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Evaluation of university students' knowledge, attitudes, and practices on food safety in Bolu, Türkiye

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ABSTRACT

This study aims to assess the food safety knowledge, attitudes, and practices of university students in Türkiye. A cross-sectional study was conducted with the participation of 630 university students from the departments of Gastronomy and Culinary Arts (GCA), Food Engineering (FE), Nursing (NUR), and Physical Therapy and Rehabilitation (PTR) in Bolu, Türkiye. The GCA students scored the highest (25.46 ±2.85) and the NUR students scored the lowest (21.81 ±3.27) on food safety knowledge. The GCA students scored the highest (51.42 ±5.58) and the NUR students scored the lowest (49.00 ±6.07) on food safety attitudes. The FE students scored the highest (10.12 ±1.69) and the NUR students scored the lowest (9.69 ±1.77) on food safety practices. The students who took a course on food safety had significantly higher scores on food safety knowledge, attitudes, and practices than those who did not. Although the students' food safety scores were above average, they had a lack of knowledge and concerns in many areas. It was emphasized the importance of food safety education to fill the knowledge gaps and thus to prevent foodborne illnesses.

Keywords: University students, Food safety, Knowledge, Attitude, Practice

Introduction

Foodborne diseases, which are generally caused by the consumption of foods contaminated with pathogenic microorganisms or microbial toxins, have clinical manifestations such as life-threatening neurological, hepatic, and renal syndromes and mostly progress with gastrointestinal symptoms (CDC, 2007). Unsafe foods containing harmful bacteria, viruses, parasites, or chemical substances cause more than 200 diseases ranging from diarrhea to cancers. An estimated 600 million – almost 1 in 10 people in the world – fall ill after eating contaminated food and 420,000 die every year, resulting in the loss of 33 million healthy life years (WHO, 2020). Foodborne diseases put a huge burden on the public healthcare system and significantly increase healthcare expenditures. If not controlled, they create significant gaps in the budgets of countries (Egan et al., 2007). Unsafe foods cost low- and middle-income countries US$ 110 billion each year in lost productivity and medical expenses (WHO, 2020). In Türkiye, it is not obligatory to report foodborne illnesses to a specified agency; therefore, data on foodborne infections and intoxications do not reflect the real situation (Şanlıer, 2009).

Food safety is an important issue that needs to be examined in detail in a broad perspective with all stakeholders of the food industry including governments, standing government authority, farmers, food manufacturers, processors, wholesalers, dealers, retail outlets, and consumers. Systematic controls carried out by the food industry to ensure a more conscious service are an assurance in terms of the continuity of food safety. In parallel with this, the continuity of food safety practices can be sustained with the awareness of consumers (Hobbs and Roberts, 2001; McMichael and Schneider, 2011). Consumers are the last element of the food chain. Most food poisoning outbreaks are known to be caused by human handling errors. Reported foodborne illness data show that a significant proportion of foodborne illnesses is attributed to inappropriate food handling in households (Clayton et al., 2002; Greig et al., 2007; Medeiros et al. 2001). A significant portion of food preparation, processing, and storage takes place in the home environment; so, understanding consumer behaviors and educating consumers about the risk of unsafe food processing practices is important to prevent foodborne illnesses (Ergönül, 2013).

Young adults, an important consumer group, can be at an increased risk for foodborne illnesses due to their risky food practices and low level of knowledge on food safety (Chuang et al. 2021). University students, who can be both consumers and food producers in their future professional business lives, play a key role in ensuring food safety. Many studies have reported that university students put their health at risk due to insufficient knowledge, attitudes, and practices about food safety (Ferk et al., 2016; Giritlioglu et al., 2011; Hassan and Dimassi, 2014; Lazou et al., 2012; Luo et al., 2019; Strateva et al., 2017; Şanlier and Konaklioglu, 2012). There is a limited number of studies on food safety for university students in Türkiye (Açıkalın, 2019; Avşar, 2019; İncedal-Sonkaya, 2018). This study, it is aimed to evaluate the food safety knowledge, attitudes, and practice of university students in Türkiye and to reveal the differences between their departments and socio-demographic variables. This study is different from previous studies in that it shows the effect of the food safety course given at the university and the difference between the departments of the students on food safety knowledge, attitudes, and practice.

Materials and Methods

Study Design and Participants

A cross-sectional study was conducted among 630 university students from the departments of Gastronomy and Culinary Arts (GCA), Food Engineering (FE), Nursing (NUR), and Physical Therapy and Rehabilitation (PTR), Bolu Abant Izzet Baysal University, Bolu, Türkiye. The departments both offering and not offering a compulsory food safety course and a career in the field of food were included in the study in order to make a comparison in this regard. This study was carried out between February and June 2019. The research data was collected through a questionnaire and face-to-face interviews. The students were informed about the study, and they participated in the research on a voluntary basis. The time devoted to administering the questionnaire ranged between 10 and 15 minutes per classroom. The Ethics Committee of Human Studies in Social Sciences of Abant Izzet Baysal University approved the study (no: 2018/329).

Questionnaire Design

The questionnaire was developed based on the knowledge, attitudes, and practices (KAP) model. The food safety KAP questionnaire was designed based on the related literature (Al-Shabib et al., 2017; Luo et al., 2019; Osaili et al., 2011). The questionnaire was finalized after a pilot study and repeated discussions with experts. Cronbach's alpha value was 0.73 for the knowledge scale, 0.83 for the attitudes scale, and 0.73 for the scale of the practice. When the scale reliability was analyzed based on the scale sections, it was found that the internal consistency of the KAP questionnaire was acceptable.

The questionnaire was divided into four sections: (a) socio-demographic characteristics, (b) food safety knowledge, (c)

food safety attitudes, and (d) food safety practices. Socio-demographic data consisted of gender, age, department, grade, history of foodborne illness, food safety training, and frequency of eating out. Food safety knowledge was assessed using 32 items. Each item was scored 1 if the answer was right and scored 0 if the answer was wrong or the answer choice "I do not know" was selected. The total score ranged from 0 to 32, and the higher the score the higher the level of knowledge on food safety. Food safety attitudes were assessed using 12 items. Each item consisted of five levels with a score ranging from 1 (strongly disagree) to 5 (strongly agree). The total score for this part ranged from 12 to 60, and the higher the score the higher the concern about food safety. Food safety practices were assessed using 14 items. The correct answers given to the practice statements were coded as 1, while the other options were coded as 0. The correct scale response differs for each statement. The total score for these items ranged from 0 to 14 and the higher the score the better the food safety practices.

Data Analysis

The data were analyzed using SPSS software (Statistical Package for the Social Sciences, version 11.0, SPSS Inc, III, USA). The food safety scores were expressed as mean and standard deviation (SD). Independent sample t-test and one-way analysis of variance (ANOVA) were carried out to identify the relationship between the participants' socio-demographic characteristics and their KAP scores. The frequency and percentages of the responses in each category were calculated and tabulated. In all analyses, the statistical significance was set at $p \leq 0.05$.

Results and Discussion

Socio-Demographic Characteristics of the Participants

Table 1 presents the university students' socio-demographic characteristics. The majority of the respondents were female (80 %). This can be explained by the structure and types of the departments. Most of the students were studying at the department of Nursing (38.9 %) followed by Gastronomy and Culinary Arts (26.0 %), Food Engineering (22.4 %), and Physical Therapy and Rehabilitation (12.7 %). 14.6 % of them were freshmen, 30.5% were sophomores, 30.2 % were juniors, and 24.8 % were seniors. 21.7 % of the participants stated that they had a history of foodborne illness, and 61.7 % of them had taken food safety training. About half of the participants (55.6 %) reported the frequency of eating out as once or twice a week.

Table 1. Socio-demographic characteristics of the participants (n=630)

Demographic Variables		Total (n=630)	Departments			
			Food Engineering	Gastronomy and Culinary Arts	Nursing	Physical Therapy and Rehabilitation
Gender	Male	126 (%20.0)	19 (%13.5)	62 (%37.8)	30 (%12.2)	15 (%18.8)
	Female	504 (%80.0)	122(%86.5)	102 (%62.2)	215 (%87.8)	65 (%81.2)
Age	18 years old	16 (%2.5)	0 (%0)	8 (%4.9)	8 (%3.3)	0 (%0.0)
	19 years old	68 (%10.8)	10 (%7.1)	21 (%12.8)	32 (13.1)	5 (%6.3)
	20 years old	165 (%26.2)	30 (%21.3)	39 (%23.8)	64 (%26.1)	32 (%40.0)
	21 years and older	381 (%60.5)	101 (%71.6)	96 (%58.5)	141 (%57.6)	43 (%53.8)
Grade	Freshman	92 (%14.6)	9 (%6.4)	36 (%22.0)	46 (%18.8)	1 (%1.3)
	Sophomore	192 (%30.5)	41 (%29.1)	38 (%23.2)	74 (%30.2)	39 (%48.8)
	Junior	190 (%30.2)	42 (%29.8)	63 (%38.4)	47 (%19.2)	38 (%47.5)
	Senior	156 (%24.8)	49 (%34.8)	27 (%16.5)	78 (%31.8)	2 (%2.5)
History of foodborne illness	Yes	137 (%21.7)	30 (%21.3)	52 (%31.7)	35 (%14.3)	20 (%25.0)
	No	493 (%78.3)	111 (%78.7)	112 (%68.3)	210 (%85.7)	60 (%75.0)
Having food safety training	Yes	389 (%61.7)	88 (%62.4)	163 (%99.4)	137 (%55.9)	1 (%1.3)
	No	241 (%38.3)	53 (%37.6)	1 (%0.6)	108 (%44.1)	79 (%98.8)
Frequency of eating out	Everyday	158 (%25.1)	46 (%32.6)	44 (%26.8)	49 (%20.0)	19 (%23.8)
	1-2 days per a week	350 (%55.6)	76 (%53.9)	102 (%62.2)	130 (%53.1)	42 (%52.5)
	1-2 days per a month	122 (%19.4)	19 (%13.5)	18 (%11.0)	66 (%26.9)	19 (%23.8)

Association Between The Participants' Scores and Socio-Demographic Characteristics

The students' mean scores for knowledge, attitude, and practices were found to be 23.63 ±3.61 (72%), 49.73 ±6.33 (79%), and 9.86 ±1.70 (70%), respectively (Table 2). Based on these results, it can be asserted that the student's knowledge, attitude, and practice scores were above average. Previous studies also reported similar results in this regard (Byrd-Bredbenner et al., 2007, Garayoa et al., 2005, Hassan and Dimassi, 2014, Lazou et al., 2012; Sharif and Al-Malki, 2010). For instance, Lazou et al. (2012) reported the mean score for food safety knowledge as 60% among Greek university students, Byrd-Bredbenner et al. (2007) as approximately 60% among American university students, and Hassan and Dimassi (2014) as 53.6% among Lebanese university students. On the other hand, the university students in Türkiye were found to have higher scores for food safety attitudes and practices compared to those reported in many previous studies (Hassan and Dimassi, 2014; Lazou et al., 2012; Unklesbay et al., 1998).

When the students were compared in terms of their departments, it was found that the GCA students had the highest score in food safety (25.46 ±2.85) and the FTR students the lowest (21.81 ±3.27). The differences among the four departments were statistically significant in terms of food safety knowledge ($p=0.001$. $p<0.05$). As for the food safety attitudes, the GCA students scored the highest (51.42 ±5.58) and the FE students scored the lowest (49.00 ±6.07). The differences among the four departments were statistically significant in terms of food safety attitudes ($p=0.001$. $p<0.05$). However, the differences among the four departments were not statistically significant in terms of food safety practices ($p=0.122$. $p>0.05$). The FE students were found to have the highest score for food safety practices (10.12 ±1.69) and the NUR students the lowest (9.69 ±1.77). The knowledge and attitude scores of the GCA students were significantly higher than those of the others ($p=0.000$, $p=0.001$. $p<0.05$). This can be attributed to the fact that the GCA students have greater access to knowledge of nutrition and food hygiene. Students studying in health sciences (NUR and FTR), on the other hand, got the lowest score in food safety knowledge and practice. Luo et al. (2019) also compared the food safety knowledge and practice scores of the students studying at the departments of education, medicine, and nursing in China and reported that the nursing students had the lowest scores, which is in agreement with the results of the present study. Contrary to this study, Lazou et al. (2012) in their study on Greek university students reported that students from health-related faculties, in general, had the highest average food safety practices and knowledge scores. They stated that this result could be attributed to the presence of modules relevant to food hygiene in health-related curricula. In our country, a food safety course is not a compulsory course in health-related departments. Additionally, Istanbullugil and Gürbüz (2019), in their study on university students in Bishkek, reported that there was no statistically significant difference between the departments in terms of the level of food safety awareness among students.

The female students were found to have a statistically significantly better food safety attitude than the males ($p=0.002$. $p<0.05$). This could be due to the fact that females tend to behave more responsibly in cooking, food handling, and kitchen hygiene (Chuang et al., 2021). This is even more evident in developing countries such as Türkiye. This result was in line with those reported in previous studies in which female university students outperformed males (Hassan and Dimassi, 2014; Lazou et al., 2012). On the other hand, gender did not have a significant effect on the student's scores for food safety knowledge and practices.

The food safety knowledge and practice scores of the senior students were significantly higher than the other participants ($p=0.000$ and $p=0.004$, respectively. $p<0.05$). This may be due to the fact that senior students have a long experience in their department, have already taken food safety courses, and do internships. As Chuang et al. (2021) asserted, consumers' food safety knowledge could increase over time as they are exposed to more learning opportunities and practice the recommended behaviors more. Previous studies also reported higher scores among seniors (Hassan and Dimassi, 2014; Lazou et al., 2012; Osaili et al., 2011).

Food safety knowledge, attitude, and practice mean scores of the students who had had food safety training were significantly higher than those of the students who had not ($p=0.000$, $p=0.002$, and $p=0.020$, respectively. $p<0.05$). This finding confirms the previous studies surveying university students in various countries (Chuang et al., 2021; Courtney et al., 2016; Hassan and Dimassi, 2014; Lazou et al., 2012). An important reason that the students in previous studies had low food safety knowledge was the lack of food safety training or courses on food handling (Chuang et al., 2021). Several studies highlighted the importance of food safety education and the need for teaching children food safety at school (Jevsnik et al., 2008; Lange et al., 2018; Marklinder et al., 2020). In Türkiye, the FE and GCA departments offer hygiene and food safety courses on a compulsory basis, while other departments usually offer them as elective courses. Such courses generally aim to provide students with knowledge about hygiene and sanitation rules, possible risk factors, and precautions to be taken in the preparation and service of foods. Offering food safety education as part of the school

curriculum could enable the development of safe habitual food handling practices and the dissemination of food safety information (Rössvoll et al., 2013). Since there is no food safety education at the primary and high school levels in Türkiye, it is of great importance to offer food safety education to university students.

Food safety attitudes of the students who had a history of foodborne illness were found to be higher than those who did not ($p=0.029$. $p<0.05$). On the other hand, the frequency of eating out was found to have no significant effect on food safety knowledge, attitude, and practice scores ($p > 0.05$).

Table 2. Total food safety knowledge, attitude and practice scores of participants by soci-demographic characteristics

Demographic Variables			Food safety knowledge		Food safety attitude		Food safety practice	
			Mean scores ± SD	P	Mean scores ± SD	P	Mean scores ± SD	P
		Total	**23.63 ± 3.61 (Range 0-32)**		**49.73 ± 6.33 (Range 12-60)**		**9.86 ± 1.70 (Range 0-14)**	
Gender	Male	126	23.26 ±4.24	0.261	47.73 ±8.34	0.002*	9.61 ±1.81	0.076
	Female	504	23.72 ±3.43		50.23 ±5.62		9.92 ±1.67	
Age	18 years old	16	22.12 ±4.36	0.006*	46.31 ±10.87	0.166	8.93 ±2.20	0.054
	19 years old	68	22.66 ±3.98		50.04 ±6.70		9.60 ±1.72	
	20 years old	165	23.35 ±3.77		49.61 ±6.36		9.82 ±1.57	
	21 years and older	381	23.98 ±3.38		49.87 ±5.99		9.96 ±1.72	
Departments	Food Engineering	141	24.06 ±3.41	0.000*	49.00 ±6.07	0.001*	10.12 ±1.69	0.122
	Gastronomy and	164	25.46 ±2.85		51.42 ±5.58		9.87 ±1.66	
	Culinary Arts	245	22.74 ±3.70		49.17 ±6.78		9.69 ±1.77	
	Nursing	80	21.81 ±3.27		49.30 ±6.31		9.87 ±1.56	
	Physical Therapy and Rehabilitation							
Grade	Freshman	92	22.60 ±3.70	0.000*	49.17 ±7.62	0.693	9.42 ±1.88	0.004*
	Sophomore	192	23.13 ±4.01		49.82 ±6.22		9.90 ±1.65	
	Junior	190	23.94 ±3.29		49.59 ±5.90		9.74 ±1.71	
	Senior	156	24.45 ±3.16		50.12 ±6.18		10.20 ±1.60	
History of foodborne illness	Yes	137	23.86 ±3.61	0.383	50.78 ±5.74	0.029*	9.86 ±1.69	0.994
	No	493	23.56 ±3.61		49.44 ±6.46		9.86 ±1.71	
Having food safety training	Yes	389	24.93 ±2.96	0.000*	50.36 ±5.57	0.002*	9.98 ±1.63	0.020*
	No	241	21.52 ±3.57		48.72 ±7.30		9.65 ±1.80	
Frequency of eating out	Everyday	158	23.42 ±3.42	0.116	49.68 ±5.49	0.368	9.78 ±1.78	0.274
	1-2 Days A Week	350	23.88 ±3.60		49.51 ±6.40		9.81 ±1.73	
	1-2 Days Per Month	122	23.16 ±3.80		50.45 ±7.13		10.08 ±1.49	

SD: standard deviation

Food Safety Knowledge

Table 3 shows the university students' food safety knowledge. There was a significant difference between the departments in terms of the student's answers to many statements ($p<0.05$), and the FE and GCA students were found to have more correct answers than the others. The students were found to be more knowledgeable (90% and above) about storage conditions (the statement: "purchased perishable food should be stored at refrigerator", ratio of correct answers: 90.8%), cross contamination ("cooked and uncooked food can be kept in the same container of the refrigerator", 94%), personal hygiene ("washing hands before handling food reduces the risk of contamination", 91%), food packaging ("damage in food packaging can cause food spoilage", 94.9%), and foodborne disease symptoms and results ("diarrhea, vomiting, abdominal pain are symptoms of foodborne illness", 95.2%). The students were less knowledgeable (50-80%) about thawing frozen foods ("frozen foods should be thawed in the refrigerator", 64.6%), safe storage temperatures for foods ("temperature danger zone for foods is 5°C-60°C", 61.6%; "The correct temperature for a refrigerator is 1-4°C",73.2%), HACCP food safety system ("HACCP is an international food safety system", 67%), and the differences between "recommended consumption date" and "expiration date" (64.9%). These findings are rather similar to those of the prior studies which reported that university students has limited knowledge about food safety (Al-Shabib et al., 2017; Luo et al., 2019; Madaki and Bavorova, 2019; Marklinder et al., 2020). On the other hand, it was found that the participants had insufficient knowledge about the following topics: reheating of foods, storage time of leftover food in the refrigerator, and safe time for keeping foods at room temperature. For instance, only 32.7% of the participants stated that "the internal temperature should be at least 74 °C when the cooked food is reheated", only 40.3% stated that "foods should not be consumed if kept at room temperature for more than 4 hours", and only 37.9% stated that "leftover food can be stored in the refrigerator for up to 3-4 days". The rules in these three statements are very important for ensuring food safety; however, most of the students answered these questions incorrectly. It takes time for the food poisoning bacteria to grow to unsafe levels. If the food has been out of temperature control for 4 hours or more, it must be disposed of. Moreover, when the leftover food is reheated, it should be ensured that it reaches 74 °C (USDA, 2021). Furthermore, Al-Shabib et al. (2017) asserted that 45.6% of foodborne disease outbreaks were due to temperature abuse during food processing and inappropriate storage temperatures of leftover or recently cooked meals. Therefore, the participant's lack of knowledge of these subjects is a remarkable result.

Food Safety Attitudes

Table 4 shows the university students' food safety attitudes. There was a significant difference between the departments in terms of the student's answers to many statements ($p<0.05$). The majority of the participants stated that they were concerned about pesticides, veterinary drug residues, and metallic contamination in food and that they thought that foodborne diseases had serious health and economic effects on society. Similarly, a previous study carried out in China reported that about 80% of university students were concerned about pesticide residues in vegetables, veterinary drug residues in meat, and the heavy metal pollution of foods (Luo et al., 2019). More than half of the participants stated that they were concerned about the food safety incidents in recent years, plastic packaging, food additives, and food safety behaviors of those working in the canteens and restaurants around schools and that they thought that foodborne diseases are more common in developing countries. It is thought that the participants' concerns about many issues may be related to the food problems experienced in Türkiye in recent years such as animal diseases, the inadequacy of inspections, and legal regulations (Food Safety News, 2015; Tosun and Demirtaş, 2012). In his study, Erden (2012) asserted that, in the field of food safety, Türkiye's weakness lay in the inadequacy of its legislation and the lack of in-service training of inspection personnel and laboratory personnel. The government is in charge of addressing the concerns of students and indeed all consumers. In this context, legal regulations should be developed for food safety, and control mechanisms should be implemented more effectively. The control mechanisms should eliminate the experts' deficiencies in in-service food safety training.

Food Safety Practices

Table 5 shows the university students' food safety practices. There was no significant difference between the departments in terms of the student's answers to many statements. The majority of the participants answered correctly the questions about food storage, cross-contamination, cleaning, and personnel hygiene. The most frequently reported food safety practice was hand washing; almost 98% of the participants stated that they wash their hands with soap and water before handling food. This percentage is the highest compared to those reported in previous studies on university students' hand-washing practices (Hassan and Dimassi, 2014; Luo et al., 2019; Marklinder et al., 2020). 69.4% of the participants stated that they do not use unwashed chopping boards or knives, 62.5% of them stated that they do not use foods with damaged packaging, and 70.3% of them stated that they decline the use of expired foods. Most of the participants stated that they store raw foods separately from cooked foods, wash

their hands before cooking, and do not purchase expired food and products with damaged packaging. These practices indicate a good implementation of food safety knowledge, which plays a key role in the control of an outbreak of foodborne diseases. On the other hand, about 23 % of the participants stated that they always prepare food when they have wounds, bruises, or injuries on their hands; whereas 26.7 % of them stated that, they never do this. This result indicates a poor implementation of the knowledge about the preparation of food with hands having wounds, bruises, or injuries. This finding is similar to that reported by Al-Shabib et al. (2017) for university students in Saudi Arabia. About 62% of the participants stated that they always guide their parents about food safety practices. This percentage is higher than those reported by Al-Shabib et al. (2017) for Saudi Arabia, Haapala and Probart (2004) for the USA, and Ovca et al. (2014) for Slovenian. The students' guiding their parents can ensure the dissemination of correct information and thus reduce the risk of foodborne diseases. Therefore, this high percentage is promising in terms of preventing foodborne diseases.

Table 3. Correct responses on food safety knowledge of students by four departments (n=630)

Statements	Departments					X^2	P
	FE (%)	GCA (%)	N (%)	PTR (%)	Total (%)		
Purchased perishable food should be stored at refrigerated.	93.6	92.1	88.6	90.0	90.8	7.811	0.252
Leftover food can be stored in the refrigerator for up to 3-4 days.	44.0	37.8	29.8	52.5	37.9	20.758	0.002*
Food should not be consumed if it has been left at room temperature for more than 4 hours.	51.1	40.9	38.4	26.3	40.3	16.516	0.011*
The Temperature danger zone for foods is 5°C-60°C	69.5	79.9	48.2	53.8	61.9	50.396	0.000*
The correct temperature for a refrigerator is 1-4°C.	80.1	90.9	60.8	62.5	73.2	62.275	0.000*
Cooked and uncooked food can be kept in the same container of the refrigerator.*	94.3	98.8	93.5	85.0	94.0	20.549	0.002*
Vegetables and meat can be chopped up with the same chopping board or knife.	85.8	91.5	80.4	61.3	82.1	41.074	0.000*
Damage in food packaging can cause food spoilage.	95.0	97.6	92.2	97.5	94.9	11.989	0.062
When reheating cooked food, it should be heated to a minimum internal temperature of 74°C.	43.3	61.0	13.9	13.8	32.7	145.060	0.000*
Inadequate cooking of raw foods can cause foodborne illness.	94.3	96.3	95.1	91.3	94.8	10.187	0.117
Frozen foods should be thawed in the refrigerator.	72.3	86.6	51.0	47.5	64.6	73.142	0.000*
Frozen foods should be thawed on the counter.*	65.2	83.5	43.7	42.5	58.7	78.502	0.000*
Shelf life is defined as the length of time a product may be stored without becoming unsuitable for use or consumption.	95.7	97.0	91.4	91.3	93.8	10.020	0.124
'Recommended consumption date' and 'Expiration date' have the same meaning.*	58.2	89.6	54.3	58.8	64.9	60.567	0.000*
Washing hands before handling food reduces the risk of contamination.	90.1	92.7	91.4	87.5	91.0	4.517	0.607
Washing hands after using toilets reduces the risk of foodborne illness.	86.5	88.4	91.0	86.3	88.7	14.054	0.029*
Washing hands time should be at least 20 seconds.	76.6	75.0	85.7	82.5	80.5	21.884	0.001*
There is no harm in using watches, earrings, rings during food preparation.*	74.5	90.9	86.1	78.8	83.8	22.479	0.001*
Food should not be touched with injured hands.	97.2	97.6	91.0	96.3	94.8	12.231	0.057
Using of gloves during food preparation reduces the risk of contamination.	92.2	89.0	91.4	88.8	90.6	3.420	0.755
Diarrhea, vomiting, abdominal pain are symptoms of foodborne illness.	92.9	97.0	95.5	95.0	95.2	3.322	0.767
High blood pressure is a symptom of foodborne illness.*	36.2	35.4	31.8	23.8	32.7	20.110	0.003*

Foodborne illnesses can result in death.	92.9	98.2	93.9	87.5	94.0	14.002	0.030*
Children, pregnant women and the elderly are more at risk of food poisoning.	78.0	71.3	86.5	73.8	79.0	20.428	0.002*
Milk is one of the most common food allergens.	73.0	89.0	72.2	68.8	76.3	24.288	0.000*
Food allergy can result in death.	82.3	82.9	93.9	91.3	88.1	20.054	0.003*
Food additives can cause food allergies.	85.8	73.8	90.6	93.8	85.6	29.288	0.000*
Shortness of breath is a symptom of a food allergy.	48.2	37.2	75.5	60.0	57.5	67.813	0.000*
Allergens should be stated on the label as different from other ingredients.	91.5	97.6	91.8	93.8	93.5	7.595	0.269
HACCP is an international food safety system.	89.4	97.6	49.0	20.0	67.0	230.141	0.000*
HACCP is a mandatory system in Türkiye.	77.3	73.2	36.7	17.5	52.9	193.401	0.000*
Consumer is responsible for food safety after purchase.	73.0	76.8	73.1	80.0	74.9	10.993	0.089

* Incorrect statements.
FE: Food Engineering; GCA: Gastronomy and Culinary Arts; N: Nursing; PTR: Physical Therapy and Rehabilitation

Table 4. Responses on food safety attitude of students by four departments (n=630)

Expressions	Departments				Total (%)	X^2	P
	FE (%)	GCA (%)	N (%)	PHR (%)			
You are concerned about food safety incidents in recent years in our country	1.4	1.8	3.3	2.5	2.4	16.282	0.179
Strongly disagree	4.3	3.7	4.5	2.5	4.0		
Disagree	9.9	12.8	19.2	22.5	15.9		
Neutral	49.6	42.1	45.3	38.8	44.6		
Agree	34.8	39.6	27.8	33.8	33.2		
Strongly agree							
You are concerned about pesticide residues in vegetables.							
Strongly disagree	2.8	1.8	2.0	5.0	2.5	41.776	0.000*
Disagree	3.5	0.0	1.2	0.0	1.3		
Neutral	7.8	0.6	7.3	7.5	5.7		
Agree	44.7	28.7	38.8	26.3	35.9		
Strongly agree	41.1	68.9	50.6	61.3	54.6		
You are concerned about the veterinary drug residue of meat.							
Strongly disagree	1.4	1.8	1.6	2.5	1.7	26.677	0.009*
Disagree	3.5	1.2	1.2	2.5	1.9		
Neutral	12.8	3.0	9.8	10.0	8.7		
Agree	46.1	32.9	41.2	35.0	39.4		
Strongly agree	36.2	61.0	46.1	50.0	48.3		
You are concerned about the heavy metal pollution of food.							
Strongly disagree	2.8	1.2	1.2	2.5	1.7	29.799	0.003*
Disagree	0.7	1.2	2.9	2.5	1.9		
Neutral	9.9	4.3	7.8	1.3	6.5		
Agree	42.6	31.7	44.5	28.8	38.7		
Strongly agree	44.0	61.6	43.7	65.0	51.1		
You are concerned about the transfer of plasticizers in food containers and packaging materials.	4.3	1.8	0.8	2.5	2.1	40.571	0.000*
Strongly disagree	14.9	3.0	3.7	6.3	6.3		
Disagree	19.9	14.0	15.1	6.3	14.8		
Neutral	30.5	38.4	41.2	38.8	37.8		
Agree	30.5	42.7	39.2	46.3	39.0		
Strongly agree							
Eating too much monosodium glutamate is bad for your health.							
Strongly disagree	1.4	1.8	0.4	0.0	1.0	16.423	0.173

Disagree	2.8	2.4	2.0	3.8	2.5		
Neutral	22.0	31.1	35.9	41.3	32.2		
Agree	34.8	26.2	25.7	21.3	27.3		
Strongly agree	39.0	38.4	35.9	33.8	37.0		
You are concerned about the current situation of food safety in the school canteen.	3.5	0.0	2.4	2.5	2.1	16.434	0.172
Strongly disagree	14.9	6.7	9.0	13.8	10.3		
Disagree	26.2	30.5	22.4	21.3	25.2		
Neutral	31.9	34.1	36.3	33.8	34.4		
Agree	23.4	28.7	29.8	28.8	27.9		
Strongly agree							
You are concerned about the safety of food in restaurants around the school.	2.8	1.2	2.4	0.0	1.9	21.849	0.039*
Strongly disagree	9.2	4.3	6.5	7.5	6.7		
Disagree	24.1	14.0	22.4	26.3	21.1		
Neutral	34.8	40.9	43.3	43.8	40.8		
Agree	29.1	39.6	25.3	22.5	29.5		
Strongly agree							
You are willing to improve your knowledge of food safety.							
Strongly disagree	0.7	1.2	0.8	1.3	1.0	81.618	0.000*
Disagree	1.4	0.0	3.3	2.5	1.9		
Neutral	4.3	4.9	11.4	8.8	7.8		
Agree	24.1	28.0	51.4	56.3	39.8		
Strongly agree	69.5	65.9	33.1	31.3	49.5		
You are willing to change your inappropriate food safety practices.							
Strongly disagree	1.4	0.6	1.6	1.3	1.3	53.766	0.000*
Disagree	1.4	0.6	1.2	1.3	1.1		
Neutral	4.3	4.9	13.1	7.5	8.3		
Agree	29.8	34.1	50.2	56.3	42.2		
Strongly agree	63.1	59.8	33.9	33.8	47.1		
You think that foodborne diseases have serious health and economic effects on society.	0.7	0.6	0.8	1.3	0.8	10.082	0.609
Strongly disagree	1.4	1.8	2.0	3.8	2.1		
Disagree	2.8	2.4	5.3	1.3	3.5		
Neutral	34.8	32.3	39.2	41.3	36.7		
Agree	60.3	62.8	52.7	52.5	57.0		
Strongly agree							
You think that foodborne diseases are more common in developing countries.	3.5	2.4	2.9	3.8	3.0	19.317	0.081
Strongly disagree	14.2	7.3	6.1	11.3	8.9		
Disagree	28.4	23.2	19.2	15.0	21.7		
Neutral	26.2	34.1	35.1	40.0	33.5		
Agree	27.7	32.9	36.7	30.0	32.9		
Strongly agree							

FE: Food Engineering; GCA: Gastronomy and Culinary Arts; N: Nursing; PTR: Physical Therapy and Rehabilitation

Table 5. Responses on food safety practice of students by four departments (n=630)

Expressions	Departments				Total(%)	X^2	P
	FE (%)	GCA (%)	N (%)	PTR (%)			
Do you use food with damaged packing?							
Always	19.9	13.4	20.0	16.3	17.8	5.861	0.439
Never	63.8	64.6	61.6	58.8	62.5		
Occasionally	16.3	22.0	18.4	25.0	19.7		
Do you use unwashed chopping board/knife?							
Always	22.0	13.4	19.2	13.8	17.6	11.324	0.079
Never	71.6	70.1	66.9	71.3	69.4		
Occasionally	6.4	16.5	13.9	15.0	13.0		
Do you check the temperature of the refrigerator before opening it?							
Always	27.0	20.1	21.6	17.5	21.9	16.049	0.013*
Never	15.6	17.7	29.4	26.3	22.9		
Occasionally	57.4	62.2	49.0	56.3	55.2		
Do you prepare food when you have wounds, bruises or injuries on hands?							
Always	24.1	18.9	27.3	17.5	23.2	12.897	0.045*
Never	26.2	24.4	24.1	40.0	26.7		
Occasionally	49.6	56.7	48.6	42.5	50.2		
Do you save the leftovers in the refrigerator?							
Always	59.6	56.1	58.8	58.8	58.3	1.265	0.974
Never	2.1	3.0	3.7	2.5	3.0		
Occasionally	38.3	40.9	37.6	38.8	38.7		
Do you wash dishes with warm water?							
Always	89.4	75.6	82.0	81.3	81.9	18.414	0.005*
Never	1.4	0.0	2.0	0.0	1.1		
Occasionally	9.2	24.4	15.9	18.8	17.0		
Do you clean the kitchen counter and utensils after food preparation?							
Always	94.3	97.0	94.7	96.3	95.4	2.843	0.828
Never	1.4	0.6	1.6	0.0	1.1		
Occasionally	4.3	2.4	3.7	3.8	3.5		
Do you check the cleanliness of the utensils before cooking?							
Always	94.3	94.5	95.1	95.0	94.8	4.443	0.617
Never	2.1	0.6	2.0	0.0	1.4		
Occasionally	3.5	4.9	2.9	5.0	3.8		
Do you use soap when washing hands?						6.892	0.331
Always	95.7	97.0	95.1	100.0	96.3		
Never	0.7	0.0	1.6	0.0	0.8		
Occasionally	3.5	3.0	3.3	0.0	2.9		
Do you remove watches, rings and jewelry before cooking?							
Always	68.1	79.9	73.1	72.5	73.7	9.614	0.142
Never	2.1	0.6	3.7	1.3	2.2		
Occasionally	29.8	19.5	23.3	26.3	24.1		
Do you use expired food items?							
Always	21.3	17.1	21.6	15.0	19.5	6.840	0.336
Never	66.0	70.7	70.6	76.3	70.3		
Occasionally	12.8	12.2	7.8	8.8	10.2		
Do you wash hands before cooking?							
Always	95.7	95.7	94.3	92.5	94.8	5.092	0.532
Never	1.4	0.6	3.3	3.8	2.2		

Occasionally	2.8	3.7	2.4	3.8	3.0		
Do you guide your parents regarding food safety practices?							
Always	80.1	60.4	57.1	51.3	62.4	27.908	0.000*
Never	2.1	3.0	2.4	1.3	2.4		
Occasionally	17.7	36.6	40.4	47.5	35.2		
Do you store raw food separately from cooked food?							
Always	80.9	81.1	70.6	76.3	76.3	11.725	0.068
Never	6.4	3.0	6.5	2.5	5.1		
Occasionally	12.8	15.9	22.9	21.3	18.6		

FE: Food Engineering; GCA: Gastronomy and Culinary Arts; N: Nursing; PTR: Physical Therapy and Rehabilitation

Conclusion

University students are an important target group as they are most likely to engage in risky eating behaviors and food handling practices making them susceptible to foodborne illnesses. Additionally, they also have the potential to work in the food industry. Our study presents insights into food safety knowledge, attitudes, and practices among university students in Türkiye. Although the university students' food safety knowledge, attitudes, and practices were found to be above average, they had some knowledge deficiencies and concerns in many areas. The students who had received a food safety education had higher scores for food safety knowledge, attitudes, and practices than the others. This once again emphasizes the importance of education. Especially in developing countries such as Türkiye, food safety education is insufficient both at primary and secondary school levels and at the university level; therefore, more attention should be paid to this education. In fact, this subject could be included in the curriculum of basic education before university. The increase in the number of responsible and conscious consumers will urge companies in the food industry to be more careful in food production. It should be known that education is the most effective solution for ensuring effective food safety in the long term and that the objectives of information and protection will only yield more positive results with education. Although this study is limited with respect to the number of respondents and the place where the research was conducted, it gives insight and direction for further studies on food safety knowledge and education.

Compliance with Ethical Standard

Conflict of interests: The author declares that for this article they have no actual, potential, or perceived conflict of interests.

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