

The effect of food microbiology course on the knowledge and practice levels of nutrition and dietetics students studying in different universities in Turkey on food safety and microbiology

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Abstract

In today's society, the increase in dining out, the consumption of ready to eat food, transportation opportunities, and the changes in lifestyles have highlighted the importance of food safety and health issues. This study aimed to assess the impact of an undergraduate Food Microbiology course on the knowledge and practices of Nutrition and Dietetics students regarding food safety and microbiology. A total of 291 students of from three Turkish universities received training in food safety, safe food preparation and food microbiology, and their knowledge levels were measured before and after the education. Results showed that students who received the training on food safety, safe food preparation, and food microbiology demonstrated a significant increase in their knowledge levels ($p<0.05$). Furthermore, 95.2% of the participants reported that the training was beneficial, contributing to their knowledge and practices. These findings suggest that food safety education should be provided to all individuals involved in food processing to prevent food-related health issues.

Keywords: Food microbiology, food safety, knowledge level, university students.

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Türkiye’de farklı üniversitelerde öğrenim gören beslenme ve diyetetik öğrencilerinin besin güvenliği ve mikrobiyolojisi konusundaki bilgi ve uygulama düzeylerine besin mikrobiyolojisi dersi’nin etkisi

Öz

Günümüz toplumunda dışarıda yemek yeme alışkanlığının artması, hazır gıda tüketimi, ulaşım olanakları ve yaşam tarzındaki değişiklikler gıda güvenliği ve sağlığı konularının önemini ön plana çıkarmıştır. Bu çalışma, lisans düzeyinde verilen Gıda Mikrobiyolojisi dersinin Beslenme ve Diyetetik öğrencilerinin gıda güvenliği ve mikrobiyolojisine ilişkin bilgi ve uygulamaları üzerindeki etkisini değerlendirmeyi amaçlamıştır. Türkiye’deki üç üniversiteden toplam 291 öğrenci gıda güvenliği, güvenli gıda hazırlama ve gıda mikrobiyolojisi konularında eğitim almış ve eğitim öncesi ve sonrasında bilgi düzeyleri ölçülmüştür. Sonuçlar gıda güvenliği, güvenli gıda hazırlama ve gıda mikrobiyolojisi eğitimi alan öğrencilerin bilgi düzeylerinde anlamlı bir artış olduğunu göstermiştir ($p<0.05$). Ayrıca, katılımcıların %95,2’si eğitimin faydalı olduğunu, bilgi ve uygulamalarına katkıda bulunduğunu bildirmiştir. Bu bulgular, gıda kaynaklı sağlık sorunlarının önlenmesi için gıda güvenliği eğitiminin gıda işleme sürecinde yer alan tüm bireylere verilmesi gerektiğini göstermektedir.

Anahtar kelimeler: Besin mikrobiyolojisi, besin güvenliği, bilgi düzeyi, üniversite öğrencileri.

1. Introduction

Ensuring and maintaining food safety and security is essential for a healthy life. "Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life" [1]. Food safety, on the other hand, refers to the food that is suitable for consumption in terms of physical, chemical, and microbiological properties and has not lost its nutritional value [2].

Food microbiology, is the study of microorganisms that inhibit, produce, or contaminate the growth of food. In other words, food microbiology studies all types of microorganisms, such as microorganisms that are naturally present in foods or that cause deterioration after a while due to unhygienic conditions, disease-causing pathogens that can be eliminated with proper cooking and storage conditions, microorganisms used to produce fermented foods such as cheese, yogurt, bread, beer, or wine, and other beneficial microorganisms [3].

Changes in people's lifestyles have increased the importance of food safety. The decrease in the time spent on cooking at home due to the increase in the working population, the rise in eating out and the consumption of ready-to-eat food, and the increase in transportation opportunities have caused countries around the world to prioritize food

security [4]. Furthermore, the increased awareness of healthy food has led to an increase in food safety awareness and has influenced the food sector.[5].

Despite the recent technological advancements, local policies, and investments, food security has not been fully achieved [6]. Unhygienic food consumption, drought, famine, barren lands, and water pollution in underdeveloped countries and the increase in the frequency of eating out due to the rise in the working population, diversity in the service sector, the hygiene deficiencies in food preparation, and the disruption in the implementation and inspection of food safety systems in developed countries, all point to food safety being a common problem for all countries. Despite quality control measures such as HACCP, ISO, risk analysis, Six Sigma, hurdle technology, and descriptive microbiology developed to ensure food safety, food-borne problems cannot be completely prevented. According to the 2018 food poisoning report by the Nutrition Working Group of the Occupational Health and Safety (OHS) Assembly in our country, there were 104 food poisoning incidents across the country, which affected 13,190 people and resulted in 18 deaths [7]. The 2019 report by the European Food Safety Authority (EFSA) and the European Center for Disease Prevention and Control (ECDC) indicates that there were 5,146 food-borne outbreaks in 2018, affecting 48,365 people in the European Union (EU) member states [8].

Field observations conducted in five EU countries- Norway, Portugal, France, the United Kingdom, and Romania- have shown that food safety relies not only on hygiene practices at home but also on food shopping behaviors. [9]. According to WHO's 2015 estimate of the global burden of food-borne diseases, one in ten people fall ill every year from consuming contaminated food, resulting in 33 million disability-adjusted life years and 420,000 deaths, one-third of which are children under the age of five [10].

Food safety is an issue that should be addressed from biological, social, and economic perspectives, because it causes economic losses such as loss of workforce and health costs, and health problems [11]. Studies have reported that many food-borne outbreaks are related with consumers' lack of knowledge about food safety practices, which can lead to cross-contamination and improper cooking [12,13]. Therefore, a significant number of studies in the literature highlight the importance of education in reducing food-borne diseases and state that the techniques used for education are essential in the development of consumer behavior [14-19]. Food safety education is a planned process aims to change knowledge, attitudes, and behaviors through a learning experience [19,20].

Based on these points, the present study aims to examine the effect of the Food Microbiology course on the knowledge and practice level of students of the Department of Nutrition and Dietetics studying at different Turkish universities. The training is expected to improve students' knowledge of food microbiology, food safety, and food hygiene, raise awareness, and enable them contribute to their environment with the knowledge they have acquired. This study can be beneficial for the development of training programs on food safety throughout the country.

2. Materials and methods

The study sample consisted of 330 second-year students from the Department of Nutrition and Dietetics at Istanbul Okan University (111 students), Ağrı İbrahim Çeçen University (100 students), and Istanbul Gelişim University (119 students) during the 2020-2021

academic year's spring semester. The sample size of 178 was calculated with a 95% confidence interval and a 5% margin error [21]. The stratified sampling method was used to select the sample due to differences in the number of students at each university. A total of 291 students volunteered to participate in the study, after obtaining approval from Istanbul Okan University Ethics Committee (Decision No: 31.03.21/155) and official permission from Istanbul Gelisim University Faculty of Health Sciences and Ağrı İbrahim Çeçen University School of Health. The study data were collected by online questionnaire method.

The food microbiology course was given for 14 weeks (4 hours/week) during one semester in the relevant universities included in the study. Course content, introduction to food microbiology and basic concepts, factors affecting the development of microorganisms in foods, microbiological spoilage in foods, foodborne infections and poisoning, food preservation methods, food safety. The course was taught online due to the Covid-19 pandemic. Students were surveyed before and after the course.

Due to the Covid-19 pandemic in data collection, the questionnaire forms presented to the participants via Google Forms consist of 4 parts. The first part includes a personal information form including demographic characteristics (e.g. gender, age, department).

The second and third parts include items related to food safety knowledge and food safety practices. The items related to food safety knowledge and food safety practices were adapted from Şanlıer's (2009) study (22).

Food safety knowledge was measured with items consisting of 10 questions. These items were graded as 1 point for correct answers and 0 points for incorrect answers. Scores related to food safety knowledge are between 0-10. In the scale, there are negative sentences (1,6,7,10) as well as positive sentences. Responses to positive sentences are "almost never", 1 point; "sometimes", 2 points; "often", 3 points; and "always", 4 points. For the negative sentences, the scores are given in reverse order. Scores related to food safety practices vary between 11-44 (22).

In the fourth part, questions related to the level of food microbiology knowledge were formed by the researchers through the topics covered in the food microbiology course. In this part, the level of knowledge was measured.

2.1. Statistical analysis

The data obtained from the study were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) version 24.00. Statistical significance was set at $p < 0.05$. Independent Samples t-Test was used to compare the means of two independent groups with a normal distribution, while the Mann-Whitney U test was used for those without normal distribution. For comparing of the means of more than two groups with normal distribution, One-Way Analysis of Variance (ANOVA) was performed, followed by Tukey's Multiple Comparison Test to identify which groups had significant differences. The results were analyzed at a confidence interval of 95% and a significance level of 5%.

3. Results and discussion

A total of 291 Nutrition and Dietetics second year students participated in the study.

Table 1. Demographic characteristics of the participants

		n %	
Gender	Male	31	10.7
	Female	260	89.3
Age	18-20	132	45.3
	21-23	137	47
	≥24	22	7.4
Marital Status	Single	280	96.2
	Married	11	3.8
Working Status	Employed	27	9.3
	Unemployed	264	90.7
Following the news in the media about food safety	Yes	162	55.7
	No	129	44.3
Having a foodborne illness	Yes	28	9.6
	No	263	90.4
Previous illness	Food poisoning	27	9.3
	Reflux	1	0.3
Having concern about the safety of the food eaten	Yes	233	80.1
	No	58	19.9
Paying attention to the instructions on the packaging when using the products	Yes	239	82.1
	No	52	17.9
Finding the education about food microbiology useful	Yes	277	95.2
	No	14	4.8

Table 1 shows, the demographic characteristics of the participants. Of these, 89.3% were female and 10.7% were male. 45.3% of the participants were in the age range of 18-20. 47% of the participants are in the age group of 21-23, while 7.4% are 24 years old and above. The proportion of the individuals classified as overweight was 13.4%, while 67% had a normal BMI and 19.6% were classified as underweight. Most participants (96.2%) were single, and the majority (90.7%) reported being unemployed. Regarding income, 28.9% stated having a good income, and 68% reported their income as average. More than half of the participants (55.7%) reported following news about food safety in the media. Only 9.6% of the participants reported having food-borne illness, with food poisoning being the most common. 80.1% of the participants expressed concerns about the safety of the foods that they consume. 82.1% of the participants stated that they pay attention to the instructions on the package when using packaged products. Nearly all participants (95.2%) found the training on food microbiology to be beneficial.

Table 2. Food safety knowledge levels of participants

Questions	Before Course (%)		After Course (%)		P
	True	False	True	False	
To see if it is safe, it is necessary to test the milk instead of looking at the expiration date.	229 (78.7)	62 (21.3)	253 (86.9)	38 (13.1)	0.008
If the lid of the can is swollen or tight, it is wrong to eat canned food.	231 (79.4)	60 (20.6)	260 (89.3)	31 (10.7)	0.001
The safest way to check if meat is well-done is to check its internal temperature with a food thermometer.	226 (77.7)	65(22.3)	262 (90)	29 (10)	0.000
For safe cooking, the internal temperature of the chicken should be high.	208 (71.5)	83 (28.5)	245 (84.2)	46 (15.8)	0.000
Pasteurized milk can be stored at refrigerator temperature for a maximum of 3 days without opening the package.	119 (40.9)	172 (59.1)	141 (48.5)	150 (51.5)	0.067
The optimum temperature for bacteria to grow is (4-7°C) refrigerator temperature.	188 (64.6)	103 (35.4)	210 (72.2)	81 (27.8)	0.050
If a cutting board is to be used to cut different types of food, such as vegetables and meat, the board should be cleaned with a clean towel to prevent bacterial growth.	234 (80.4)	57(19.6)	233 (80.1)	58 (19.9)	0.917
Raw chicken, fish and meat should not come into contact with each other.	280 (96.2)	11 (3.8)	279 (95.9)	15 (4.1)	0.832
Bacteria transmitted from hands to food can cause harmful microorganisms to grow in food.	278 (95.5)	13 (4.5)	285 (97.9)	6 (2.1)	0.103
To get rid of bacteria, simply wash your hands under cold tap water before touching food.	237 (81.4)	54 (18.6)	237(81.4)	54 (18.6)	1.000

After the education, the participants' level of food safety knowledge significantly increased, as shown by the questions used to assess their knowledge. Specifically, there was a statistically significant improvement in knowledge related to the safety of canned, meat, and dairy products after the training ($p < 0.05$, Table 2).

Table 3. Food safety practices levels of participants

Questions	Before Course (%)				After Course (%)				p
	Hardly ever	Sometimes	Frequently	Always	Hardly ever	Sometimes	Frequently	Always	
I wash my hands before preparing and eating food at home.	0 (0.0%)	1 (0.3%)	18 (6.2%)	272 (93.5%)	0 (0.0%)	4 (1.4%)	5 (1.7%)	282 (96.9%)	0.037
I wash my hands before eating in the school canteen/restaurant.	0 (0.0%)	35 (12.0%)	80 (27.5%)	176 (60.5%)	1 (0.3%)	12 (4.1%)	63 (21.6%)	215 (73.9%)	0.000
I dry my hands with a paper towel.	11 (3.8%)	34 (11.7%)	83 (28.5%)	163 (56.0%)	1 (0.3%)	23 (7.9%)	54 (18.6%)	213 (73.2%)	0.000
I wash my hands before preparing food containing raw meat and processed meat products.	1 (0.3%)	10 (3.4%)	27 (9.3%)	253 (86.9%)	0 (0.0%)	1 (0.3%)	15 (5.2%)	275 (94.5%)	0.000
I clean surfaces with chlorine based cleaners after each use and before preparing food.	67 (23.0%)	108 (37.1%)	72 (24.7%)	44 (15.1%)	45 (15.5%)	63 (21.6%)	74 (25.4%)	109 (37.5%)	0.034
I put the leftover in the refrigerator in 2 hours.	4 (1.4%)	32 (11.0%)	99 (34.0%)	156 (53.6%)	2 (0.7%)	12 (4.1%)	63 (21.6%)	214 (73.5%)	0.000
I check the expiration date on the food packaging.	0 (0.0%)	8 (2.7%)	48 (16.5%)	235 (80.8%)	1 (0.3%)	6 (2.1%)	44 (15.1%)	240 (82.5%)	0.442
I taste the food to see if it's safe.	105 (36.1%)	114 (39.2%)	53 (18.2%)	19 (6.5%)	153 (52.6%)	90 (30.9%)	33 (11.3%)	15 (5.2%)	0.367

Table 3. (Continued)

I eat meat after it is well cooked, I do not consume undercooked meat.	18 (6.2%)	44 (15.1%)	62 (21.3%)	167 (57.4%)	3 (1.0%)	20 (6.9%)	60 (20.6%)	208 (71.5%)	0.000
I do not eat raw eggs or food made from raw eggs.	43 (14.8%)	56 (19.2%)	41 (14.1%)	151 (51.9%)	26 (8.9%)	31 (10.7%)	46 (15.8%)	188 (64.6%)	0.000
As soon as I buy perishable foods, I put them in the refrigerator.	4 (1.4%)	10 (3.4%)	35 (12.0%)	242 (83.2%)	1 (0.3%)	2 (0.7%)	30 (10.3%)	258 (88.7%)	0.000

Table 3 presents the results of the examination of the food safety practice levels of the participants., There was a significant improvement in the absence of information regarding the statements "I wash my hands before eating at the school canteen/restaurant." and "I put the leftover in the refrigerator for 2 hours". The difference before and after the training in the overall of food safety practices was statistically significant ($p=0.001$).

Table 4. Food microbiology knowledge levels of participants

Questions	Before Education (%)			After Education (%)			p
	Right Answer	Wrong Answer	No Idea	Right Answer	Wrong Answer	No Idea	
At what temperature does bacteria reproduce more rapidly?	116 (%39.9)	71 (24.3%)	104 (35.6%)	209 (%71.8)	60 (20.5%)	22 (7.5%)	0.000
Which degree is appropriate for the refrigerator or cooler temperature?	174 (%59.8)	57 (19.5%)	60 (20.5%)	235 (%80.8)	53 (18.2%)	3 (1.0%)	0.000
What should be the minimum degree of the deep freeze temperature?	124(% 42.6)	107 (36.6%)	60 (20.5%)	204 (%70.1)	72 (24.7%)	15 (5.1%)	0.000
What is the risk of storing cooked and raw food together?	166 (%57)	51 (17.5%)	74 (25.3%)	252 (%86.6)	26 (8.9%)	13 (4.5%)	0.000

Table 4. (Continued)

At what temperature are hot meals served?	77 (%26.5)	131 (44.9%)	83 (28.4%)	150 (%51.5)	109 (37.3%)	32 (11.0%)	0.000
How is the bacterial food poisoning detected in food?	58 (%19.9)	187 (64.0%)	46 (15.8%)	68 (%23.4)	210 (71.9%)	13 (4.5%)	0.314
What happens to bacteria at 37 °C?	103 (%35.4)	84 (28.8%)	104 (35.6%)	189 (%64.9)	83 (28.4%)	19 (6.5%)	0.000
Which one should be applied to destroy the bacteria effectively?	187 (%64.3)	74 (25.3%)	30 (10.3%)	215 (%73.9)	62 (21.2%)	14 (4.8%)	0.012
What are the most common symptoms of food poisoning?	194 (%66.7)	47 (16.1%)	50 (17.1%)	241 (%82.8)	44 (15.1%)	6 (2.1%)	0.000
What are the sterile foods that do not contain pathogenic microorganisms?	193 (%66.3)	52 (17.8%)	46 (15.8%)	254 (%87.3)	19 (6.5%)	18 (6.2%)	0.000
What should be the order of use of the stored foods from the warehouse?	194 (%66.7)	44 (15.1%)	53 (18.2%)	234 (%80.4)	41 (14.0%)	16 (5.5%)	0.000
After which process should hands be washed?	266 (%91.4)	23 (7.9%)	2 (0.7%)	272 (%93.5)	13 (4.5%)	6 (2.1%)	0.347
How many seconds should hand washing continue?	175 (%60.1)	116 (39.7%)	0 (0.0%)	209 (%71.8)	78 (26.7%)	4 (1.4%)	0.003
What is the best way for drying hands?	248 (%85.2)	40 (13.7%)	3 (1.0%)	241 (%82.8)	39 (13.4%)	11 (3.8%)	0.428
What bacteria can be found in raw milk if not cooked properly?	91 (%31.3)	102 (34.9%)	98 (33.6%)	154 (%52.9)	112 (38.4%)	25 (8.6%)	0.000
What are the factor(s) affecting the reproduction of bacteria?	223 (%76.6)	53 (18.2%)	15 (5.1%)	255 (%87.6)	28 (9.6%)	8 (2.7%)	0.001
Which of the following is true about bacteria?	123 (%42.3)	58 (19.9%)	110 (37.7%)	204 (%70.1)	59 (20.2%)	28 (9.6%)	0.000

Table 4. (Continued)

What should be the ideal cooler temperature for products such as meat, fish, chicken?	187 (%64.3)	25 (8.6%)	79 (27.1%)	245 (%84.2)	29 (9.9%)	17 (5.8%)	0.000
In which situations would there be a risk of foodborne illness?	190 (%65.3)	84 (28.8%)	17 (5.8%)	238 (%81.8)	50 (17.1%)	3 (1.0%)	0.000
What is the most common bacteria found on nails, nose, and pimples?	58 (%19.9)	64 (21.9%)	169 (57.9%)	125 (%43)	69 (23.6%)	97 (33.2%)	0.000

Table 4 presents the assessment of participants' food microbiology knowledge levels. The most significant knowledge gaps were observed in relation to statements such as 'At what temperature does bacteria reproduce more rapidly?', 'At what temperature are hot meals served?', and 'What bacteria can be found in raw milk if it is not cooked properly?'. Following the training, there was a noticeable improvement in the knowledge levels regarding these topics. In 17 out of the 20 questions asked, it was observed that the participants' knowledge increased after the training compared to before. The difference in the overall evaluation of food microbiology knowledge before and after the training was statistically significant ($p=0.000$)."

Table 5. The effect of course on food safety, practices and microbiology knowledge levels

	n	Mean±SD		t	p
		Before Education	After Education		
Food Safety Knowledge Level	291	7.66 ±1.46	8.26±1.52	-4.835	.000
Food Safety Practices Level	291	27.87±2.58	28.52±2.13	-3.441	.001
Food Microbiology Knowledge Level	291	10.81±3.56	14.41±3.79	-11.595	.000

Food safety knowledge, safe food preparation and food microbiology knowledge levels were examined based on the total correct knowledge averages before and after the course. There was a significant increase in all knowledge levels after the course ($p < 0.05$, Table 5).

It is well-known that a lack of information on food safety contributes to many of the food-borne outbreaks, and providing training on these topics can significantly reduce such incidents [12,13]. In this study conducted among university students to evaluate the effectiveness of food microbiology courses, 95.2% of the participants reported that the course was beneficial (Table 1). In addition, there was a significant improvement before and after the training ($p < 0.05$) in food safety knowledge, safe food preparation practices and food microbiology knowledge,

In a separate study involving 401 university students from various faculties in Turkey revealed that 4.2% had low, 67.8% moderate, and 27.9% had high levels of food safety knowledge [23].

Another study conducted with 200 university students aged 19-24 found incomplete knowledge on food safety and identified incorrect attitudes and behaviors [24].

In a research study, involving 205 university students, the impact of undergraduate education in food and beverage management on food safety knowledge was examined. The group of 145 students who received the training were compared to a control group of 60 individuals. The study revealed that the students who received the training demonstrated a higher level of knowledge compared to the control [25].

Another study found that the level of food safety awareness among students studying in higher education institutions was 50% [26].

Abdulatif Al-Shabib *et al.* (2017) conducted a study assessing the food safety knowledge of 808 students, which revealed that the students possessed sufficient knowledge regarding food safety [27].

In Lebanon, a research aimed at assessing the food safety and processing knowledge and practices of the university students showed that students had a generally low level of knowledge, and highlighted the need for education to improve food awareness [28].

In the food safety awareness and attitude study conducted with dietitian students in Lebanon, England and the USA revealed that the students in all three countries had incomplete knowledge about basic food safety concepts, emphasizing the importance of comprehensive food safety education for dietetics students [29].

A study conducted with 215 students in the Culinary Department of Mengen School in Turkey investigated food safety knowledge and practices, identifying deficiencies in the knowledge levels and food safety practices of the students who received culinary education [30].

Şanlıer *et al.* (2017) conducted a study at Gazi University in Turkey involving a total of 250 students, including 140 students from health sciences, 46 students from social sciences, and 64 students from sciences. The study measured students' knowledge levels of food safety and hygiene practices, revealing that students majoring in health sciences had a higher knowledge level compared to those majoring in science or social sciences [31].

In a recent study conducted with 163 students from natural sciences (36.6%), health sciences (48.2%) and social sciences (15.2%) in Kyrgyzstan, the awareness levels of students on food safety were examined and compared. 75% of the participants stated that they had heard about the concept of food safety before, and the food safety awareness level was found to be higher among students studying in health sciences [32].

Lazou *et al.* (2012) conducted research at Aristotle University Thessaloniki in Greece, involving 375 students from health sciences departments and 375 students from other faculties. The students were surveyed about food microbiology and food processing methods. The study found that health science students had higher knowledge of food processing and food safety compared to students from other faculties. Veterinary medicine students from health sciences departments achieved the highest correct answer rate, which was attributed to the curriculum's inclusion of food hygiene lectures in the veterinary department [33].

At Amasya University in Turkey, a study involving 470 students examined the knowledge, attitudes and behaviors related to the concepts of food safety and food literacy. The results showed that only 15.3% of the answers regarding food safety and 14.7% of the answers regarding food literacy were correct, indicating that students had insufficient knowledge about these concepts [34].

In a recent study involving 606 students from 24 universities in Sweden, the level of food safety knowledge was assessed. The research data indicated that the food safety knowledge level was determined to be 63.4%. It was observed that students who had

received food safety, food hygiene and microbiology education had higher knowledge levels [35].

Studies in the literature have consistently shown that students who did not receive food safety education have low levels of knowledge in this area, highlighting the importance of food safety education.

In a study conducted in Istanbul, food safety and hygiene knowledge level of 115 students from the gastronomy and cookery departments was assessed. The results revealed deficiencies in the knowledge of food safety and hygiene rules, but it was found that they had high knowledge and adherence to hand hygiene and kitchen equipment hygiene. For example, 94.8% of the participants used the statement "The food that should be stored in the cupboards should be stored at +4°C" and 97.4% of the participants gave the correct answer to the statement "I wash my hands with hot water and soap after touching raw meat and hands should be washed with hot water and soap before touching the food". 98.3% of the participants gave the correct answer by stating that different chopping boards and knives should be used for meat, kebab and vegetables [36].

The hygiene knowledge levels of 260 students from a cookery program at a university in Muğla, Turkey were measured. According to the food groups of the students (meat, vegetables, etc.), the level of knowledge in the statements "I use different chopping boards and knives, I wash fresh vegetables and fruits abundantly underwater, I regularly clean the tools I use in food preparation" was found to be higher [37].

In this study, it was found that 80.4% of the students used the statement "If a cutting board is to be used to cut different types of food such as vegetables and meat, the board should be cleaned with a clean towel to prevent bacteria formation", 96.9% always used the statement "At home, I wash my hands before preparing and eating food", 73.2% always used the statement "I dry my hands with a paper towel", 71.8% used the statement "Hand washing should take 20 seconds", 73.5% used the statement "I put the leftover in the refrigerator in 2 hours". 86.6% of the students stated that it is risky to store cooked and raw food together, 71.8% stated that bacteria reproduce faster at 25°C, and 82.8% stated that diarrhea is the most common symptom of food poisoning.

In another study examining the risk perceptions and behavior of food engineering students regarding food safety, 74.79% of the students stated that they always looked at the expiration date of the products while shopping [38].

In this study, 82.5% of the students stated that they always checked the expiry date written on the food packaging. All the results obtained through this study revealed that the students have some idea and knowledge about food preparation, safety, and microbiology since they are educated at the nutrition and dietetics department. However, the food microbiology lecture has more impact on the reinforcement of the information because one of the main roles of the dietitians is to educate the public.

4. Conclusion

In today's ever-changing food consumption habits, ensuring food safety is crucial for maintaining a high quality of life. Insufficient knowledge about food preparation

conditions can lead to food-related health issues and financial losses. Therefore, it is necessary to include courses on food safety and food microbiology in the curricula of not only health-related departments but also other faculties in the universities across Turkey. Thorough Food microbiology education, it was aimed to teach food-related microorganisms, the causes of food spoilage and food-borne infections the prevention methods, and importance of food safety and food hygiene. It is thought that the fact that the course content is comprehensive, the education is one semester, the lectures are open to discussion, the students make presentations about the content of the course, and the exams during and at the end of the semester increase the level of food microbiology and food safety knowledge of the students.

The course provided to students should be sustainable, continuous, and reinforced with practica applications. While undergraduate students generally have a higher awareness of food safety, food hygiene and food microbiology compared to the general population, there are still some deficiencies in certain areas. The data evaluated in this study indicated that education should cover all the topics related to food safety, preservation and storage to prevent food-borne infections and poisoning. It is particularly important to assessthe effectiveness of the courses routinely offered to students pursuing careers in the health and food related fields and make necessary adjustments to the programs. Surveys can be conducted at the end of the semester to evaluate the efficiency of these courses. In general, organizing training sessions on healthy and safe food practices and food preservation for university students can contribute to raising awareness and informing the broader society.

Studies on food microbiology and food safety have been conducted with university students (23-26). There is a lack of extensive research on food safety and microbiology among university students, especially in health-related departments. This study represents the second piece of literature assessing the food safety knowledge and attitudes of nutrition and dietetics students. Considering the significant role of dietitians in shaping nutritional habits and public health, further exploration of this topic is warranted. Awareness-raising initiatives targeting the society should be organized, covering various aspects such as factors to be considered when choosing foods, food storage conditions, cooking methods, and food hygiene. Education provided to students in the nutrition department which combines health and food, holds great importance as these students will be involved in future public health awareness activities. Therefore, the effectiveness of such training programs must be ensured.

More studies are needed to demonstrate the importance of food microbiology and food safety. It is especially important for nutrition and dietetics students working in the field of health to be aware of food preservation and hygiene and to follow new information. The effectiveness of the courses given for this purpose should be followed up with detailed studies.

References

- [1] WHO, The First Action Plan for Food and Nutrition Policy-**WHO European Region** 2000-2005, Roma, (2001).
- [2] Republic of Turkey Ministry of Health, (2017), <https://hsgm.saglik.gov.tr/tr/beslenme/besin-guvenligi-ve-hijyen.html>
- [3] Ray, B. **Fundamental Food Microbiology** 3rd Edn, CRC Press, FL, ISBN: 0-8493-1610-3, 439-534, (2004).

- [4] Artık, N., Konar, N., Toplu Tüketim Yerleri İçin Hijyen ve HACCP Uygulamaları, **Turizm, Sağlık ve Hukuk Sempozyumu**, Nevşehir, Türkiye, 03-05 Nisan (2015).
- [5] Gaaloul, I., Riabi, S., Ghorbel, R.E., Implementation of ISO 22000 in Cereal Food Industry “SMID” in Tunisia, **Food Control** 22, 59-66, (2011).
- [6] da Cunha, D.T., Improving food safety practices in the foodservice industry, **Current Opinion in Food Science**, 38:127-133, (2021).
- [7] Anonymous1 2019, <https://sendika.org/2019/01/isig-meclisi-beslenme-calisma-grubu-2018-yilinda-en-az-13-bin-190-kisi-gida-zehirlenmesi-yasadi-525658/>
- [8] EFSA & ECDC (European Food Safety Authority and European Centre for Disease Prevention and Control), Scientific report on the European union one health 2018 zoonoses report, **EFSA Journal** 17(12):5926, (2019).
- [9] Skuland, S.E., Borda, D., Didier, P., et al. European food safety: Mapping critical food practices and cultural differences in France, Norway, Portugal, Romania and the UK. **SIFO Report**, 6–2020. Oslo: Consumption research Norway, Oslo Metropolitan University.
- [10] Anonymous2, 2015, https://reliefweb.int/report/world/estimates-global-burden-foodborne-diseases?gclid=CjwKCAjw0qOIBhBhEiwAyyVcf8XMbpULav_bIWC6O6lpwybK2t1H4E_3sL5esoso8DbVM6IlycmfxoCjBEQAvD_BwE
- [11] Focker, M., Van Der Fels-Klerx, H.J., Economics applied to food safety, **Current Opinion in Food Science**, 36:18-23, (2020).
- [12] Langiano, E., Ferrara, M., Lanni, L., Viscardi, V., Abbatecola, A.M., De Vito, E., Food safety at home: Knowledge and practices of consumers, **Journal of Public Health**, 20(1): 47-57, (2012).
- [13] Wu, Y., Liu, X., Chen, Q., Liu, H., Dai, Y., Zhou, Y., Wen, J., Tang, Z., Chen, Y., Surveillance for foodborne disease outbreaks in China, 2003 to 2008, **Food Control**, 84:382–388, (2018).
- [14] McFarland, P., Checinska Sielaff, A., Rasco, B., Smith, S., Efficacy of food safety training in commercial food service, **Journal of Food Science**, 84(6):1239-1246, (2019).
- [15] Medeiros, C.O., Cavalli, S.B., Salay, E., Proença, R.P.C., Assessment of the methodological strategies adopted by food safety training programmes for food service workers: A systematic review, **Food Control**, 22(8):1136-1144, (2011).
- [16] Young, I., Waddell, L.A., Wilhelm, B.J., Greig, J.A., systematic review and meta-regression of single group, pre-post studies evaluating food safety education and training interventions for food handlers, **Food Research International**, 128, 108711, (2020).
- [17] Yu, H., Neal, J., Dawson, M., Madera, J.M., Implementation of behavior-based training can improve food service employees’ handwashing frequencies, duration, and effectiveness, **Cornell Hospitality Quarterly**, 59(1): 70–77, (2018).
- [18] Yu, H., Sirsat, S.A., Neal, J.A., Linking food safety training with whistle-blowing: The mediation roles of job satisfaction and self-efficacy, **International Journal of Contemporary Hospitality Management**, 31(1): 141-160, (2019).
- [19] Zanin, L.M., da Cunha, D.T., De Rosso, V.V., Capriles, V.D., Stedefeldt, E., Knowledge, attitudes and practices of food handlers in food safety: An integrative review, **Food Research International**, 100: 53–62, (2017).
- [20] Griffith, C.J., Developing and maintaining a positive food safety culture (1st ed.) Doncaster: Highfield, (2014).

- [21] Anonymous3, 2004, <http://www.raosoft.com/samplesize.html>
- [22] Şanlıer, N., The knowledge and practice of food safety by young and adult consumers, **Food Control**, 20:538-542, (2009).
- [23] Açıkalın, B., Knowledge, attitude and behavior of university students about food safety, Master Thesis, (Istanbul) Biruni University Institute of Health Sciences, (2019).
- [24] Avşar, İ.O., Determination of knowledge attitudes and behaviors of university students on food safety, Master Thesis, (Gaziantep) Hasan Kalyoncu University Institute of Health Sciences, (2019).
- [25] Kocaman, E.M., The Effect of Food and Beverage Management Education on the Knowledge Level of Students Regarding Food Safety, **Kastamonu Education Journal**, 23(1):269-280, (2015).
- [26] Gündüz, O., Aydoğan, C., A Research on Awareness Level of Food Safety of Vocational School Students, **Journal Of Academic Approaches**, 6(1):34-44, (2015).
- [27] Al-Shabib, N.A., Husain, F.M., Khan, J.M., Study on food safety concerns, knowledge and practices among university students in Saudi Arabia, **Food Control**, 73: 202-208, (2017).
- [28] Hassan, H.F., Dimassi, H., Food safety and handling knowledge and practices of Lebanese university students, **Food Control**, 40:127-133, (2014).
- [29] Evans, E.W., Redmond, E.C., Alwan, N., Ilic, S., Awareness and attitudes of student dietitians in Lebanon, UK and USA towards food safety, **Foods**, 10, 1875, (2021).
- [30] Aratoğlu, C., Information and application levels on food safety of the students who receive culinary education in "Vocational and technical Anatolian high school and vocational higher school", Master Thesis, (Ankara) Gazi University Institute Of Education Sciences, (2015).
- [31] Şanlıer, N., Adanur, E., Uyar, G.Ö., Elibol, E., Coşkun, A.B., Erdoğan, R., Bozbaş, E., Evaluation of The Nutrition and Food Safety Knowledge and Behaviour of The Young, **Kastamonu Education Journal**, 25(3), 941-956, (2017).
- [32] İstanbullugil, F.R., Gürbüz, Ü., Determining the Level of Food Safety Awareness of University Students in Bishkek; A Case Study, **Manas Journal of Agriculture Veterinary and Life Sciences**, 9(2):85-90, (2019).
- [33] Lazou, T., Georgiadis, M., Pentieva, K., McKeivitt, A., Iossifidou, E., Food safety knowledge and food-handling practices of Greek university students: A questionnaire-based survey, **Food Control**, 28(2): 400-411, (2012).
- [34] İncedal-Sonkaya, Z., Balcı, E., Ayar, A., University students food literacy and food safety knowledge, attitudes and behaviors "Example of Amasya University Sabuncuoğlu Şerefeddin Health Services Vocational School", **Turkish Bulletin of Hygiene & Experimental Biology**, 75(1): 53-64, (2018).
- [35] Marklinder, I., Ahlgren, R., Blücher, A., Börjesson, S.M.E., Hellkvist, F., Moazzami, M., Schelin, J., Zetterström, E., Eskhult, G., Danielsson-Tham, M.L., Food safety knowledge, sources thereof and self-reported behaviour among university students in Sweden, **Food Control**, 113, 107130, (2020).
- [36] Özcan, F.Ö., Cookery and Gastronomy Students Food Safety-Determination of Knowledge Level for Hygiene Online Cross-Sectional Study, **Saffron Journal of Culture and Tourism Researches**, 3(2):116-124, (2020).

- [37] Ertopcu, İ., Avcıkurt, A., Çetinkaya, T.A., Study on Hygiene Knowledge Levels of Cooking Program Students, **Journal of Tourism and Gastronomy Studies**, 2187-2203, (2019).
- [38] Çelik, A.D., Risk Perceptions and Behaviours of Food Engineering Students About Food Safety: The Case Study of Hatay Mustafa Kemal University, **Turkish Journal of Agriculture-Food Science and Technology**, 9(7): 1237-1241, (2021).