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Food safety knowledge of young food handlers: A cross-sectional study in Türkiye

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ABSTRACT

The aim of this study was to investigate food safety knowledge levels according to the socio-demographic profiles of young food handlers and to find out the determinants of the knowledge level. A cross-sectional survey was conducted in Türkiye; it consisted of sections including hygienic design, freezing and thawing, preparation, cooking and reheating, service, storage, and foodborne diseases sections. The food safety knowledge level differed according to gender, age, income, grade level, and intership status. Participants who coded 60% of the survey statements correctly were considered to have "good" food safety knowledge. Knowledge about cooking and reheating, foodborne diseases, and service was found to be at a poor level, but food safety knowledge (overall) was good (68%). The correct score ratio was found to be the highest for hygienic design. Binary logistic regression presented that gender, income, grade level, and internship status significantly affected knowledge level. The strongest predictors were found to be income of $638-$850 (exp (β)=12.9) and more than $850 (exp (β)=4.6), respectively. This study highlights that female students under the age of 25 with an income of more than $638, who have not yet completed an internship, have the highest level of food safety knowledge. This study presented a holistic approach to the food safety knowledge of young food handlers. These insights can contribute to the development of hygiene/sanitation and food safety course content for culinary and gastronomy students.

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Introduction

Foodborne diseases are a major public health concern (WHO, 2022). Worldwide, one in 10 people gets sick from contaminated food. Unsafe food causes 600 million cases a year from more than 200 different diseases. This results in more than 420,000 deaths each year. In European countries, 23 million people are affected by foodborne diseases, and about 5,000 of them die (Lee and Yoon, 2021). In Türkiye, between 2015 and 2020, there were 18,314,239 applications to hospitals due to foodborne diseases, and 1,714 people lost their lives (Turkish Ministry of Health, 2021). Foodborne diseases can be caused by improper food preparation attitudes, inadequate temperature control, poor sanitation, infected food handlers, and contamination of food by pathogens. Bacteria (359,747,422) are a more common agent than viruses (138,513,782) and protozoa (77,462,734) causing foodborne diseases (WHO, 2015). Food handlers mediate the transmission of disease-causing bacteria (Tappes et al., 2020).

Food handlers are responsible for food preparation process. Throughout this process, they must follow food safety rules to prevent food poisoning and protect human health. To follow these rules correctly, they need to have knowledge about personal hygiene and foodborne diseases how to ensure that food is stored, thawed, cooked, and reheated at the correct temperature; preventing cross-contamination; and following proper food handling techniques during serving of food (WHO, 2022). Recent studies have also emphasized the importance of food safety knowledge among food handlers (Alemayehu et al., 2021; Al-Kandari et al., 2019; Gruenfeldova et al., 2019; Islam et al., 2023; Lee et al., 2017; Moreb et al., 2017; Ncube et al., 2020; Tuglo et al., 2021). However, no studies have discussed food safety knowledge from such holistic perspective consisting of food facility design, food handling steps (freezing, thawing, cooking, reheating, preparation, and storage), foodborne diseases, and food service for safe food production. Moreover, the food safety knowledge of young food handlers who have

gastronomy/culinary education is critical to predict the safety status of prepared food in the future. Despite this, previous studies have not been conducted among the student or newly graduated food handlers; thus, factors affecting food knowledge levels of these young food handlers are still unclear. Furthermore, some studies have claimed that young food handlers have poor food safety knowledge (Fein et al., 2011; Green and Knechtges, 2015), although this claim may not be true for those who have university education in food hygiene and sanitation. More research is needed to clarify these findings and to determine the training needs of food handlers regarding food safety, if necessary.

The originality of this study rested in its intent to assess the food safety knowledge level of educated, young food handlers in terms of seven aspects requiring a theoretical background and kitchen experience. In fact, this research revealed the differences in knowledge levels between graduates and students of the culinary programs. The outputs of this study contributed to the literature on food safety assurance systems in multiple countries. The objectives of the study were (1) to investigate the food safety knowledge of the educated, young food handlers, (2) to evaluate the relationship between socio-demographics and food safety knowledge levels, and (3) to determine sections with the highest and the lowest correct scores used to identify food safety knowledge level. In addition, this study created a foresight for the development of course content in line with the deficiencies in food safety knowledge of gastronomy students taking food hygiene and sanitation courses.

Material and Methods

Instrumentation

In this study, the 3-point Likert scale was used; thus, each statement was scored as (1) incorrect, (2) not sure, and (3) correct. The survey is divided in two parts: socio-demographics (6 questions) and food safety knowledge (43 statements). The questions in the socio-demographic section asked about gender, age, monthly income, marital status, grade level, and internship status. The food safety knowledge construct consists of seven sections: hygienic design (4 statements), freezing and thawing (6 statements), preparation (6 statements), cooking and reheating (5 statements), service (6 statements), storage (5 statements), and foodborne diseases (11 statements). The survey statements were created using the guidelines provided by Better Health (2023), the FDA Commissioner (2023), Food Standards Agency (2023), and Western Australia Department of Health (2023). While creating the foodborne diseases section statements, active and passive food infection microorganisms were taken into consideration; these included *Clostridium perfringens, Listeria monocytogenes, Salmonella spp., Vibrio parahaemolyticus, Yersinia enterocolitica, Aeromonas hydrophila, Escherichia coli O157:H7, Salmonella typhi, Salmonella paratyphi, Vibrio cholerae, Campylobacter jejuni, Shigella dysenteria, Mycobacterium tuberculosis, Brucella spp., Coxiella burnetii, Staphylococcus aureus, Bacillus cereus, Clostridium botulinum,* mycotoxin-producing molds, and some viruses, in addition to intoxication microorganisms.

Samples

A cross-sectional survey was conducted to assess the level of knowledge in relation to food safety of young food handlers. For this purpose, survey data were collected from students and graduates of the Culinary Programs in Türkiye.

The minimum sample size was determined as 200 using G*power software (Appendix A; version 3.1.9.4, 2019, Heinrich Heine Universität Düsseldorf, Düsseldorf, Germany) (available as supplementary material). The sample size (200) was acquired at alpha level 0.05, effect size 0.25, and power level 0.80 as suggested by McCrum-Gardner (2010). However, 337 volunteer participants were involved in the study. The results of 9 participants who did not respond consistently to the reverse coded statements were removed from the survey results, thus the study was conducted with 328 individuals. The participants were selected using the simple random sampling method. All respondents had experience in food handling and taken food safety course in their universities.

Data Collection

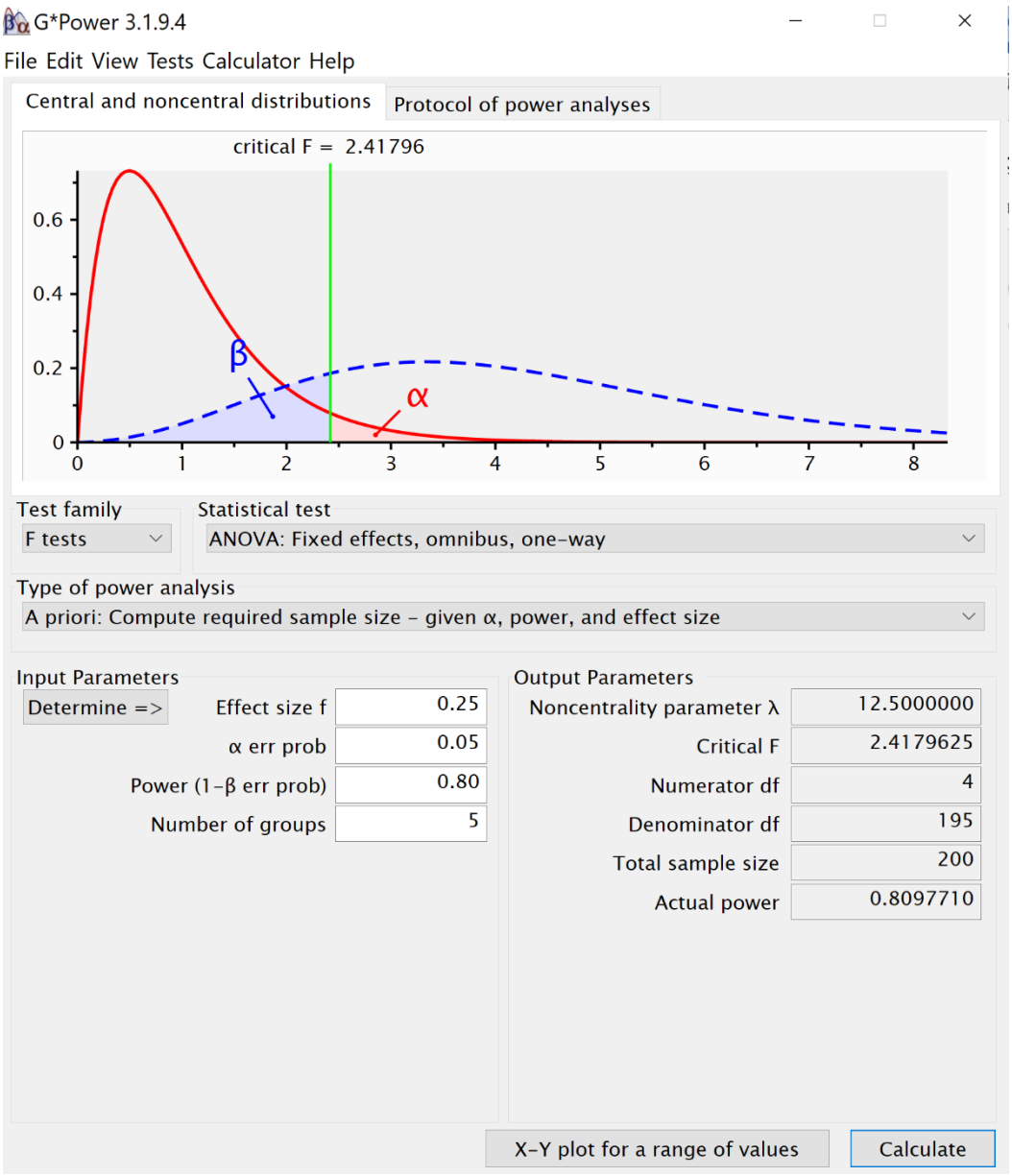
The data were collected via online survey form. As this survey was voluntary, not all graduates and students may have shown interest in participating. Each respondent signed a voluntary participation form. All procedures were conducted according to the The World Medical Association's Declaration of Helsinki and the Turkish National Research Committee's ethical standards.

Pilot Study

The initial version of the survey form was sent to 30 participants (not involved in the actual study) to check the items grammatically and to increase the readability of the form. The revised survey form was scored by these 30 participants; then, consistency of the responses was measured using Cronbach's alpha value. For all statements, the value was found to be 0.8. Since values above 0.70 are acceptable levels (Cortina, 1993), it can be said that the food safety knowledge construct has good internal consistency.

Statistical Analysis

Statistical analysis was performed using SPSS 23 (IBM, New York, USA). A frequency test was used for the correct, incorrect and not sure score ratios, cross-tabulation was used for distribution of food safety knowledge ratios, and variance analyses were used for comparison of the results among the demographics. Binary logistic regression was also performed to find the relationship between the good knowledge levels of food safety and demographics. In addition, Microsoft Excel (version 365, Microsoft Corporation, Washington, US) was also utilized to assign good knowledge levels to the respondents based on rates of 60% correct and above and to visualize the correct score rates for the sections. In variance analysis, Hochberg's GT2 and Games Howell were conducted for equal variance, assumed and not assumed, respectively, in the multiple comparisons, since the sample numbers of the monthly income groups are not close to each other as they were in Field's work (2013). For this study, binary logistic regression was chosen as the essential method because it is a powerful tool that analyzes both categorical and numeric independent variables affecting change in a categorical dependent variable. In the study, a 95% confidence interval was used, and the results were interpreted according to $P<0.05$ significance level.



Appendix A. Sample size calculation in G*power

Research Presentation

The independent variables of the study were socio-demographics, and the dependent variable was food safety knowledge level of young food handlers. The flow of the study was as follows: at first, the correct, incorrect, and not sure score rates were presented. Secondly, the correct score rates were found for each section and for the socio-demographic group. Then, the correct scores for overall (food safety) knowledge were calculated, and the calculated correct score rates were used to classify the food safety knowledge level of the respondents as good or poor. For classification, the rate of 60% was chosen as the threshold value in the Osaili et al. (2017) and Ruby et al. (2019) studies. Therefore, the food safety knowledge level of those who scored all statements with fewer than 60% correct was assigned as "poor" whereas the knowledge level of those whose rate of correct scores was 60% or above was coded as "good". As a result, logistic regression analysis results were interpreted for good knowledge level (in dependent variable encoding; poor=0, good=1).

Results and Discussion

The socio-demographic profile of the respondents are summarized in Table 1. Accordingly, 56.4% (n = 185) of the respondents were male; 59.1% (n = 194) were 18-24 years of age; 64.6% (n = 212) earned less than $425; 74.4% (n = 244) were single; 58.5% (n = 192) were graduates; and 75.6% (n = 248) had completed their internship.

In a general overview of correct answer scores, shown in Table 2, the highest score (84.8%) was found in the statement "Meat, dairy products, and raw or cold-served foods have a high risk of causing food poisoning" as an item of foodborne diseases. It was followed by a statement of preparation, "A spoon (or any equipment) should never come into contact with food after the spoon (or equipment) has been used for tasting" with 83.5%. The majority score (82.9%) of hygienic design was "The areas immediately beyond the hygiene barrier are the cleanest parts of the food production facility". "Thawed food has the same characteristics as fresh food" was the highest score (71.6%) of the freezing and thawing section. In addition, in the

cooking and reheating section, 81.1% of the respondents agreed with "thawed foods have a high microbiological hazard, so cooking temperatures for frozen foods should be chosen more carefully than with fresh foods". Unlike this study, McIntyre et al. (2013) compared untrained and trained food handlers' knowledge levels, but similarly they stated that trained food handlers had better knowledge about thawing of foods with 95% correct answer rate. Ncube et al. (2020) also reported more than 85% of food handlers in Zimbabwe restaurants having excellent knowledge about proper thawing procedures. In both studies, the overlap of the results obtained from food handlers currently working in the service industry with those in this study allows the results to be generalized. In the service section, "The temperature of the foods served in the buffet should be checked every 2 hours" was scored correctly at the highest rate (78.4%). Moreover, while the respondents knew (71.0%) that the danger zone for foods was between 5°C–60°C, they could not use this information sufficiently for food service applications because the correct score rates for temperatures of cold (60.4%) and hot (61.6%) displays were lower than the danger zone temperature score rate. For this reason, it should be emphasized in student practices that the rule of dangerous temperature ranges is valid at every stage of food preparation. Likewise, in the McIntyre et al. (2013) study, the knowledge level of food handlers on safe temperatures was found to be at 71%; however, danger zone score rate was found to be lower (61%). Another highly scored temperature statement was "In a refrigerator, food should be stored between 0°C and +4°C". It was the most correctly scored (74.7%) of statements in the storage section. This score rate was consistent with the finding of the Ncube et al. (2020) study. They reported that 73% of the food handlers knew safe refrigerator temperatures with a near satisfactory score (72%). Similarly, 73% of the respondents in the Lee et al. (2017) study agreed with the ideal refrigerator temperature. All statements that had high correct score rates were involved in course content, or the food handlers had received warning for incorrect application of the knowledge covered in these statements. Therefore, training and reminding about knowledge via individual warnings may have helped to teach better food safety rules. Overall assessment of the high-scoring statements indicates that young food handlers have a good understanding of temperature guidelines for safe food preparation. Even, the fact that food handlers trained in food safety had good temperature knowledge in this study and the previous works suggests that temperature-related food poisoning is caused by negligence, not lack of knowledge.

On the other hand, the lowest correct score rate (22.3%) was found in the cooking and reheating section with "Food should be reheated to a higher temperature than the initial cooking temperature". When the students were asked about the reasons for this item's low score, they stated that the microbiological hazard of a cooked product is low and that heating it at high temperatures can cause burns in the food and reduce its nutritional value. Lack of knowledge about reheating temperatures was also reported by Osaili et al. (2017, 2018), as less than 20% of food service staff who consisted of dietitians, cooks, and food workers in Jordanian hospitals and universities agreed with the appropriate reheating temperature. In any case, it could not be expected that any food staff would know better the knowledge that young food handlers use while preparing meals. Another poorly scored statement was "It is safe to store leftovers from a buffet they have been after covered and dated", with a 30.5% correct answer rate. The food handlers might have been in a dilemma while choosing the correct option because it is a reverse coded statement; the not sure rate (53.7%) of this statement also supports this assumption. In the Osaili et al. (2017) study, 23.5% of food workers thought that leftovers should be discarded. In fact, every food worker should know that food that goes to a buffet becomes risky due to contamination by people (via cough or possible contact with hands) and should not be stored. For safe food service, if necessary, products returned from a buffet should be consumed without waiting.

Table 1. Socio-demographic profile of the respondents

Variables	Frequency (n = 328)	Percentage
Gender		
Female	143	43.6
Male	185	56.4
Age (years)		
18-24	194	59.1
25–30	134	40.9
Monthly income (household)		
Less than $425	212	64.6
$425–$637	33	10.1
$638–$850	47	14.3
More than $850	36	11.0
Marital status		
Married	84	25.6
Single	244	74.4
Grade level		
Student	136	41.5
Graduate	192	58.5
Internship status		
No	80	24.4
Yes	248	75.6

Table 2. Score rates of food safety knowledge

Sections and statements	Correct	Incorrect	Not sure
Hygienic design			
The layout of the food preparation area should be oriented from dirty to clean. (-)	78.4[†]	7.3	14.3
Access to food preparation areas should be through a single door.	78.0	3.7	18.3
Returned food should not be allowed in the food preparation area.	77.1	3.4	19.5
The areas immediately beyond the hygiene barrier are the cleanest parts of the food production facility.	82.9	3.4	13.7
Freezing and thawing			
Freezing food does not eliminate the risk of poisoning.	60.7	13.7	25.6
Freezing food does not eliminate the risk of spoilage.	47.3	29.8	22.9
Defrosted food should be consumed within 24 hours.	64.6	7.0	28.4
Thawed food has the same characteristics as fresh food. (-)	71.6	11.9	16.5
It is safe to thaw food in hot water. (-)	64.9	12.8	22.3
Defrosting food in the microwave is safe.	63.7	7.6	28.7
Preparation			
When the portion size of a food decreases, its shelf life is shortened.	45.1	18.0	36.9
The cutting boards used for cooked and raw foods should be different colors to prevent cross contamination.	78.4	8.2	13.4
It is risky to touch ready-to-serve food after touching raw food.	79.3	5.5	15.2
Blending leftovers with freshly prepared foods increases the risk of cross contamination.	53.7	35.3	11.0
A spoon (or any equipment) should never come into contact with food after the spoon (or equipment) has been used for tasting.	83.5	8.0	8.5
Foods should not be kept at room temperature for more than 2 hours.	80.2	3.0	16.8
Cooking and reheating			
Food should be cooked at a minimum of 75°C to inhibit bacterial growth.	60.4	16.8	22.8
Food should be reheated to a higher temperature than the initial cooking temperature.	22.3	58.5	19.2
Thawed foods have a high microbiological hazard, so cooking temperatures for frozen foods should be chosen more carefully than with fresh foods.	81.1	4.6	14.3
There is no harm in storing and reheating thawed foods after cooking. (-)	59.5	13.1	27.4
The middle of a food item is the coldest region.	52.1	19.8	28.1
Service			
Cold displays should be set below 5°C.	60.4	9.8	29.8
Hot displays should be set above 60°C.	61.6	18.6	19.8
The danger zone is the temperature between 5°C – 60°C.	71.0	10.4	18.6
It is safe to store leftovers from a buffet after they have been covered and dated. (-)	30.5	15.8	53.7
It is sufficient to switch on the heating and cooling units of the buffets as soon as the food service starts. (-)	53.4	24.6	22.0
The temperature of the foods served in the buffet should be checked every 2 hours.	78.4	10.4	11.3
Storage			
In a refrigerator, food should be stored between 0°C and +4°C.	74.7	11.9	13.4
Refrigerator temperatures should be checked at least twice a day.	61.0	14.3	24.7
The leftovers from buffets should not be stored.	64.3	22.9	12.8
The expiration date of a product is not valid after a package has been opened.	58.5	26.3	15.2
Raw materials should always be stored below ready-to-eat foods.	56.4	14.3	29.3
Foodborne diseases			
Foodborne diseases can result in business closure.	63.4	4.0	32.6
Foodborne diseases are less likely to be transmitted.	38.1	36.6	25.3
Immunity to foodborne diseases may occur. (-)	41.5	52.4	6.1
Microorganisms that spoil food and that cause food poisoning are different.	32.6	50.0	17.4
Some food poisonings are fatal.	73.2	20.1	6.7
Meat, dairy products, and raw or cold-served foods have a high risk of causing food poisoning.	84.8	3.3	11.9
Foods with a high moisture content have a high risk of causing food poisoning.	38.4	22.0	39.6
Washing hands without soap after using the restroom increases the risk of foodborne illness.	66.8	11.6	21.6
Handshaking in the food preparation area increases the risk of food poisoning.	68.0	10.4	21.6
Failure to wash with soap or disinfect hands after smoking increases the risk of food poisoning.	67.7	4.9	27.4
Drying wet hands on clothing increases the risk of foodborne disease.	61.6	7.9	30.5

[†]Percentages of the score numbers for each statement.; (-): Reverse-coded statements.

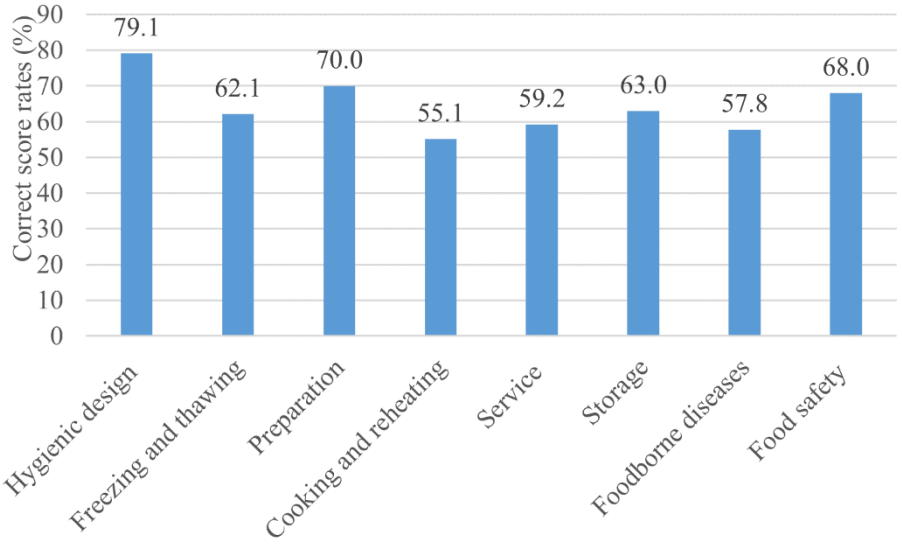


Figure 1. The correct score rates of food safety knowledge

One of the preparation section items, "When the portion size of a food decreases, its shelf life is shortened", got a low correct answer rate (45.1%); however, the rate of not sure was 36.9%. Similarly, the statement "Foods with a high moisture content have a high risk of causing food poisoning" was one (38.4%) of the lowest correctly scored items in the foodborne diseases section, but it had 39.6% not sure rate. For both items, these statements may have created confusion as they contain a comparison based on food characteristics. In general, it can be said that the respondents have knowledge about each section of food safety. However, it was observed that the knowledge levels in some sections remained below the threshold determined as 60%. All these findings show that young food handlers do not fully know the difference between food spoilage and food poisoning. In addition, these individuals do not know the food characteristics that are risky for food poisoning. Therefore, in food safety and hygiene/sanitation training, the difference between food poisoning and food spoilage can be explained through food characteristics and optimum breeding conditions of causative microorganisms.

As shown in Figure 1, according to section-based averages, the highest correct score rate was found in hygienic design (79.1%) whereas the lowest rate (55.1%) was in cooking and reheating. Food safety knowledge (overall) among food handlers was considered good (68%), and it was higher than that found in the Baş et al. (2006) study conducted in Türkiye (43.4%). This might be attributed to the fact that the present study was conducted among food handlers who were educated at a university for food safety because almost half of the food handlers did not even have basic food safety training. For the sections of food safety, the respondents' knowledge about cooking and reheating, foodborne diseases, and service was found to be insufficient, with less than 60%. Regarding the statements in Table 2, improving food safety education in the areas of cooking and reheating temperatures and the mechanism of heating foods can contribute to increased knowledge level regarding cooking and reheating. Osaili et al. (2013) reported that cooking and reheating knowledge of food handlers in fast-food restaurants was found to be at the lowest level (52.4%). It is normal for this score to be lower than that found in the current study because there is no reheating in the fast-food restaurant and cooking temperatures are not set by the food workers. This finding is also in line with the Al-Kandari et al. (2019) study conducted in Kuwait restaurants, in which 37.3% of food handlers correctly scored in the area of cooking and reheating temperatures. This score is lower than that found in the current study. Since the study was conducted face-to-face (orally) and Kuwaiti food handlers had to answer the questions immediately. For the foodborne diseases section, the reason for the low score rates is that food poisoning and food infections are considered important only if they present severe symptoms, and another reason is that training on this issue only includes theoretical knowledge without opportunity for practice and discussing a retrospective of foodborne disease cases. Therefore, students may have forgotten their knowledge about foodborne diseases. Therefore, it should be reinforced which foods are more risky and can be poisoned without changing their taste, smell, color, or appearance. Moreover, the reason why the items in the service section received low scores, such as 30.6% and 53.4%, may be economical. Because using leftovers and operating cooling and heating units just before starting food service in order to save energy indicates monetary concerns. It is known that economic issues such as long-term high inflation and its resulting decrease in solvency negatively affect food safety in Türkiye (Baş et al., 2006; Karaman et al., 2012).

Table 3 includes the percentage distribution and statistical within-demographic-group comparison of the respondents who pass the 60% correct scoring rate. All ratios in Table 3 represent the percentage of respondents with a good knowledge ratio (level). Accordingly, good knowledge rates in hygienic design, freezing and thawing, cooking and reheating, and storage were significantly different between males and females ($P<0.05$). The rates for freezing and thawing and storage were significantly different between age groups ($P<0.05$). Good knowledge rates in preparation, cooking and reheating, storage, and foodborne diseases varied depending on income ($P<0.05$). In all sections, rates were found to be different according to the grade level and internship status ($P<0.05$), excluding the freezing and thawing section for the internship status.

Table 3. Comparison of good knowledge rates of food safety sections.

Variables	HD	FT	P	CR	S	ST	FD	O
Gender								
Female	83.9[†a]	69.2[a]	79.7	71.3[a]	60.1	75.5[a]	53.1	79.7[a]
Male	74.1[b]	54.6[b]	73.0	56.2[b]	57.8	61.6[b]	45.4	58.9[b]
Age (years)								
18-24	78.9	67.5[a]	77.3	61.9	59.3	72.7[a]	50.0	75.3[a]
25–30	77.6	51.5[b]	73.9	64.2	58.2	60.4[b]	47.0	57.5[b]
Monthly income (household)								
Less than $425	76.4	59.4	71.2[b]	54.2[b]	53.8	59.9[b]	42.9[b]	57.5[b]
$425–$637	78.8	57.6	78.8[ab]	72.7[ab]	63.6	75.8[ab]	57.6[a]	78.8[ab]
$638–$850	83.0	63.8	95.7[a]	80.9[a]	74.5	87.2[a]	68.1[a]	95.7[a]
More than $850	83.3	69.4	75.0[ab]	80.6[a]	63.9	80.6[ab]	50.0[a]	83.3[a]
Marital status								
Married	77.4	58.3	73.8	66.7	52.4	70.2	50.0	67.9
Single	78.7	61.9	76.6	61.5	61.1	66.8	48.4	68.0
Grade level								
Student	84.6[a]	67.6[a]	82.4[a]	73.5[a]	71.3[a]	79.4[a]	60.3[a]	87.5[a]
Graduate	74.0[b]	56.3[b]	71.4[b]	55.2[b]	50.0[b]	59.4[b]	40.6[b]	54.2[b]
Internship status								
No	87.5[a]	67.5	83.4[a]	81.3[a]	75.0[a]	80.0[a]	62.5[a]	95.0[a]
Yes	75.4[b]	58.9	73.4[b]	56.9[b]	53.6[b]	63.7[b]	44.4[b]	59.3[b]

HD: Hygienic design; FT: Freezing and thawing, P: Preparation; CR: Cooking and reheating; S: Service; ST: Storage; FD: Foodborne diseases; O: Overall (food safety); [†]Percentages of the number of people who gave more than 60% correct answers to the statements in the sections; P<0.05 significance level was used in statistical lettering. The ratios without lettering are the results found to be statistically the same.

Food safety (overall) knowledge rates are also shown in Table 3. The good knowledge rates of females (28.44 ± 5.50) were found to be significantly higher than the males' rates (25.72 ± 6.92) with the values of t (324.94) =4.20 and P=0.000. This difference may be due to the fact that females are more aware of food safety than males because they are also interested in food processing and taking care of children at home. This result is consistent with the Ruby et al. (2019); Yilmaz (2015) outputs. Ruby et al. (2019) also emphasized that females with high scores had children and prepared food every day. In terms of age groups, there was a significant difference between the 18-24 (27.90 ± 5.51) and the 25–30 (25.48 ± 7.45) age groups [t (259.93) = 3.36, P=0.001]. The reason is that the under-25 age group had a better level of food safety knowledge. It might be due to the fact that most of these respondents were university students or had just graduated. Thus, the knowledge of these respondents is expected to be fresh. The food handlers under the age of 25 had better knowledge, especially in the food storage and food hygiene sections, than the older individuals; however, the below-25-years-old group had the lowest knowledge level for overall (average) assessment (Islam et al., 2023). These findings were also consistent with the Moreb et al. (2017) study results. This may be due to the fact that individuals under 25 years old in these studies were household food handlers, not students or new graduates, so they may not have already received food safety training. Furthermore, good knowledge levels regarding food safety changed among the incomes statistically [F (3, 324) = 12.05, P=0.000]. The multiple comparison showed that good knowledge rates of the respondents earning $638 or more were significantly higher than those having less than $425 income (P=0.000). Mean scores were found to be 30.50 ± 3.10 for $638–$850 and 27.89 ± 8.31 for more than $850 groups whereas 25.75 ± 6.34 was found for the less than $425 income group. As Gong et al. (2016), Islam et al. (2023), and Tuglo et al. (2021) reported that people who earned less were found to have poorer knowledge of food safety. This may be because high-income food handlers work in businesses that comply with food safety and hygiene rules. Regarding grade level, good knowledge rates of students (29.28 ± 5.04) were found to be higher than the graduates' rates (25.23 ± 6.85) with t (324.78) = 7.26 and P=0.000 values. Grade level results were in line with the results of age groups. The fact that good knowledge level of the respondents under the age of 25 was good showed that the results of the students would also be high. In addition, grade level is related with length of employment. Priorities and workload in commercial food businesses may cause food safety rules to be put on the back burner. Likewise, Çakıroğlu and Uçar (2008) stated that employees under the age of 25 had higher food hygiene scores than those of staff between 26–34 years old. The effect of age depending on working experience was also determined by Santos et al. (2008), in whose study the food handlers working in the canteen for less than 9 years had better food safety attitudes than those who had worked more than 9 years. The findings reported by Adesokan and Raji (2014) supported this relationship, in which workers were less likely to obtain good knowledge level after 3 years of work experience. Moreover, internship status changed good knowledge rates significantly. Levels of the respondents who had not yet completed an internship (30.16 ± 4.14) were found to be higher than the rates for those who had completed their internships (25.86 ± 6.75) with the t (295.14) = 8.99 and P=0.000 values. Internship may also have affected knowledge level, similar to grade level and work experience. Because the excess number of occasions such as events and banquets in the food business obliges food to be prepared quickly, food safety perceptions of the kitchen staff may be weakened. In the study of da Cunha et al. (2014), it was reported that the workload, that is, the increase in the number of prepared foods, affects food

safety negatively. Santos et al. (2008) also emphasized this inverse relationship. Furthermore, there was no significant difference in food safety scores according to marital status. These results similar to found by Osaili et al. (2018). This study highlighted that female students under the age of 25 with an income of more than $638, who had not yet completed an internship, had the highest level of knowledge about food safety and passed the 60% threshold value.

As shown in Table 4, the regression model was used to determine the effect of socio-demographics on good knowledge levels of young food handlers regarding food safety. The model and the predictors were tested using Omnibus Tests of Model Coefficients (χ^2 = 99.4, df = 8, *p* = 0.0). The Hosmer and Lemeshow Test (χ^2 = 7.1 df = 8, *p* = 0.5) is the most reliable test to check goodness of fit. To confirm the fit of the model, the *p*-value has to be greater than 0.05 (Pallant, 2020); thus, the model could be accepted as a good predictor of food safety knowledge level. The model can explain the variations in the food safety knowledge of young food handlers with a 36.6% rate (Nagelkerke R^2). The accuracy of the model showed that the predictions were correctly classified in 77.1% of cases. The regression analysis results determined that good knowledge about food safety significantly changed according to gender, income, grade level, and internship status (P<0.05). Income between $638–$850 was the strongest predictor, with exp (β) (odds ratio) of 12.9. It meant that a $638–$850 income provided 12.9 times more possibility of having good food safety knowledge among the young food handlers. In addition, an income of more than $850 provided a 4.6-fold increase in the rate of good knowledge level on food safety. Similarly, in the Al Banna et al. (2021) study, an income of more than $234 was found to be associated with good knowledge level of food safety. Yu et al. (2018) determined that income positively affected perceptions of food safety. On the other hand, money can create a sense of security (Dontsov et al., 2013; Garai-Fodor and Csiszárik-Kocsir, 2022); thus, when employees earn a high income, they may not prioritize or pay attention to food safety instructions in the kitchen. Moreover, the reason for this may be that food handlers whose earnings increase, decrease their attention to food safety. It is known that the salary of kitchen staff increases with work experience; however, length of employment may negatively affect the food safety knowledge level. The Webb and Morancie (2015) study reported that employees handling food for many consecutive years had poorer food safety knowledge than those having shorter work experience. This is in line with the Alemayehu et al. (2021) study findings.

Table 4 presents that variation in food safety knowledge between males and females was found to be significant (P<0.05). Males were 0.4 times less likely to score higher than females. The Burke et al. (2016) study of young food handlers showed that females were more likely to know about food safety than males. Low et al. (2016) found that males had lower knowledge levels than females. The exp (β) of 0.4 for graduate level implied that graduates were 0.4 times less likely to score higher than students. Likewise, those who have completed an internship were 0.2 times less likely to score a good level of food safety knowledge. Graduation and completion of an internship had a negative effect on food safety knowledge with a similar coefficient. As Cumhur (2021), Gruenfeldova et al. (2019), and Smigic et al. (2020) stated, education regarding food safety (theoretical and applied courses) improved knowledge level, and Adesokan et al. (2015) predicted that refresher training might increase food safety knowledge level 45-fold. On the contrary, marital status was not a predictor of food safety knowledge level in this study. Osaili et al. (2018) also found that marital status was not a predictor of food safety knowledge level.

Table 4. Logistic regression results for good knowledge level of food safety

Variables	B	S.E.	Exp (β) (95% CI)	Significance
Gender				
Female			1.0	
Male	-1.0	0.3	0.4 (0.2, 0.7)	0.001***
Age (years)				
18-24			1.0	
25-30	-0.5	0.3	0.6 (0.3, 1.1)	0.084
Monthly income (household)				
Less than $ 425			1.0	
$ 425 - $ 637	0.7	0.5	1.9 (0.7, 5.2)	0.203
$ 638 - $ 850	2.6	0.8	12.9 (2.9, 57.9)	0.001***
More than $ 850	1.5	0.5	4.6 (1.6, 13.2)	0.004***
Marital status				
Married			1.0	
Single	0.3	0.4	1.4 (0.7, 2.9)	0.338
Grade level				
Student			1.0	
Graduate	-0.9	0.4	0.4 (0.2, 0.8)	0.013**
Internship status				
No			1.0	
Yes	-1.5	0.6	0.2 (0.1, 0.7)	0.015**

** The values are significantly different at P<0.05;***The values are significantly different at P<0.01; Omnibus Test of Model Coefficients: χ^2 = 99.4, df = 8, P=0.000; Hosmer and Lemeshow Test: χ^2 = 7.1 df = 8, P=0.525; Nagelkerke R^2 = 0.4

Conclusion

The study concluded that the level of food safety knowledge of young food handlers in Türkiye was satisfactory. They had good knowledge regarding hygienic design of food processing facilities, preparation, storage, and freezing and thawing of foods whereas their knowledge of cooking and reheating, foodborne diseases, and service were found insufficient. The highest correct scoring was found in hygienic design whereas the lowest rate was in cooking and reheating. The young food handlers have a good understanding of temperature guidelines for safe food preparation; however, they do not know the food characteristics that are risky for food poisoning. In addition, there are also some issues that need to be improved about the factors that cause food poisoning. Reheating temperature, distinguishing food poisoning bacteria from food spoilage microorganisms, storage conditions of leftovers are the main problems in food safety knowledge of the young food handlers. Food safety knowledge level varied depending on gender, age, monthly income, grade level, and internship status, but age did not affect the knowledge level of young food handlers. The strongest effect was found to be monthly income. The variable with the least significant effect was found to be internship status. This study presents more comprehensive content than previous studies as it examined food safety knowledge of young food handlers in seven sections and then reported the effects of gender, income, grade level, and internship status on knowledge level as well as variation in knowledge levels according to these socio-demographic variables. For future studies, both food safety knowledge and attitudes of young and old food handlers can be analyzed within the same model; thus, it may be determined whether theoretical knowledge is applied during food preparation in both age groups.

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Conflict of Interest

The work and the author have no conflict of interest or unity of conflict with any person or institution.

Ethical Statement

This study was approved by the Institutional Review Board of Amasya University (approval number is E-30640013-108.01-135632).

Informed Consent

Written informed consent was obtained from all study participants

References

Adesokan, H. K., Akinseye, V. O., & Adesokan, G. A. (2015). Food safety training is associated with improved knowledge and behaviours among foodservice establishments' workers. *International Journal of Food Science*, *2015*, e328761. doi:10.1155/2015/328761

Adesokan, H. K., & Raji, A. O. Q. (2014). Safe meat-handling knowledge, attitudes and practices of private and government meat processing plants' workers: Implications for future policy. *Journal of Preventive Medicine and Hygiene*, *55*(1), 10–16.

Al Banna, Md. H., Disu, T. R., Kundu, S., Ahinkorah, B. O., Brazendale, K., Seidu, A.-A., Okyere, J., Rahman, N., Mondal, S., Matubber, B., & Khan, M. S. I. (2021). Factors associated with food safety knowledge and practices among meat handlers in Bangladesh: A cross-sectional study. *Environmental Health and Preventive Medicine*, *26*(1), 84. doi:10.1186/s12199-021-01004-5

Alemayehu, T., Aderaw, Z., Giza, M., & Diress, G. (2021). Food safety knowledge, handling practices and associated factors among food handlers working in food establishments in Debre Markos Town, Northwest Ethiopia, 2020: Institution-based cross-sectional study. *Risk Management and Healthcare Policy*, *14*, 1155–1163. doi:10.2147/RMHP.S295974

Al-Kandari, D., Al-abdeen, J., & Sidhu, J. (2019). Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control*, *103*, 103–110. doi:10.1016/j.foodcont.2019.03.040

Baş, M., Şafak Ersun, A., & Kıvanç, G. (2006). The evaluation of food hygiene knowledge, attitudes, and practices of food handlers' in food businesses in Turkey. *Food Control*, *17*(4), 317–322. doi:10.1016/j.foodcont.2004.11.006

Better Health. (2023, April 14). Food safety when cooking—Better Health Channel. Retrieved from https://www.betterhealth.vic.gov.au/health/healthyliving/food-safety-when-cooking

Burke, T., Young, I., & Papadopoulos, A. (2016). Assessing food safety knowledge and preferred information sources among 19–29 year olds. *Food Control*, *69*, 83–89. doi:10.1016/j.foodcont.2016.04.019

Çakıroğlu, F. P., & Uçar, A. (2008). Employees' perception of hygiene in the catering industry in Ankara (Turkey). *Food Control*, *19*(1), 9–15. doi:10.1016/j.foodcont.2007.01.001

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology*, *78*, 98–104. doi:10.1037/0021-9010.78.1.98

Cumhur, Ö. (2021). The effect of food safety and hygiene education on the knowledge levels of tourism students in Turkey. *Gastroia: Journal of Gastronomy And Travel Research*, *5*(3), 505–521.

da Cunha, D. T., Stedefeldt, E., & de Rosso, V. V. (2014). The role of theoretical food safety training on Brazilian food handlers' knowledge, attitude and practice. *Food Control*, *43*, 167–174. doi:10.1016/j.foodcont.2014.03.012

Dontsov, A. I., Zinchenko, Y. P., & Zotova, O. Y. (2013). Notions of security as a component of students attitudes towards money. *Procedia - Social and Behavioral Sciences*, *86*, 98–103. doi:10.1016/j.sbspro.2013.08.532

FDA Commissioner. (2023, April 20). Are You Storing Food Safely? Retrieved from https://www.fda.gov/consumers/consumer-updates/are-you-storing-food-safely

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. doi:10.4315/0362-028X.JFP-11-017

Field, A. (2013). *Discovering Statistics Using IBM SPSS Statistics* (4th Edition). Sage, London.

Food Standards Agency. (2023, April 21). Consumer advice/Food safety. Retrieved from https://www.food.gov.uk/

Garai-Fodor, M., & Csiszárik-Kocsir, Á. (2022). Consumer segments according to their perception of the value of money after the coronavirus pandemic from the financial literacy aspect. *2022 IEEE 26th International Conference on Intelligent Engineering Systems (INES)*, Crete, Greece, 000193–000198. doi:10.1109/INES56734.2022.9922621

Giritlioglu, I., Batman, O., & Tetik, N. (2011). The knowledge and practice of food safety and hygiene of cookery students in Turkey. *Food Control*, *22*(6), 838–842. doi:10.1016/j.foodcont.2010.09.016

Gong, S., Wang, X., Yang, Y., & Bai, L. (2016). Knowledge of food safety and handling in households: A survey of food handlers in Mainland China. *Food Control*, *64*, 45–53. doi:10.1016/j.foodcont.2015.12.006

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

Gruenfeldova, J., Domijan, K., & Walsh, C. (2019). A study of food safety knowledge, practice and training among food handlers in Ireland. *Food Control*, *105*, 131–140. doi:10.1016/j.foodcont.2019.05.023

Islam, Md. N., Roy, N., Amin, Md. B., Madilo, F. K., Karmakar, K., Hossain, E., Aktarujjaman, Md., Islam, Md. S., & Airin, N. J. (2023). Food safety knowledge and handling practices among household food handlers in Bangladesh: A cross-sectional study. *Food Control*, *147*, 109578. doi:10.1016/j.foodcont.2022.109578

Karaman, A. D., Cobanoglu, F., Tunalioglu, R., & Ova, G. (2012). Barriers and benefits of the implementation of food safety management systems among the Turkish dairy industry: A case study. *Food Control*, *25*(2), 732–739. doi:10.1016/j.foodcont.2011.11.041

Lee, H. K., Abdul Halim, H., Thong, K. L., & Chai, L. C. (2017). Assessment of food safety knowledge, attitude, self-reported practices, and microbiological hand hygiene of food handlers. *International Journal of Environmental Research and Public Health*, *14*(1), Article 1. doi:10.3390/ijerph14010055

Lee, H., & Yoon, Y. (2021). Etiological agents implicated in foodborne illness world wide. *Food Science of Animal Resources*, *41*(1), 1. doi:10.5851/kosfa.2020.e75

Low, W. Y., Jani, R., Halim, H. A., Alias, A. A., & Moy, F. M. (2016). Determinants of food hygiene knowledge among youths: A cross-sectional online study. *Food Control*, *59*, 88–93. doi:10.1016/j.foodcont.2015.04.032

McCrum-Gardner, E. (2010). Sample size and power calculations made simple. *International Journal of Therapy and Rehabilitation*, *17*(1), 10–14. doi:10.12968/ijtr.2010.17.1.45988

McIntyre, L., Vallaster, L., Wilcott, L., Henderson, S. B., & Kosatsky, T. (2013). Evaluation of food safety knowledge, attitudes and self-reported hand washing practices in FOODSAFE trained and untrained food handlers in British Columbia, Canada. *Food Control*, *30*(1), 150–156. doi:10.1016/j.foodcont.2012.06.034

Moreb, N. A., Priyadarshini, A., & Jaiswal, A. K. (2017). Knowledge of food safety and food handling practices amongst food handlers in the Republic of Ireland. *Food Control*, *80*, 341–349. doi:10.1016/j.foodcont.2017.05.020

Ncube, F., Kanda, A., Chijokwe, M., Mabaya, G., & Nyamugure, T. (2020). Food safety knowledge, attitudes and practices of restaurant food handlers in a lower-middle-income country. *Food Science & Nutrition*, *8*(3), 1677–1687. doi:10.1002/fsn3.1454

Osaili, T. M., Abu Jamous, D. O., Obeidat, B. A., Bawadi, H. A., Tayyem, R. F., & Subih, H. S. (2013). Food safety knowledge among food workers in restaurants in Jordan. *Food Control*, *31*(1), 145–150. doi:10.1016/j.foodcont.2012.09.037

Osaili, T. M., Al-Nabulsi, A. A., & Allah Krasneh, H. D. (2018). Food safety knowledge among foodservice staff at the universities in Jordan. *Food Control*, *89*, 167–176. doi:10.1016/j.foodcont.2018.02.011

Osaili, T. M., Obeidat, B. A., Hajeer, W. A., & Al-Nabulsi, A. A. (2017). Food safety knowledge among food service staff in hospitals in Jordan. *Food Control*, *78*, 279–285. doi:10.1016/j.foodcont.2017.02.057

Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. Routledge, UK.

Ruby, G. E., Ungku Zainal Abidin, U. F., Lihan, S., Jambari, N. N., & Radu, S. (2019). A cross sectional study on food safety knowledge among adult consumers. *Food Control*, *99*, 98–105. doi:10.1016/j.foodcont.2018.12.045

Santos, M.-J., Nogueira, J. R., Patarata, L., & Mayan, O. (2008). Knowledge levels of food handlers in Portuguese school canteens and their self-reported behaviour towards food safety. *International Journal of Environmental Health Research*, *18*(6), 387–401. doi:10.1080/09603120802100212

Smigic, N., Lazarov, T., & Djekic, I. (2020). Does the university curriculum impact the level of students' food safety knowledge? *British Food Journal*, *123*(2), 563–576. doi:10.1108/BFJ-06-2020-0485

Tappes, S. P., Chaves Folly, D. C., da Silva Santos, G., de Aquino Feijó, C., & Pustiglione, M. (2020). Food handlers and foodborne diseases: Grounds for safety and public and occupational health actions. *Revista Brasileira de Medicina Do Trabalho*, *17*(3), 431–440. doi:10.5327/Z1679443520190316

Tuglo, L. S., Agordoh, P. D., Tekpor, D., Pan, Z., Agbanyo, G., & Chu, M. (2021). Food safety knowledge, attitude, and hygiene practices of street-cooked food handlers in North Dayi District, Ghana. *Environmental Health and Preventive Medicine*, *26*(1), 54. doi:10.1186/s12199-021-00975-9

Turkish Ministry of Health. (2021, March 29). Food-borne diseases in Turkey in 2021. Retrieved from https://www.cumhuriyet.com.tr/haber/bes-yilda-gida-kaynakli-1714-kisi-oldu-1859815

Webb, M., & Morancie, A. (2015). Food safety knowledge of foodservice workers at a university campus by education level, experience, and food safety training. *Food Control*, *50*, 259–264. doi:10.1016/j.foodcont.2014.09.002

Western Australia Department of Health. (2023, March 22). Bacteria grow in the temperature danger zone. Retrieved from https://www.health.wa.gov.au/Articles/A_E/Bacteria-grow-in-the-temperature-danger-zone

WHO. (2015, April 11). World Health Organization estimates of the global burden of foodborne diseases: Foodborne disease burden epidemiology reference group 2007-2015. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf?sequence=1

WHO. (April 22, 2022). Food safety. Retrieved from https://www.who.int/news-room/fact-sheets/detail/food-safety

Yilmaz, E. (2015). Consumer food safety knowledge, practices and differences in behaviors in thrace region of Turkey. *Journal of Agricultural Sciences*, *21*(2), 279-287. doi:10.15832/tbd.41783

Yu, H., Neal, J. A., & Sirsat, S. A. (2018). Consumers' food safety risk perceptions and willingness to pay for fresh-cut produce with lower risk of foodborne illness. *Food Control*, *86*, 83–89. doi:10.1016/j.foodcont.2017.11.014