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Kailing Chen

Zhihong Lin

Isabelle do Prado

Zahra Mohammad

Karla M. Acosta

See next page for additional authors

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Authors

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College Students' Domestic Kitchen Food Safety Perceptions and Knowledge

Kailin Chen[1], Zhihong Lin[1], Isabelle do Prado[1], Zahra Mohammad[1], Karla M. Acosta[1], and Sujata A. Sirsat[1]

AUTHORS: [1]University of Houston.

Abstract. This study investigates college students' current food safety knowledge and food-handling perceptions and utilized an online survey which designed based on previous studies as method. The questionnaire measured respondents' food safety knowledge and perception, and were divided into knowledge, attitudes and perception categories. The results show that college students significantly lacked in basic food safety knowledge as well as food handling skills and implies a high need to develop enhanced food safety resources for college students, especially on topics related to cross-contamination prevention, correct food preparation procedures, time and temperature control, and awareness of pathogens that cause foodborne illness.

INTRODUCTION

Foodborne diseases are a major global public health concern that cause 1 in 10 people to fall ill annually (World Health Organization [WHO], 2015b). According to the statistics from the WHO, in the region of the Americas, more than 9,000 of 77 million patients who suffer from foodborne illnesses die every year (WHO, 2015a). According to the annual report of the Centers for Disease Control and Prevention (CDC), in 2017, 841 foodborne outbreaks were reported, including 14,481 illnesses, 827 hospitalizations, and 20 deaths. Among these cases, about 10% (n = 74) of the outbreaks and 8% (n = 989) of the illnesses were caused by foods prepared in private homes (CDC, 2017). Foodborne illness is caused by the consumption of food or beverages that are contaminated with bacteria and/or their toxins, parasites, viruses, chemicals, or other agents (U.S. Food and Drug Administration [FDA], 2011). In a globalized world, the potential for foodborne diseases to spread across countries is enormous (Bosch et al., 2018), leading to an increased global public health threat and concern (Luo et al., 2019; Odeyemi et al., 2019; Stratev et al., 2017). According to the CDC (2011), 48 million people experience foodborne illness, 120,000 are hospitalized, and 3,000 die of foodborne diseases annually. Previous literature has shown that more than 200 known diseases can be transmitted through food, and although governments around the globe attempt to improve food safety, outbreaks and recalls continue to happen in developed and developing nations (WHO, 2006). With the implementation of the Food Safety Modernization Act (FSMA) in 2011, the approach toward food safety has become proactive rather than reactive (FDA, 2011). FSMA has allowed governments to reduce the risk of food contamination enroute from farm to sale.

Previous studies have reported high risks of foodborne illness from food prepared in domestic kitchens (Byrd-Bredbenner, Maurer, Wheatley, Cottone, & Clancy, 2007; Chuang et al., 2021; Evans & Redmond, 2019). Hassan and Dimassi (2014) reported that students in health-related majors had significantly more knowledge regarding food safety than those who were not due to courses in food safety, hygiene, and microbiology. Similarly, another study that assessed students at four Japanese universities indicated that students who completed more food-relevant classes, acquired more food-safety knowledge, and/or majored in food- or nutrition-related fields performed more risk-averse behaviors (Takeda et al., 2011).

Previous programs have designed and disseminated public health and consumer food-safety messages (Partnership for Food Safety Education, n.d.); however, even when educational material containing food safety messages has been provided to consumers and enhanced their knowledge, it has not often translated to improved behaviors (Doyle et al., 2015). The domestic environment is a multifunctional space, which directly influences the need for food-safety

improvement (Azevedo et al., 2014), as poor food-handling practices and lack of hygiene are some of the main causes of foodborne-illness outbreaks (Woh et al., 2016). Pathogens are introduced to the domestic kitchen during food preparation and can be controlled or eliminated by safe food-handling practices and proper sanitation (Borrusso & Quinlan, 2013). Foodborne pathogens in the domestic environment have been well documented, including *Staphylococcus aureus*, *Escherichia coli*, *Campylobacter jejuni*, *Salmonella* spp., and *Listeria monocytogenes*. The ability of foodborne pathogens to survive on food contact surfaces indicates the importance of consumer behavior when it comes to foodborne-illness prevention (Borrusso & Quinlan, 2013). Moreover, inappropriate food-handling practices can increase individuals' risk for foodborne illnesses and be particularly dangerous for immunocompromised populations (Yeung et al., 2019). According to research conducted by Byrd-Bredbenner et al. (2013), many consumers, including those in high-risk groups, do not take adequate precautions or follow all recommended appropriate food-safety practices—which are vital to prevent foodborne illness—because they do not see themselves as susceptible. The number of home economics and cooking classes has significantly decreased in public schools, meaning that many students do not have food-safety certification, have never prepared or served food, and have not taken a college course that addresses food safety (Courtney et al., 2016). Based on a study of college students' food-safety knowledge and perceptions, more than half of students had not had any food-safety training (Chuang et al., 2021). Although college students are not a high-risk group for foodborne illnesses, they lack knowledge about proper food-safety practices (Fein et al., 2011; Ferk et al., 2016; Green & Knechtges, 2015; Hassan & Dimassi, 2014; Xiong, 2017). Previous studies have also found that college students are at increased risk of getting foodborne illness due to their unsafe food-handling behaviors (Booth et al., 2013; Byrd-Bredbenner, Maurer, Wheatley, Cottone, & Clancy, 2007; Chuang et al., 2021; Green & Knechtges, 2015). Luo et al.'s (2019) study demonstrated that students in nursing, education, and medical colleges had insufficient knowledge and demonstrated improper food-safety practices (Luo et al., 2019). According to Doyle et al. (2015), despite all the efforts the food industry and the government have made, such factors as pathogen evolution, immunocompromised populations, and consumers' lack of knowledge regarding elements contributing to unsafe food in the home could counteract these efforts and cause increased foodborne illnesses. Hence, the objective of this study was to identify food-safety knowledge and perception (self-reported practice) gaps in students attending an urban university. The findings could help create specific educational resources for college students and assist in reducing food-safety risks associated with poor domestic food-handling practices.

MATERIALS AND METHODS

QUESTIONNAIRE DEVELOPMENT

The methods for this study were designed based on Lazou et al.'s (2012) research, in which a questionnaire-based survey was designed to evaluate the food-safety knowledge and handling practices of Greek university students. This survey included questions selected from an updated, reliable, and valid instrument created by Byrd-Bredbenner et al. (2007) to assess food-safety knowledge and practices. Some modifications were made according to Sharif and Al-Malki's (2010) and Lim et al.'s (2016) research to better fulfill the purpose of this study. Sharif and Al-Malki (2010) divided their survey questions into categories of knowledge, attitudes, and practices; Lim et al. (2016) constructed their questionnaire with four parts, including food-safety knowledge, attitude, and behaviors; and our study measured knowledge and practices through survey questions. Because the study was self-reported, food-safety practices were substituted with participants' perceptions of their practices, as most answers were related to how the respondents viewed their behaviors. The questionnaire for this study was administered as an online survey on a self-reported basis, and participants took part in the study on their own accord. The survey measured the five key behavioral constructs for food-safety education as per a previous study (Medeiros et al., 2001): Practice personal hygiene, cook food adequately, avoid cross-contamination, keep food at safe temperatures, and avoid food from unsafe sources.

After we obtained approvals from the Institutional Review Board, a self-reported questionnaire-based survey was disseminated through Qualtrics to college students in the Houston, Texas, area. The questionnaire was designed in English, and participation in the study was anonymous and voluntary. Survey questions are included in the supplementary section. The survey was composed of a total of 49 multiple-choice questions: 9 questions were about participants' demographics, including age, gender, race, and ethnicity; 20 questions focused on participants' basic food-safety knowledge related to domestic cooking (e.g., "All foods are considered safe when cooked to an internal temperature of:"; "Staphylococcus bacteria that cause food poisoning are most likely associated with which food?"); and 20 questions focused on perceptions of food-safety practices, including respondents' food-handling behaviors and frequencies of behaviors (e.g., "Which procedure for cleaning kitchen counters is most likely to prevent food poisoning?"; "In case your electricity went off and the meat, chicken, and/or seafood in your freezer thawed and felt warm, what do you do?"). The questions were divided into five subcategories corresponding to the five key behavioral constructs for statistical analysis: Practice personal hygiene, cook food adequately, prevent cross-contamination, keep food at safe tem-

peratures, and avoid food from unsafe sources. Each correct answer was assigned 1 point, and each incorrect answer was assigned 0 points.

DATA COLLECTION

The survey was disseminated through Qualtrics, and 116 responses were collected. Participants were prescreened to ensure that they (a) had access to domestic kitchens and (b) cooked in domestic kitchens.

DATA ANALYSIS

The data were coded and entered into SPSS version 22 for data analysis. First, a sum score for general food-safety knowledge and food-handling perceptions was generated. With those scores, a paired *t* test was conducted to determine whether their differences were significant. Then, 10 numerical variables were defined as a sum of correct answers for knowledge and perception of each subcategory. Finally, independent sample *t* tests were conducted to compare the mean of subcategories. A significance level of 0.05 was used for all statistical comparisons.

RESULTS

DEMOGRAPHICS

A total of 116 college students participated in the online survey administered through Qualtrics. Information about the sample's demographics can be found in Table 1. The subjects included 75 female and 41 male participants. Participants' ages ranged from 18 to 57, with a mean of 24.8. More than 60% of respondents were ages 21–26. Participants' race/ethnicity was predominantly Asian (42%), White (28%), and Hispanic (22%). When asked about their cooking habits, 39 participants (34%) reported cooking more than two times per week, 38 (33%) reported cooking one to two times per week, 26 (22%) reported cooking daily, and 13 (11%) reported cooking one to three times per month. When questioned about previously experiencing food poisoning, 42% of participants had no experience, 33% had prior experience, and 25% were unsure whether they had experienced food-borne-illness symptoms in the past. Regarding food-safety information, 39% of participants reported acquiring information from friends or family, 34% from other sources, 13% from social media, 10% from TV shows or magazines, and 4% from primary care doctors.

KNOWLEDGE AND PERCEPTION SCORES

Information about the sample's food-safety knowledge and food-handling perception scores can be found in Table 2. The average sum score for knowledge was 5.22 out of 20, and the average sum score for practices was 5.57 out of 20. Correct rates for knowledge and perception were less than 28%—a great gap. The measurement of food-safety knowledge and food-handling perception was broken into five subcategories: Practice personal hygiene, cook food adequately, prevent cross-contamination, keep food at safe temperatures, and avoid food from unsafe sources. In this study, $p < 0.05$ was considered significant, and $p > 0.05$ was considered not significant.

For "practice personal hygiene" knowledge, the mean score was 1.37 out of 4, with a correct response rate of 34%, a standard deviation of 1.02, and $p > 0.05$. For "practice personal hygiene" perception, the mean score was 1.47 out of 4, with a correct response rate of 37% and a standard deviation of 0.98.

For "cook food adequately" knowledge, the mean score was 1.05 out of 4, with a correct response rate of 26%, a stan-

Table 1. Demographic Characteristics of the Study Sample

Demographic variables		Frequency	Percentage
Gender	Male	41	35%
	Female	75	65%
Age group	18–20	12	10%
	21–26	78	67%
	27–57	26	23%
Race/Ethnicity	White	32	28%
	Black or African American	3	3%
	American Indian or Alaska Native	3	3%
	Asian	49	42%
	Native Hawaiian or Pacific Islander	1	1%
	Hispanic	26	22%
	Other	1	1%
Cooking habit	Every day	26	22%
	More than two times per week	39	34%
	1–2 times per week	38	33%
	One to three times per month	13	11%
Food safety information source	Family or friends	45	39%
	Primary care doctor	5	4%
	Social media	15	13%
	TV show or magazine	12	10%
	Other	39	34%
Food-poisoning experience	Yes	38	33%
	Maybe	29	25%
	No	49	42%

dard deviation of 0.96, and $p < 0.05$. For "cook food adequately" perception, the mean score was 0.57 out of 4, with a correct response rate of 14% and a standard deviation of 0.76.

For "prevent cross-contamination" knowledge, the mean score was 0.79 out of 4, with a correct response rate of 20%, a standard deviation of 0.94, and $p < 0.05$. For "prevent cross-contamination" perception, the mean score was 1.06 out of 4, with a correct response rate of 27% and a standard deviation of 0.91.

For "keep food at safe temperatures" knowledge, the mean score was 0.99 out of 4, with a correct response rate of 25%, a standard deviation of 1.00, and $p < 0.05$. For "keep food at safe temperatures" perception, the mean score was 1.38 out of 4, with a correct response rate of 35% and a standard deviation of 1.23.

For "avoid food from unsafe sources" knowledge, the mean score was 1.24 out of 4, with a correct response rate of 31%, a standard deviation of 1.08, and $p < 0.05$. For "avoid food from unsafe sources" perception, the mean score was 1.01 out of 4, with a correct response rate of 25% and a standard deviation of 1.00.

COMPARISONS BETWEEN KNOWLEDGE AND PERCEPTION

A *t* test was conducted to determine the significance between knowledge and perception scores, and independent sample *t* tests were conducted to compare the mean of each subcategory within knowledge and perception. The comparisons between knowledge and perception scores can be found in Table 3. According to the results, the overall food-safety knowledge and perception levels were not significantly different. The knowledge and perception levels for the "practice personal hygiene" subcategory was also not significantly different. On the other hand, the knowledge and perception levels for "cook food adequately" were significantly different ($p < 0.05$), as the knowledge mean score was 0.48 higher than the perception score. The knowledge and perception levels for "prevent cross-contamination" were also significantly different ($p < 0.05$), with a perception mean score that was 0.26 higher than the knowledge mean score. Additionally, the knowledge and perception levels for "keep food at safe temperatures" also diverged significantly ($p < 0.05$), as the mean score for knowledge was 0.39 less than the mean score for perception. The knowledge and perception levels for "avoid food from unsafe sources" were significantly different ($p < 0.05$), with the perception mean score 0.23 less than the mean score for knowledge.

Table 2. Mean Score of Each Category

Category	Mean	Standard deviation
Knowledge sum result	5.22	3.55
"Practice personal hygiene" knowledge	1.37	1.02
"Cook food adequately" knowledge	1.05	0.96
"Prevent cross-contamination" knowledge	0.79	0.94
"Keep food at safe temperatures" knowledge	0.99	1.00
"Avoid food from unsafe sources" knowledge	1.24	1.08
Self-reported practice/perception sum result	5.57	3.80
"Practice personal hygiene" practice	1.47	0.98
"Cook food adequately" practice	0.57	0.76
"Prevent cross-contamination" practice	1.06	0.91
"Keep food at safe temperatures" practice	1.38	1.23
"Avoid food from unsafe sources" practice	1.01	1.00

DISCUSSION

Food safety is a part of every individual's day-to-day life, regardless of their age. However, in a domestic setting, the levels of proper food handling and hygiene practices vary by age, and young adults, such as college students, are more likely to mishandle foods when compared to other groups (Courtney et al., 2016). The results of this study showed low levels in food-safety knowledge and food-handling perception for college students cooking in domestic kitchens. This study supports the findings of other studies that have also reported consumers having limited food-safety knowledge and inadequate compliance with safe food-handling practice perceptions, such as failure to follow proper food-preparation procedures and use thermometers (Abbot et al., 2009; Booth et al., 2013; Byrd-Bredbenner et al., 2013; Courtney et al., 2016; Lange et al., 2016). Previous studies have also indicated that students are at higher risk of getting foodborne illness and lack sufficient food-safety-specific education (Gkana & Nychas, 2018; Lange et al., 2016). The participants in the current study scored, on average, 26% and 28% of the maximum scores for food-safety knowledge and food-safety perception, respectively. Although Lazou et al.'s (2012) study also showed low results, with correct scores of 37% for food-safety knowledge and 38% for food-safety practice, the results were higher compared to the current study. Other similar studies also had higher results when compared to the current study: McArthur and Holbert's (2007) study had a mean of 39% and Green and Knechtges's (2015) study had a mean of 43% correct responses for food-safety knowledge; Byrd-Bredbenner et al.'s (2007) had means of 50% and 60%, respectively, for best practices and food-safety knowledge measures. Lim et al.'s (2016) study showed a mean of about 50% for partici-

Table 3. Comparisons Between Knowledge and Practice

Comparison		Mean difference	SD	Sig.
Knowledge sum score	Self-reported practice/perception sum score	–0.35	2.31	0.109
"Practice personal hygiene" knowledge	"Practice personal hygiene" practice	–0.10	0.09	0.250
"Cook food adequately"knowledge	"Cook food adequately" practice	0.48	0.09	*0.000
"Prevent cross-contamination" knowledge	"Prevent cross-contamination" practice	–0.26	0.08	*0.001
"Keep food at safe temperatures" knowledge	"Keep food at safe temperatures" practice	–0.39	0.10	*0.000
"Avoid food from unsafe sources" knowledge	"Avoid food from unsafe sources" practice	0.23	0.09	*0.013

Note. * refers to significant differences between knowledge and practice scores.

pants' food-safety knowledge and about 65% for food-safety behaviors and practices. Courtney et al.'s (2016) study had a mean of 56% correct answers for food-safety knowledge, and Hassan & Dimassi's (2014) study had means of 53.6% and 44.7%, respectively, for food-safety knowledge and food-safety practices. Sharif and Al-Malki's (2010) research results were significantly higher when compared to our and these similar studies, with an 80.29% mean for food-safety practices and 74.95% mean for food-safety knowledge. Despite these studies having higher percentages of correct responses, all of them reported a lack of food-safety knowledge and suggested room for improvement. Our study showed a lower number of correct responses for food-safety knowledge and food-handling perception when compared to other studies.

Participants had various sources from which they obtained food-safety information: 13% obtained their food-safety information from social media, 10% from TV shows or magazines, and 34% from other sources. A study by Geppert et al. (2019) assessed food-safety practices in German TV cooking shows to identify differences between professional and amateur chefs. Their findings showed that amateur chefs tended to make more mistakes regarding personal hygiene, but there was no significant difference in the frequency of food safety–related mistakes made by professional or amateur chefs. Despite these shows being broadcast to a large audience, not too much attention was focused on safe food-handling practices. A study by Morrison and Young (2019) evaluated food-safety messages in recipe blogs and found few to no recommendations regarding cross-contamination prevention, handwashing before food preparation or after handling raw meat, and food contact-surface and equipment sanitation. These recommendations are critical to prevent foodborne illnesses, even though they may seem too obvious to be included with recipes (Morrison & Young, 2019). Murray et al.'s (2017) study showed that most respondents (87%) followed cooking instructions from food labels. These results suggest that adding instructions to television cooking shows, recipe blogs, or other social media platforms could help promote food safety to the general public. People's low awareness of food-safety knowledge and perception contributes to a higher susceptibility to food poisoning. The findings from our study demonstrated that a significant number of respondents did not have enough information to identify foodborne illness, which could contribute to their perception of behaviors that increase food-safety risks. Rodríguez-Lázaro and Hernandez (2018) stated that foodborne diseases pose significant threats to public health because of not only the huge number of cases but also the economic cost associated with the treatments, hospitalizations, and time away from work. Their study also showed clear evidence that the existing data on the prevalence of foodborne pathogens may be underestimated, mostly due to the difficulties in gathering precise data on the incidence of outbreaks, let alone the constant occurrence of isolated cases. The incidence of enteric viruses associated with food consumption has increased in recent years, and the data in their research showed that parasitic diseases were relatively neglected. Their research also indicated that even though foodborne pathogens were largely unknown, a considerable variety of viruses and parasites can spread in the environment and infect people through food and water. According to Ergönül (2013), education regarding safe food-handling practices in the domestic environment is essential to proactively prevent foodborne illnesses. Moreover, the diagnosis of a foodborne illness case in one individual could be the key for physicians to detect or even prevent a foodborne outbreak (Dichtl et al., 2020), so it is vital for people to obtain knowledge related to food safety. Hence, a food-safety training program should include foodborne illness symptom awareness to encourage participants to report foodborne illnesses as soon as possible.

Lazou et al.'s (2012) study showed the food microbiology/cross-contamination knowledge subsection receiving the lowest proportion of correct responses in the survey. Another study reported that respondents were not aware of the risks of cross-contamination and showed inadequate handling practices to avoid it (Lange et al., 2016). Lack of

knowledge about foodborne pathogens may be the main reason why many consumers do not recognize foodborne-illness symptoms. Likewise, in the current study, "personal hygiene" ranked high in terms of food-safety handling perceptions, while the "cook food adequately" category ranked last. In Abbot et al.'s (2009) domestic-kitchen food-safety practices study, 97% of participants did not use a thermometer to determine whether a protein was cooked to a safe temperature. According to Byrd-Bredbenner et al. (2013), many consumers do not use a food thermometer due to its inconvenience and the fact that they need to remember different temperature recommendations for different proteins. Their research also stated that the lack of usage of thermometers and color recommendations in some cooking television shows may lead consumers to believe that a thermometer is not essential in the cooking process and that using it is a sign of being an inexperienced cook. Booth et al.'s (2013) research suggested that young adults consume raw or undercooked foods of animal origin; based on the results of Courtney et al.'s (2016) study, although the university students who were handling food for the public did provide comparatively more correct responses than non-food handlers, they were no more knowledgeable about safety items, including correct handwashing and thermometer use, meaning that they may still pose food-safety risks. Therefore, a food-safety training program for college students should include basic knowledge about foodborne pathogens, their risks, and adequate cooking temperatures and practices. Our results showed a significant difference between the knowledge and perception scores for the "cook food adequately" subcategory, as participants scored higher in the knowledge category. This finding suggests that despite respondents' having knowledge about the potential consequences of not cooking foods to a certain temperature, they were not able to perform the correct behaviors to avoid these potential consequences. Even when consumers possess information related to food safety and improved hygiene, knowledge often does not translate into noticeable changes in real-life practices (Doyle et al., 2015). However, even though knowledge does not necessarily translate into safe food-handling behaviors, a recent study demonstrated that consumers with higher levels of food-safety knowledge showed more concerns about food safety and quality when purchasing food and were more likely to perform safe food-handling practices at home (Mihalache et al., 2021). On the other hand, in our study, for the "preventing cross-contamination" and "keeping food at safe temperatures" subcategories, participants scored significantly better in the perception category than in the knowledge category. More information regarding cross-contamination and food time and temperature control should be disseminated to this group through food-safety training. The data generated from this study have revealed a high need for food-safety educational materials for consumers, including college students, with topics related to all food-safety aspects.

CONCLUSIONS

Our findings show the high need for food-safety education resources for college students. This study identified specific gaps in preventing cross-contamination, cooking food adequately, keeping food at safe temperatures, practicing personal hygiene, and avoiding food from unsafe sources for food-handling perception and food-safety knowledge. This study was useful in providing basic insights regarding college students—whose behaviors are critical to protecting public health in the future—with regard to their food-safety knowledge and practices and how these can be improved by filling the aforementioned gaps. The data from this study could be used to design a tailored training program for college students that could bridge those gaps and improve food safety for at-risk groups. However, this study was not without limitations. One was that the sample was gathered online, and Internet access may have been a problem for some people. In addition, respondents could have developed question fatigue during the survey; to address this possibility, only complete surveys were included in the study, and partially completed surveys were discarded. In addition, the respondent population was restricted to the Houston, Texas, area. Future studies could revise the methodology to gather a broader sample.

REFERENCES

Abbot, J. M., Byrd-Bredbenner, C., Schaffner, D., Bruhn, C. M., & Blalock, L. (2009). Comparison of food safety cognitions and self-reported food-handling behaviors with observed food safety behaviors of young adults. *European Journal of Clinical Nutrition*, *63*(4), 572–579. https://doi.org/10.1038/sj.ejcn.1602961

Azevedo, I., Albano, H., Silva, J., & Teixeira, P. (2014). Food safety in the domestic environment. *Food Control*, *37*(1), 272–276. https://doi.org/10.1016/j.foodcont.2013.09.058

Booth, R., Hernandez, M., Baker, E. L., Grajales, T., & Pribis, P. (2013). Food safety attitudes in college students: A structural equation modeling analysis of a conceptual model. *Nutrients*, *5*(2), 328–339. https://doi.org/10.3390/NU5020328

Borrusso, P., & Quinlan, J. J. (2013). Development and piloting of a food safety audit tool for the domestic environment. *Foods*, *2*(4), 572–584. https://doi.org/10.3390/FOODS2040572

Bosch, A., Gkogka, E., Le Guyader, F. S., Loisy-Hamon, F., Lee, A., van Lieshout, L., Marthi, B., Myrmel, M., Sansom, A., Schultz, A. C., Winkler, A., Zuber, S., & Phister, T. (2018). Foodborne viruses: Detection,

risk assessment, and control options in food processing. *International Journal of Food Microbiology*, *285*, 110–128. https://doi.org/10.1016/J.IJFOODMICRO.2018.06.001

Byrd-Bredbenner, C., Berning, J., Martin-Biggers, J., & Quick, V. (2013). Food safety in home kitchens: A synthesis of the literature. *International Journal of Environmental Research and Public Health*, *10*(9), 4060–4085. https://doi.org/10.3390/IJERPH10094060

Byrd-Bredbenner, C., Maurer, J., Wheatley, V., Cottone, E., & Clancy, M. (2007). Food safety hazards lurk in the kitchens of young adults. *Journal of Food Protection*, *70*(4), 991–996. https://doi.org/10.4315/0362–028X-70.4.991

Byrd-Bredbenner, C., Maurer, J., Wheatley, V., Schaffner, D., Bruhn, C., & Blalock, L. (2007). Food safety self-reported behaviors and cognitions of young adults: Results of a national study. *Journal of Food Protection*, *70*(8), 1917–1926. https://doi.org/https://doi.org/10.4315/0362–028X-70.8.1917

Centers for Disease Control and Prevention. (2011). *Burden of foodborne illness: Findings | Estimates of foodborne illness | CDC*. https://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html

Centers for Disease Control and Prevention. (2017). *Surveillance for foodborne disease outbreaks United States, 2017: Annual report*. http://www.cdc.gov/foodsafety/fdoss/

Chuang, E., Thomas, M., & Feng, Y. (2021). Young adult food safety knowledge gaps and perceptions of roommates' food handling practices: A survey of university students in Indiana. *Food Control*, *126*(February), 108055. https://doi.org/10.1016/j.foodcont.2021.108055

Courtney, S. M., Majowicz, S. E., & Dubin, J. A. (2016). Food safety knowledge of undergraduate students at a Canadian university: Results of an online survey. *BMC Public Health*, *16*(1), 1147. https://doi.org/10.1186/S12889–016–3818-Y/TABLES/7

Dichtl, K., Koeppel, M. B., Wallner, C. P., Marx, T., Wagener, J., & Ney, L. (2020). Food poisoning: An underestimated cause of Boerhaave syndrome. *Infection*, *48*(1), 125–128. https://doi.org/10.1007/S15010–019–01367–6/FIGURES/1

Doyle, M. P., Erickson, M. C., Alali, W., Cannon, J., Deng, X., Ortega, Y., Smith, M. A., & Zhao, T. (2015). The food industry's current and future role in preventing microbial foodborne illness within the United States. *Clinical Infectious Diseases*, *61*(2), 252–259. https://doi.org/10.1093/CID/CIV253

Ergönül, B. (2013). Consumer awareness and perception to food safety: A consumer analysis. *Food Control*, *32*(2), 461–471. https://doi.org/10.1016/j.foodcont.2013.01.018

Evans, E. W., & Redmond, E. C. (2019). Older adult consumers' attitudes and perceptions of risk, control, and responsibility for food safety in the domestic kitchen. *Journal of Food Protection*, *82*(3), 371–378. https://doi.org/10.4315/0362–028X.JFP-18–357

Fein, S. B., Lando, A. M., Levy, A. S., Teisl, M. F., & Noblet, C. (2011). Trends in U.S. consumers' safe handling and consumption of food and their risk perceptions, 1988 through 2010. *Journal of Food Protection*, *74*(9), 1513–1523. https://doi.org/10.4315/0362–028X.JFP-11–017

Ferk, C. C., Calder, B. L., & Camire, M. E. (2016). Assessing the food safety knowledge of University of Maine students. *Journal of Food Science Education*, *15*(1), 14–22. https://doi.org/10.1111/1541–4329.12076

Geppert, J., Schulze Struchtrup, S., Stamminger, R., Haarhoff, C., Ebert, V., Koch, S., Lohmann, M., & Böl, G. F. (2019). Food safety behavior observed in German TV cooking shows. *Food Control*, *96*, 205–211. https://doi.org/10.1016/J.FOODCONT.2018.09.017

Gkana, E. N., & Nychas, G. J. E. (2018). Consumer food safety perceptions and self-reported practices in Greece. *International Journal of Consumer Studies*, *42*(1), 27–34. https://doi.org/10.1111/ijcs.12391

Green, E. J., & Knechtges, P. L. (2015). Food safety knowledge and practices of young adults. *Journal of Environmental Health*, *77*(10), 18–25. https://doi.org/10.2307/26330266

Hassan, H. F., & Dimassi, H. (2014). Food safety and handling knowledge and practices of Lebanese university students. *Food Control*, *40*(1), 127–133. https://doi.org/10.1016/J.FOODCONT.2013.11.040

Lange, M., Göranzon, H., & Marklinder, I. (2016). Self-reported food safety knowledge and behaviour among home and consumer studies students. *Food Control*, *67*, 265–272. https://doi.org/10.1016/j.foodcont.2016.03.014

Lazou, T., Georgiadis, M., Pentieva, K., McKevitt, A., & Iossifidou, E. (2012). Food safety knowledge and food-handling practices of Greek university students: A questionnaire-based survey. *Food Control*, *28*(2), 400–411. https://doi.org/10.1016/J.FOODCONT.2012.05.027

Lim, T. P., Chye, F. Y., Sulaiman, M. R., Suki, N. M., & Lee, J. S. (2016). A structural modeling on food safety knowledge, attitude, and behaviour among Bum Bum Island community of Semporna, Sabah. *Food Control*, *60*, 241–246. https://doi.org/10.1016/J.FOODCONT.2015.07.042

Luo, X., Xu, X., Chen, H., Bai, R., Zhang, Y., Hou, X., Zhang, F., Zhang, Y., Sharma, M., Zeng, H., & Zhao, Y. (2019). Food safety related knowledge, attitudes, and practices (KAP) among the students from nursing, education and medical college in Chongqing, China. *Food Control*, *95*,

181–188. https://doi.org/10.1016/J.FOODCONT.2018.07.042

McArthur, L., & Holbert, D. (2007). College students and awareness of food safety. *Journal of Family and Consumer Sciences*, *99*(1), 60–67.

Medeiros, L. C., Hillers, V. N., Kendall, P. A., & Mason, A. (2001). Food safety education: What should we be teaching to consumers? *Journal of Nutrition Education and Behavior*, *33*(2), 108–113. https://doi.org/10.1016/s1499–4046(06)60174–7

Mihalache, O. A., Dumitraşcu, L., Nicolau, A. I., & Borda, D. (2021). Food safety knowledge, food shopping attitude and safety kitchen practices among Romanian consumers: A structural modelling approach. *Food Control*, *120*. https://doi.org/10.1016/j.foodcont.2020.107545

Morrison, E., & Young, I. (2019). The missing ingredient: Food safety messages on popular recipe blogs. *Food Protection Trends*, *39*(1), 28–39. https://www.foodprotection.org/files/food-protection-trends/jan-feb-19-morrison.pdf

Murray, R., Glass-Kaastra, S., Gardhouse, C., Marshall, B., Ciampa, N., Franklin, K., Hurst, M., Thomas, M. K., & Nesbitt, A. (2017). Canadian consumer food safety practices and knowledge: Foodbook study. *Journal of Food Protection*, *80*(10), 1711–1718. https://doi.org/10.4315/0362–028X.JFP-17–108

Odeyemi, O. A., Sani, N. A., Obadina, A. O., Saba, C. K. S., Bamidele, F. A., Abughoush, M., Asghar, A., Dongmo, F. F. D., Macer, D., & Aberoumand, A. (2019). Food safety knowledge, attitudes and practices among consumers in developing countries: An international survey. *Food Research International*, *116*, 1386–1390. https://doi.org/10.1016/J.FOODRES.2018.10.030

Partnership for Food Safety Education. (n.d.). *Featured resources | Partnership for food safety education*. https://www.fightbac.org/featured/

Rodríguez-Lázaro, D., & Hernandez, M. (2018). Emerging biological risks in a global context: An introduction. *Advances in Food and Nutrition Research*, *86*, 1–12. https://doi.org/10.1016/BS.AFNR.2018.04.001

Sharif, L., & Al-Malki, T. (2010). Knowledge, attitude and practice of Taif University students on food poisoning. *Food Control*, *21*(1), 55–60. https://doi.org/10.1016/J.FOODCONT.2009.03.015

Stratev, D., Odeyemi, O. A., Pavlov, A., Kyuchukova, R., Fatehi, F., & Bamidele, F. A. (2017). Food safety knowledge and hygiene practices among veterinary medicine students at Trakia University, Bulgaria. *Journal of Infection and Public Health*, *10*(6), 778–782. https://doi.org/10.1016/J.JIPH.2016.12.001

Takeda, S., Akamatsu, R., Horiguchi, I., & Marui, E. (2011). Relationship among food-safety knowledge, beliefs, and risk-reduction behavior in university students in Japan. *Journal of Nutrition Education and Behavior*, *43*(6), 449–454. https://doi.org/10.1016/j.jneb.2010.08.009

U.S. Food & Drug Administration (FDA). (2011). *Food Safety Modernization Act (FSMA) | FDA*. https://www.fda.gov/food/guidance-regulation-food-and-dietary-supplements/food-safety-modernization-act-fsma

Woh, P. Y., Thong, K. L., Behnke, J. M., Lewis, J. W., & Mohd Zain, S. N. (2016). Evaluation of basic knowledge on food safety and food handling practices amongst migrant food handlers in Peninsular Malaysia. *Food Control*, *70*, 64–73. https://doi.org/10.1016/J.FOODCONT.2016.05.033

World Health Organization. (2006). *Five keys to safer food manual*. https://www.who.int/foodsafety/publications/consumer/manual_keys.pdf

World Health Organization. (2015a). *WHO estimates of the global burden of foodborne diseases: foodborne diseases in the WHO regions*. https://apps.who.int/iris/handle/10665/327502

World Health Organization. (2015b). *WHO's first ever global estimates of foodborne diseases find children under 5 account for almost one third of deaths*. https://www.who.int/news/item/03–12–2015-who-s-first-ever-global-estimates-of-foodborne-diseases-find-children-under-5-account-for-almost-one-third-of-deaths

Xiong, J. (2017). *Food safety knowledge and practices of college students*. College of Saint Benedict/Saint John's University. https://digitalcommons.csbsju.edu/elce_cscday/135/

Yeung, H. F., Bruhn, C., Blackburn, M., Ganthavorn, C., Martin, A., Mendoza, C., Neelon, M., Smith, D., Soule, K., Spezzano, T. M., Barrett, T., & Feng, Y. (2019). Evaluation of in-person and on-line food safety education programs for community volunteers. *Food Control*, *99*, 34–39. https://doi.org/10.1016/J.FOODCONT.2018.12.021