most difficulties with items related to cooking responsibilities and with food sources of foodborne pathogens. Chi-square results revealed that students who were seniors and in majors related to health sciences, always prepared foods by themselves, reported that they had excellent or very good food safety knowledge, ate out 3 times or less from restaurants, and previously got food poisoning were more likely to pass food safety knowledge questions (P < 0.05). In conclusion, improving students’ knowledge about food safety is an issue that should be taken in consideration; therefore there is a need for developing food safety educational programs that cover key food safety concepts. The school and university setting would be an effective place to reach and teach the young with food safety concepts.

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1. Introduction

Food safety continues to be a concern for consumers, food industry and regulatory agencies. Every year, millions of people worldwide die and many are hospitalized from foodborne diseases and illnesses as a result of consumption of contaminated food (Notermans, Gallhof, Zweitering, & Mead, 1995; Redmond & Griffith, 2003; World Health Organization, 2000). Epidemiological data from different parts of the globe have shown that a significant proportion of foodborne illnesses are attributable to improper food processing practices in consumers’ homes (Redmond & Griffith, 2003). Food can be mishandled at many places during food preparation, handling and storage (Knabel, 1995; Worsfold & Griffith, 1995) and several studies indicate that consumers have inadequate knowledge about procedures needed to prevent foodborne illnesses at home (Altekruse, Street, Fein, & Levy, 1996; Knabel, 1995; Mederios, Hillers, Kendall, & Mason, 2001; Meer & Misner, 2000; Redmond & Griffith, 2003; Woodburn & Raah, 1997). The prevention of foodborne illnesses requires educating food consumers on safe food handling practices (Jevsnik, Hlebec, & Raspor, 2008). However, prior to education, it is important to assess food safety issues relevant to consumers.

Food handlers at all ages seem to think that they know how to handle food safely, but their self-reported food handling behaviors do not support this confidence (Bruhn & Schutz, 1999; Frewer, Shepherd, & Sparks, 1994; Gettings & Kiernan, 2001; Redmond & Griffith, 2003). Food safety knowledge and behaviors among young adults have been studied in different parts of globe. The results revealed that this group of consumers are engaging in food safety behaviors that put their health at risk for foodborne diseases (Byrd-Bredbenner et al., 2008; Byrd-Bredbenner, Maurer, et al., 2007; Garayoa, Córdoba, García-Jalón, Sanchez-Villegas, & Vitas, 2005; Morrone & Rathburn, 2003; Sanlier, 2009; Sharif & Al-Malki, 2010; Unklesbay, Sneed, & Toma, 1998). A recent study showed that over 50% of the Saudi college students consumed raw eggs and raw white cheese and 34% believed that there is no risk of disease from eating cooked food kept at room temperature for one day if covered (Sharif & Al-Malki, 2010). About one third of the
<table>
<thead>
<tr>
<th>Questions</th>
<th>Total responses (n)</th>
<th>Correct responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The best way to keep from getting food poisoning from fresh fruits and vegetables is to wash them with regular soap; hot water; anti-bacterial soap; an anti-bacterial sponge; <strong>cool running water</strong></td>
<td>857</td>
<td>28.4</td>
</tr>
<tr>
<td>2. After you have used a cutting board to slice raw meat, chicken, or fish and need to cut other foods, which of these is the best way to prevent food poisoning? Choice 1: wipe the cutting board off with a paper towel Choice 2: rinse the cutting board under very hot water Choice 3: turn the board over and use the other side Choice 4: wash the cutting board with hot soapy water and rinse Choice 5: set the cutting board aside and use a different cutting board to cut other foods Choice 1 or 3; Choice 2, 3, or 5; Choice 3 or 4; <strong>Choice 4 or 5; All of the choices</strong></td>
<td>853</td>
<td>61.6</td>
</tr>
<tr>
<td>3. To prevent food poisoning, the best way to wash dishes is to: Choice 1: wash and dry them in an automatic dishwasher Choice 2: soak them in the sink for several hours and then wash them in the same water Choice 3: hand-wash them right after the meal and then let them air-dry Choice 4: hand-wash them right after the meal and then dry them with a dish towel Choice 1 or 2; <strong>Choice 1 or 3; Choice 2 or 4; Choice 3 or 4; Any choice is fine as long as the dishes look clean</strong></td>
<td>857</td>
<td>21.1</td>
</tr>
<tr>
<td>4. When should kitchen counters be washed, rinsed, and sanitized? After each use; when you begin working with another type of food; at 4-h intervals if the counter is in constant use; <strong>all of the above</strong></td>
<td>850</td>
<td>82.4</td>
</tr>
<tr>
<td>5. Which procedure for cleaning kitchen counters is most likely to prevent food poisoning? Spray with a strong sanitizing solution; <strong>wash with a detergent, rinse, then wipe with a sanitizing solution; wipe with a sanitizing solution, then rinse with clean water and wipe dry, brush off any dirt or food pieces, then wipe with sanitizing solution</strong></td>
<td>851</td>
<td>31</td>
</tr>
<tr>
<td>6. To prevent food poisoning, how often should the kitchen sink drain in your home be sanitized? Daily; weekly; monthly; only when food is going to be thawed or washed in the sink</td>
<td>850</td>
<td>82.4</td>
</tr>
<tr>
<td>7. Which is the most hygienic way to wash your hands? Apply sanitizer, run water, rub hands together for 20 s, rinse hands, dry hands, rub on an antiseptic hand lotion; apply soap, rub hands together for 20 s, rinse hands under water, dry hands; apply sanitizer; run water, moisten hands, apply soap, rub hands <strong>together for 20 s, rinse hands, dry hands, rub on an antiseptic hand lotion</strong></td>
<td>860</td>
<td>51</td>
</tr>
<tr>
<td>8. If you have a sore on the back of your hand, should you prepare food for other people? Yes, if it isn’t infected; Yes, if you put a bandage on it; Yes, if you wear a glove; <strong>Yes, if you bandage the sore and wear a glove; No, you should not prepare food until the sore heals</strong></td>
<td>856</td>
<td>23</td>
</tr>
<tr>
<td>9. Which should not be done when storing raw meat, fish, or poultry in the refrigerator? Place it in the coldest part of the refrigerator; set it in a larger container before refrigerating; place it on the lowest shelf in the refrigerator; leave it in the package it came in; <strong>all should be done when storing raw meat, fish, or poultry</strong></td>
<td>836</td>
<td>20.4</td>
</tr>
<tr>
<td>10. To prevent food poisoning, which of these individuals should not prepare food for other people? A person with diarrhea: <strong>Correct; Incorrect</strong> A person with severe acne: Correct; Incorrect A person with bandaged burns on his or her hands that are covered with gloves: Correct; Incorrect A person with a fever: Correct; Incorrect A person with unexplained itching: Correct; Incorrect A person who smokes: Correct; Incorrect A person with a sore throat: Correct; Incorrect A person with a cold: Correct; Incorrect A person with vomiting: Correct; Incorrect Person with HIV: Correct; Incorrect None of these individuals: Correct; Incorrect</td>
<td>867</td>
<td>32.1</td>
</tr>
<tr>
<td>11. When preparing food, you should wash your hands after touching which of these? Your face: Correct; Incorrect Clean pots and pans: Correct; Incorrect Utensils that are being used to prepare food: Correct; Incorrect Fresh fruit: Correct; Incorrect Dishes that came out of the dishwasher: Correct; Incorrect A pimple: Correct; Incorrect Clean countertop: Correct; Incorrect Clothing: Correct; Incorrect</td>
<td>867</td>
<td>50.9</td>
</tr>
</tbody>
</table>

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American college students reported eating fried eggs with soft yolks, and about the half reported eating raw cookie dough, and undercooked chicken and hamburger (Byrd-Bredbenner, Maurer et al., 2007; Morrone & Rathburn, 2003). In Turkey, Sanlier (2009) found that more than half of young consumers (14–19 year old) did not know that checking the internal temperature of the food is the safest way to know if the meat was cooked well. Garayoa et al. (2005) discovered that 13.5% of pregraduate students in Spain washed their hands with soap and water before and during food preparation, 38.6% used safe methods to defrost frozen food and only 2.1 and 10.1% knew the food vehicles of Listeria monocytogenes and Staphylococcus aureus, respectively.

To the best of our knowledge, limited studies focused on young females have been found in the literature and there is no any formal study concerning food safety knowledge of college students in Jordan. Therefore, this study aimed to assess the level of food safety knowledge and to investigate the association between the level of food safety knowledge and the socio-demographic and academic characteristics among college female students staying at dorms in north of Jordan. There is a need to assess the food safety knowledge of this target group because 1) they are more likely to engage in risky eating behaviors than others and thus more susceptible to foodborne illnesses 2) they are more likely to engage in risky food handling practices than others because of their future roles as mothers and food preparer for household members. Although there is no education program in Jordan to enhance food safety knowledge and practices of consumers in any age group, assessing the basic knowledge of young consumers is essential for developing an effective food safety education programs.

2. Materials and methods

2.1. Subjects selection and recruitments

A cross-sectional study was conducted from February to November 2009 to assess food safety knowledge level of college female students who are living at dorms (private and university dorms) in Irbid city (north of Jordan). The researchers met with dorm supervisors to inform them about the study, explain the objectives, the significance, and the protocol of the study, and obtain a list of students’ names and contact information. All students live in the dorms were asked to participate in the study. The dorms’ supervisors distributed the questionnaire on the students. An explanation of the study objectives, significance, and protocol, and request for the student to participate in the study were included on the first page of the questionnaire. Upon initial approval, informed written consent was obtained from each participant who was willing to participate in the study (1200 students). The study protocol was approved by Human Ethics Committee at Jordan University of Science and Technology. The participants were asked to complete the questionnaire within 1 week and return it to the dorm’s supervisor. Participants who did not return the questionnaire were contacted after 1 week and if necessary again 1 week later. The subjects who did not respond after 3 weeks, they were considered not interested. A total of 867 students participated in the study. The overall response rate was 72.3%.

2.2. Data collection

After signing the consent form, students were asked to complete a self-administered questionnaire that composed of two parts. The first part was developed by the researchers to collect information about students’ socio-demographic and academic characteristics (students’ college status, students major, maternal educational level (years), household income level, GPA, self-preparing of foods, self rated food safety knowledge level, enrollment in food science, nutrition, or food microbiology classes, weekly consumption of foods from restaurants, previously getting food poisoning). The second part of the questionnaire was adapted from published, reliable and valid questionnaire (the coefficient of reliability was 0.92) to assess students’ knowledge about basic food safety principles and foodborne pathogens and diseases (Byrd-Bredbenner, Wheatley, et al., 2007). Food safety knowledge questions covered the following food safety concepts: cross contamination prevention and disinfection procedures (29 questions, score varies from 0 to 29), safe times/temperatures for cooking/storing food (14 questions, score varies from 0 to 14), foods that increase risk of foodborne disease (20 questions, score varies from 0 to 20), groups at greatest risk for foodborne disease (10 questions, score varies from 0 to 10), and common food sources of foodborne disease pathogens (8 questions, score varies from 0 to 8). The questionnaire took approximately 30 min to be completed.

The total score of students’ knowledge were calculated by summation of correct answers of knowledge questions which were 81 questions. A higher score represents a higher level of knowledge.

2.3. Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences, Version 15.0 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics (means and standard deviations, or frequencies) were used for all variables. Chi-square ($\chi^2$) test was performed to test for differences in socio-demographic and academic variables between students who passed the food safety knowledge questions and those who failed. Findings with a $P$-value < 0.05 were considered to be statistically significant.

3. Results

3.1. General characteristics of the study population

A total of 867 female students participated in the study with a mean age of 20.07 (SD = 1.81); 17.5% of them were freshmen, 21.9% were sophomores, 23.8% were juniors, and 36.8% were seniors. Approximately 62% of respondents had a mother of educational level $\geq$ 12 years, 67.5% had a family income level 600 JD

<table>
<thead>
<tr>
<th>Questions</th>
<th>Total responses</th>
<th>Correct responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>None of these foods: Correct; Incorrect</td>
<td>867</td>
<td>95.4</td>
</tr>
<tr>
<td>Scale passing %</td>
<td>72.8</td>
<td></td>
</tr>
<tr>
<td>Scale knowledge mean score (± SD)</td>
<td>15.91 ± 2.529</td>
<td></td>
</tr>
</tbody>
</table>

Note: correct answers appear in bold.

SD = standard deviation.

a The percentage of students who answered correctly $\geq$ 50% of the questions.

b Score scales could range from 0 to 29.
Table 2
Correct responses to safe times/temperatures for cooking/storing food scale questions among female college students.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Total responses (n)</th>
<th>Correct responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Which practice is most likely to cause food poisoning?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaving stuffing in a cooked turkey until it cools to room temperature; stuffing turkeys just before cooking them; cooking turkeys until the stuffing reaches 165°F; removing the giblet bag before cooking a turkey</td>
<td>807</td>
<td>38.3</td>
</tr>
<tr>
<td>2. When is it safest to place refrigerated foods in your cart when grocery shopping? Early in the shopping trip; about halfway through the shopping trip; near the end of the shopping trip; at the very end of the shopping trip; just before checking out; it doesn’t matter when I place them in the cart</td>
<td>853</td>
<td>73.6</td>
</tr>
<tr>
<td>3. What is the recommended freezer temperature for preventing food poisoning?</td>
<td>0°F (−18°C); 18°F (−8°C); 24°F (−4°C); 32°F (0°C)</td>
<td>20.6</td>
</tr>
<tr>
<td>4. Imagine that your electricity went off and the meat, chicken, and/or seafood in your freezer thawed and felt warm. To prevent food poisoning, what should you do? Throw them away; cook them right away; see how they smell or look before deciding what to do; immediately re-freeze until solidly frozen, then cook them</td>
<td>838</td>
<td>20.1</td>
</tr>
<tr>
<td>5. Which of the following is considered the most important way to prevent food poisoning? Spray for pests in the kitchen area at least every week; rarely or never serve leftovers; keep foods refrigerated until it’s time to cook or serve them; clean kitchen counters with sanitizing solutions weekly</td>
<td>824</td>
<td>58.4</td>
</tr>
<tr>
<td>6. For ground beef to be safe to eat, it needs to be cooked until its internal temperature reaches 90°F (32°C); 125°F (52°C); 160°F (71°C); 250°F (121°C)</td>
<td>808</td>
<td>33.1</td>
</tr>
<tr>
<td>7. What is the maximum temperature refrigerators should be to preserve the safety of foods?</td>
<td>0°F (−18°C); 25°F (−4°C); 40°F (4°C); 45°F (7°C); 60°F (16°C)</td>
<td>34.1</td>
</tr>
<tr>
<td>8. If a family member is going to be several hours late for a hot meal, how should you store the meal to keep it safe until this person is ready to eat it? Store it in the refrigerator and reheat it when the person is ready to eat it; store it in on the kitchen counter until the person is ready to eat it; store it in a cool oven until the person is ready to eat it; store it in a warm oven until the person is ready to eat it</td>
<td>849</td>
<td>49.8</td>
</tr>
<tr>
<td>9. All foods are considered safe when cooked to an internal temperature of 130°F (54°C); 140°F (60°C); 150°F (66°C); 165°F (74°C)</td>
<td>807</td>
<td>33</td>
</tr>
<tr>
<td>10. Which method is the most accurate way of determining whether hamburgers are cooked enough to prevent food poisoning? Cut one to check the color of the meat inside; check the color of the juice to be sure it is not pink; measure the temperature with a food thermometer; check the texture or firmness of the meat; measure the length of time the hamburgers cook</td>
<td>834</td>
<td>8.2</td>
</tr>
<tr>
<td>11. Which food does not need to be refrigerated to prevent food poisoning? Fresh fruit salad; roasted ears of corn on the cob; open box of raisins; chocolate pudding; an open can of green beans</td>
<td>805</td>
<td>46.3</td>
</tr>
<tr>
<td>12. To prevent food poisoning, how long should leftover foods be heated? Until they are boiling hot; just until they are hot, but not too hot to eat right away; just until they are at least room temperature; reheating isn’t necessary</td>
<td>840</td>
<td>36.9</td>
</tr>
<tr>
<td>13. What is the least safe method for thawing a frozen roast? Leave it in the refrigerator until it is thawed; leave it on the kitchen counter until it is thawed; put it in a microwave oven set to automatic defrost; put it in under running water for 1 h</td>
<td>833</td>
<td>27.1</td>
</tr>
<tr>
<td>14. What is the safest method for cooking a large pot of hot soup? Put the soup in a shallow pan and refrigerate it right away; place the cooking pot filled with soup in the refrigerator right away; transfer the soup to clean, deep pot before refrigerating it; leave it on the counter until it cools to room temperature, then refrigerate it; add ice cubes to the soup</td>
<td>848</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Scale knowledge mean score (± SD)

<table>
<thead>
<tr>
<th>Scale passing %</th>
<th>Scale knowledge mean score (± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.4</td>
<td>4.85 ± 2.070</td>
</tr>
</tbody>
</table>

Note: correct answers appear in bold.
SD = standard deviation.

a The percentage of students who answered correctly ≥ 50% of the questions.

b Scale scores could range from 0 to 14.

(845) or more per month, and 60.1% were in majors related to health sciences while 15.4% and 24.5% were in majors related to basic sciences and engineering, respectively, with an average GPA of 76.45 (SD ± 10.30) for total respondents. Approximately, more than half of the respondents reported that they enrolled in food science, nutrition, or microbiology classes (56%), they some times prepared foods (53.0%), and they rated their food safety knowledge as excellent or very good (55.6%). About two third of respondents (64.8%) reported that they eat foods from restaurants 3 times or less per week, 24.5% eat 4–6 times and 10.7% eat 7 times or more, also only 18.2% of them reported that they were getting food poisoning.
3.2. Overall food safety knowledge score

The questionnaire was composed of 5 major scales that covered key food safety concepts. The overall passing percentage was 33.9% (percentage of participants who answered correctly ≥ 50% of the 81 knowledge questions) and the overall knowledge mean score was 37.39 (score could range from 0 to 81).

3.2.1. Cross contamination prevention/disinfection procedures scale

The passing percentage of the cross contamination prevention/disinfection procedures scale (29 questions) was 73% and knowledge mean score was 15.9 (score could range from 0 to 29) (Table 1). However, only 21% and 28% of the correspondents knew that the best way to wash dishes and fruits and vegetables, respectively, and 31% and 38% knew the procedure and occasions necessary for cleaning kitchen counters, respectively, to prevent food poisoning. Also, a low percentage of the correspondents (20%) knew the right procedure for storing raw meat, poultry and fish in refrigerators. Less than two third of the participants knew that indirect cross contamination from using cutting board that have been used to slice raw meat could be prevented either by using different cutting board or by washing the cutting board with hot soapy water. Regarding food handlers, a low percentage of the correspondents (23%) knew that person with sore on his/her hand can prepare foods for others after bandage the sore and wearing a glove and slice raw meat could be prevented either by using different cutting board or by washing the cutting board with hot soapy water.

3.2.2. Safe time/temperature for cooking/storing food scale

The passing percentage of the safe time/temperature for cooking/storing food scale (14 questions) was 20% and knowledge mean score was 4.9 (score could range from 0 to 14) (Table 2). Only 21% and 34% of the correspondents knew the recommended temperature of the freezer and refrigerator, respectively, and 27% knew the safe ways of thawing frozen meat. Only 33% of the correspondents knew that cooking food to an internal temperature of 74 °C is sufficient to produce a safe food. A very low percentage of the correspondents (6–8%) knew that putting a soup in a shallow pan and refrigerate it right way is the safest method for cooling a hot soup and measuring the temperature with a food thermometer is the accurate way of determining whether hamburgers are cooked enough to prevent food poisoning. About 37% of the total correspondents knew that leftover foods should be heated until boiling to prevent food poisoning. About 74% of the correspondents answered correctly that the safest time to buy refrigerated food is at the very end of the shopping trip.

3.2.3. Foods that increase risk of foodborne disease scale

The passing percentage of the foods that increase risk of foodborne disease scale (20 questions) was 54% and knowledge mean score was 9.6 (score could range from 0 to 20) (Table 3). Thirty percent or less of the correspondents knew that eating home canned beans, food right from the refrigerator that is warm, sliced melon, fresh salad stored at room temperature and picnic foods that were stored at room temperature for more than 2 h will increase the risk of food poisoning. About half of the correspondents knew that eating fried eggs with a runny or soft yolk, raw homemade cookie dough or cake batter, fresh raw milk cheese or soft scrambled eggs will increase a person’s risk of food poisoning. More than two third of the correspondents knew that eating rare

Table 3
Correct responses to foods that increase risk of foodborne disease scale questions among female college students.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Total responses (n)</th>
<th>Correct responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chilling or freezing eliminates harmful germs in food.</td>
<td>826</td>
<td>52.2</td>
</tr>
<tr>
<td>true; false</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Which food is least likely to cause food poisoning?</td>
<td>838</td>
<td>32.6</td>
</tr>
<tr>
<td>slices of cantaloupe left on the counter overnight; baked potato that was</td>
<td></td>
<td></td>
</tr>
<tr>
<td>left on the kitchen counter overnight; leftover turkey eaten cold;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chocolate cake that was left on the kitchen counter overnight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Eating which of these foods will increase a person’s risk of food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>poisoning?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home canned beans, carrots, peas or potatoes right from the jar: Correct;</td>
<td>867</td>
<td>11.3</td>
</tr>
<tr>
<td>Incorrect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unpasteurized milk: Correct; Incorrect</td>
<td>867</td>
<td>64.1</td>
</tr>
<tr>
<td>Rare hamburgers: Correct; Incorrect</td>
<td>867</td>
<td>79</td>
</tr>
<tr>
<td>Leftover soup reheated until warm, but not boiling: Correct; Incorrect</td>
<td>867</td>
<td>21.8</td>
</tr>
<tr>
<td>Fried eggs with a runny or soft yolk: Correct; Incorrect</td>
<td>866</td>
<td>52.9</td>
</tr>
<tr>
<td>Raw homemade cookie dough or cake batter: Correct; Incorrect</td>
<td>867</td>
<td>48.2</td>
</tr>
<tr>
<td>Grilled steak served on the same plate that held raw steak without</td>
<td>867</td>
<td>69.7</td>
</tr>
<tr>
<td>washing the plate: Correct; Incorrect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food right from the refrigerator that feels warm: Correct; Incorrect</td>
<td>867</td>
<td>21.8</td>
</tr>
<tr>
<td>Sliced melon: Correct; Incorrect</td>
<td>867</td>
<td>3.8</td>
</tr>
<tr>
<td>Foods prepared in a kitchen with a pet present: Correct; Incorrect</td>
<td>866</td>
<td>56.5</td>
</tr>
<tr>
<td>Fresh fruit salad stored at room temperature: Correct; Incorrect</td>
<td>867</td>
<td>8.9</td>
</tr>
<tr>
<td>Frozen foods with frost build up on the package: Correct; Incorrect</td>
<td>867</td>
<td>93.5</td>
</tr>
<tr>
<td>Food stored in a cabinet beside oven: Correct; Incorrect</td>
<td>867</td>
<td>78.9</td>
</tr>
<tr>
<td>Fresh raw milk cheese: Correct; Incorrect</td>
<td>867</td>
<td>44.6</td>
</tr>
<tr>
<td>Soft food like jelly or sour cream after scraping off mold: Correct;</td>
<td>867</td>
<td>59.6</td>
</tr>
<tr>
<td>Incorrect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft scrambled eggs: Correct; Incorrect</td>
<td>867</td>
<td>51.2</td>
</tr>
<tr>
<td>Commercially canned vegetables right out the can without reheating them:</td>
<td>867</td>
<td>78.2</td>
</tr>
<tr>
<td>Correct; Incorrect</td>
<td>867</td>
<td>30.2</td>
</tr>
</tbody>
</table>

Scale passing %a

54.2

Scale knowledge mean score (± SD)b

9.59 ± 3.307

Note: correct answers appear in bold.

SD = standard deviation.

a The percentage of students who answered correctly ≥ 50% of the questions.

b Score scales could range from 0 to 20.
hamburgers and food stored in a cabinet beside oven will increase the risk of food poisoning.

3.2.4. Groups at greatest risk for foodborne disease scale
The passing percentage of groups at greatest risk for foodborne disease scale (10 questions) was 64% and knowledge mean score was 5.4 (score could range from 0 to 10) (Table 4). Although, about 50% of the correspondents knew that people with diabetes, HIV infection and cancer should not eat raw seafood, only 25% of the correspondents answered correctly that pregnant woman, infants and children do not need to avoid eating canned vegetables and drinking pasteurized milk as these foods do not cause food poisoning. About 25%, 39%, 53% and 54% of the correspondents knew that cancer patients, older people, pregnant women, people with HIV positive are more likely to get sick or seriously ill from harmful germs in food than most people, respectively. More than two third of the correspondents knew that preschool children are among the individuals who are more likely to get sick ill from harmful germs and teenagers are not among these groups.

Table 4
Correct responses to groups at greatest risk for foodborne disease scale questions among female college students.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Total responses (n)</th>
<th>Correct responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. People should be especially careful about not eating raw seafood, if they have Diabetes; HIV infection; cancer: <strong>any of these diseases</strong></td>
<td>792</td>
<td>49.9</td>
</tr>
<tr>
<td>2. Which foods do pregnant women, infants, and children not need to avoid? soft cheeses, cold smoked fish, cold deli salads; hot dogs and lunchmeats that have not been reheated; raw or undercooked eggs; <strong>canned vegetables, pasteurized fruit juice</strong>; These individual do not need to avoid any type of food</td>
<td>792</td>
<td>25.5</td>
</tr>
<tr>
<td>3. Compared to most people, which of these individuals are more likely to get sick or seriously ill from harmful germs in food?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preschool children: <strong>Correct</strong>; Incorrect</td>
<td>867</td>
<td>68.3</td>
</tr>
<tr>
<td>Teenagers: <strong>Correct</strong>; Incorrect</td>
<td>867</td>
<td>82</td>
</tr>
<tr>
<td>Pregnant women: <strong>Correct</strong>; Incorrect</td>
<td>866</td>
<td>52.8</td>
</tr>
<tr>
<td>Older people (age 60 and over): <strong>Correct</strong>; Incorrect</td>
<td>866</td>
<td>38.6</td>
</tr>
<tr>
<td>People who are HIV positive: <strong>Correct</strong>; Incorrect</td>
<td>866</td>
<td>54</td>
</tr>
<tr>
<td>Cancer patients: <strong>Correct</strong>; Incorrect</td>
<td>866</td>
<td>24.8</td>
</tr>
<tr>
<td>People who frequently eat at restaurants or get take-out food often: <strong>Correct</strong>; Incorrect</td>
<td>867</td>
<td>48.7</td>
</tr>
<tr>
<td>None of these individuals: <strong>Correct</strong></td>
<td>867</td>
<td>98.3</td>
</tr>
</tbody>
</table>

Scale passing %\(^a\)
Scale knowledge mean score (± SD)\(^b\)

Note: correct answers appear in bold.
SD = standard deviation.
\(^a\) The percentage of students who answered correctly ≥ 50% of the questions.
\(^b\) Score scales could range from 0 to 10.

Table 5
Correct responses to common food sources of foodborne disease pathogens scale questions among female college students.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Total responses (n)</th>
<th>Correct responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Salmonella bacteria can cause food poisoning. How can a food be made safe if it has salmonella in it?</td>
<td>865</td>
<td>43.9</td>
</tr>
<tr>
<td><strong>Cook it thoroughly</strong>; wash it under extremely hot running water; freeze it for at least 3 days; the food cannot be made safe; don’t know</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Staph (Staphylococcus) bacteria that cause food poisoning are most likely associated with which food? contaminated water from unfiltered mountain streams and lakes; <strong>food prepared by cooks with their bare hands and then left at room temperature</strong>; undercooked pork, especially bacon; raw or undercooked eggs and poultry; don’t know</td>
<td>866</td>
<td>13.1</td>
</tr>
<tr>
<td>3. Botulism is a disease that is most likely associated with which food? <strong>canned foods</strong>; food prepared by cooks with their bare hands and then left at room temperature; undercooked pork, especially bacon; raw eggs; <strong>raw or undercooked poultry</strong>; don’t know</td>
<td>867</td>
<td>22.8</td>
</tr>
<tr>
<td>4. Listeria bacteria are most likely associated with which food? <strong>home canned foods</strong>; raw or undercooked beef; <strong>deli meats</strong>; raw eggs and poultry; don’t know</td>
<td>866</td>
<td>10.6</td>
</tr>
<tr>
<td>5. Harmful E. coli bacteria are most likely associated with which food? raw or undercooked pork; sliced lunch meat; <strong>soft cheeses like Brie</strong>; <strong>raw or undercooked beef</strong>; don’t know</td>
<td>864</td>
<td>17.3</td>
</tr>
<tr>
<td>6. Trichinosis is most likely associated with which food? <strong>deli meats</strong>; <strong>raw or undercooked pork</strong>; <strong>soft cheeses like Brie</strong>; raw or undercooked beef; don’t know</td>
<td>867</td>
<td>11.5</td>
</tr>
<tr>
<td>7. Campylobacter bacteria are most likely associated with which food? <strong>canned food</strong>; raw or undercooked pork; <strong>raw or undercooked poultry</strong>; raw or undercooked beef; don’t know</td>
<td>867</td>
<td>9</td>
</tr>
<tr>
<td>You may contaminate the next food you touch with salmonella bacteria if you don’t wash your hands after touching: raw pork; <strong>raw sprouts and lettuce</strong>; raw beef; <strong>raw chicken</strong>; don’t know</td>
<td>866</td>
<td>33.1</td>
</tr>
</tbody>
</table>

Scale passing %\(^a\)
Scale knowledge mean score (± SD)\(^b\)

Note: correct answers appear in bold.
SD = standard deviation.
\(^a\) The percentage of students who answered correctly ≥50% of the questions.
\(^b\) Score scales could range from 0 to 8.
Table 6
The association between general characteristics and food safety knowledge of female college students.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total knowledge scores&lt;sup&gt;a&lt;/sup&gt;</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fail</td>
<td>Pass</td>
</tr>
<tr>
<td>College status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>109 (73.6)</td>
<td>39 (26.4)</td>
</tr>
<tr>
<td>Sophomore</td>
<td>130 (69.9)</td>
<td>56 (30.1)</td>
</tr>
<tr>
<td>Junior</td>
<td>141 (69.8)</td>
<td>61 (30.2)</td>
</tr>
<tr>
<td>Senior</td>
<td>181 (58.9)</td>
<td>131 (42.0)</td>
</tr>
<tr>
<td>Students major</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health sciences</td>
<td>316 (61.6)</td>
<td>197 (38.4)</td>
</tr>
<tr>
<td>Engineering</td>
<td>101 (77.1)</td>
<td>30 (22.9)</td>
</tr>
<tr>
<td>Basic sciences</td>
<td>145 (69.4)</td>
<td>64 (30.6)</td>
</tr>
<tr>
<td>Maternal educational level (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;12</td>
<td>170 (66.1)</td>
<td>87 (33.9)</td>
</tr>
<tr>
<td>12 or more</td>
<td>261 (61.4)</td>
<td>164 (38.6)</td>
</tr>
<tr>
<td>Household income level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;300 JDs</td>
<td>32 (60.4)</td>
<td>21 (39.6)</td>
</tr>
<tr>
<td>300–999 JDs</td>
<td>90 (72.0)</td>
<td>35 (28.0)</td>
</tr>
<tr>
<td>600–899 JDs</td>
<td>81 (61.4)</td>
<td>51 (38.6)</td>
</tr>
<tr>
<td>≥900 JDs</td>
<td>149 (62.6)</td>
<td>89 (37.4)</td>
</tr>
<tr>
<td>GPA&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceptable</td>
<td>45 (78.9)</td>
<td>12 (21.1)</td>
</tr>
<tr>
<td>Good</td>
<td>137 (64.6)</td>
<td>75 (35.4)</td>
</tr>
<tr>
<td>Very good or excellent</td>
<td>153 (61.9)</td>
<td>94 (38.1)</td>
</tr>
<tr>
<td>Self preparing of foods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>97 (57.1)</td>
<td>73 (42.9)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>305 (66.6)</td>
<td>153 (33.4)</td>
</tr>
<tr>
<td>Rarely</td>
<td>134 (71.3)</td>
<td>54 (28.7)</td>
</tr>
<tr>
<td>Never</td>
<td>35 (72.9)</td>
<td>13 (27.1)</td>
</tr>
<tr>
<td>Self rated food safety knowledge level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>64 (60.4)</td>
<td>42 (39.6)</td>
</tr>
<tr>
<td>Good</td>
<td>230 (62.3)</td>
<td>139 (37.7)</td>
</tr>
<tr>
<td>Weak</td>
<td>39 (69.6)</td>
<td>17 (30.4)</td>
</tr>
<tr>
<td>Enrolling in food science, nutrition, or food microbiology classes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>209 (55.9)</td>
<td>165 (44.1)</td>
</tr>
<tr>
<td>No</td>
<td>352 (73.8)</td>
<td>125 (26.2)</td>
</tr>
<tr>
<td>Weekly consumption of foods from restaurants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Times or less</td>
<td>281 (57.1)</td>
<td>211 (42.9)</td>
</tr>
<tr>
<td>4–6 Times</td>
<td>141 (75.6)</td>
<td>45 (24.2)</td>
</tr>
<tr>
<td>7 Times or more</td>
<td>65 (80.2)</td>
<td>16 (19.8)</td>
</tr>
<tr>
<td>Getting food poisoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>92 (59.0)</td>
<td>64 (41.0)</td>
</tr>
<tr>
<td>No</td>
<td>472 (67.4)</td>
<td>228 (32.6)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Data presented as numbers and percent within parenthesis.
<sup>b</sup> GPA = Grade Point Average: Acceptable = < 68; Good = 68–75.9; Very Good or Excellent = ≥ 76.

3.2.5. Common food sources of foodborne disease pathogens scale

The passing percentage of common food sources of foodborne disease pathogens scale (8 questions) was 14% and knowledge mean score was 1.6 (score could range from 0 to 8) (Table 5). Less than 18% of the correspondents knew the foods that most likely associated with Staphylococcus, Listeria, harmful Escherichia coli, Trichinella and Campylobacter. About 33% of the correspondents knew that touching raw chicken may contaminate the next touched food with Salmonella if the hands are not washed and 44% knew that cooking food thoroughly kills Salmonella in the food.

3.3. General characteristics of study population and passing food safety knowledge questions

The association between general characteristics and food safety knowledge of female college students is shown in Table 6. Significant associations were found between many characteristics and passing food safety knowledge questions; students who were seniors and in majors related to health sciences, always prepared foods by themselves, reported that they had excellent or very good food safety knowledge, ate out 3 times or less from restaurants, and previously got food poisoning were more likely to pass food safety knowledge questions (P < 0.05). Also, marginally significant association was found between students’ GPAs and passing food safety knowledge questions; a higher percentage of students who had GPA ≥ 76 (38.1%) tended to pass the food safety knowledge questions compared with students who had GPA < 68 (21.1%) (P = 0.052). Although there was no significant association between the educational level of the mother and passing food safety knowledge questions, a higher percentage of students who had mothers with educational level ≥ 12 years (38.6%) passed the food safety knowledge questions compared with students who had mothers with less education (33.9%) (P > 0.05)

4. Discussion

The role of young females in the prevention of foodborne illnesses is very important because of their future roles as mothers and food preparers for household members (Byrd-Bredbenner, Maurer et al., 2007; Subba Rao, Sudershan, Pratima Rao, Vishnu Vardhana Rao, & Polasa, 2009).

Most of the studies that examined food safety knowledge of young adults discovered, as this study did, that food safety knowledge of young adults is at an insufficient level (Byrd-Bredbenner, Maurer et al., 2007; Garayoa et al., 2005; Sanlier, 2009; Sharif & Al-Malki, 2010; Unklesbay et al., 1998). Sanlier (2009) reported that food safety knowledge score of young consumers in Ankara, Turkey was of 5.81 out of 10 points. Sharif and Al-Malki (2010) reported a good food poisoning knowledge percentage score for Taif University students, Saudi Arabia (75%); however, they found that students had low knowledge on some important factors related to food poisoning. The current study used the same validated questionnaire used by Byrd-Bredbenner, Wheatley et al. (2007). Although they reported higher knowledge mean score (53.7 out 89 points) for young adults with education beyond high school in USA than that reported in our study, similar to our finding, they found that participants were least knowledgeable about common food sources of foodborne disease pathogens. Our study revealed that female college students were most knowledgeable about prevention of cross contamination and disinfection procedures and had the most difficulties with items related to cooking responsibilities and with food sources of foodborne pathogens. The reason behind these findings could be related to the culture. In Jordan, families are more concern on cleaning specially the kitchen and usually this task is assigned to females. Also in our community, several meals are prepared and cooked at homes where certain food safety related practices may be traditionally practiced and passed on by the mothers of young girls without a scientific knowledge. Other reason could be related to absences or insufficient food safety related topics in school or college curricula.

College female students had poor knowledge about preparing, cooking, cooling and storing foods and that would imply in foodborne diseases. Studies have expected that between 50 and 87% of reported foodborne disease outbreaks have been associated with the domestic kitchen (Redmond & Griffith, 2002) and World Health Organization report (Tirado & Schmidt, 2000) mentioned that 45.6% of foodborne disease outbreaks was due to temperatures abuse during food processing; poor refrigeration and inappropriate storage temperatures of leftover or recently cooked meals accounted for 23.5% and 12.6% of the cases, respectively.

Proportion of participants who identified food vehicle associated with transmission of Salmonella was greater than those who...
identified food vehicle associated with the other foodborne pathogens. This difference could be due to the fact that *Salmonella* is the pathogen involved in most outbreaks of foodborne illness in Jordan in the past few years. Similar finding was discovered by Garayoa et al. (2005) who found that proportion of Spanish university students correctly identified the food vehicle for transmission of *Salmonella* was greater than those who identified the food vehicle for transmission of *S. aureus, Clostridium botulinum, L. monocytogenes* and *Trichinella*.

Low personal perception of food safety reported by female college students live in dorms in north of Jordan likely contributes, at the short term, to their decision to consume risky foods which may affect students' susceptibility to foodborne illness and contributes, at the long term, to foodborne illnesses in the home as this target group is future mothers and food preparers.

This study showed that there was strong association between college status, students major and self rated food safety knowledge and food safety knowledge score. Similar findings were reported in previous studies, in which higher food safety knowledge scores have been reported for senior college students, students who had described their food safety knowledge as excellent or good and students who study in health colleges (Byrd-Bredbenner, Maurer et al., 2007; Garayoa et al., 2005; Sharif & Al-Malki, 2010; Unklesbay et al., 1998). Students who study in health colleges may have enrolled in courses that included information about food safety. This may be true because we found that students who enrolled in food science, nutrition or microbiology courses had better food safety knowledge score. Students who previously got food poisoning had higher food safety knowledge score. Perhaps they were informed about the food or the practices that made them sick. Students who prepare their foods by themselves and infrequently eat from restaurants had higher food safety knowledge scores. Perhaps this group gained knowledge about food safety by experience during preparation of their meals.

The data gathered from this study have revealed that there is an urgent need for food safety education in this target group. An effective food safety education program should cover information concerning temperature control of food, proper food preparation practices, prevention of cross contamination, suitable clean up procedures, causative foodborne illness agents, high risk groups, and other contributing factors to foodborne diseases and prevention strategies. The school and university setting would be the best place to reach and teach the young with key food safety concepts.

5. Limitation of the study

This study focused on the college female students live in dorms in north of Jordan, therefore the results should not be generalized to all females or college female students in the entire country. The study measured self-reported knowledge, which may be subjected to bias by the participants.

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References


