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**ARAŞTIRMA MAKALESİ** **RESEARCH ARTICLE**

# Do the Sociodemographic Factors and Body Mass Index Have an Impact on Food Safety Knowledge, Attitudes and Practices?

Sosyodemografik Faktörler ve Beden Kütle İndeksinin Gıda Güvenliği Bilgisi, Tutum ve Davranışları Üzerine Etkisi Var Mıdır?

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## Abstract

It was aimed to evaluate the relation between food safety knowledge, attitude, and behavior, with some socio-demographic factors and body mass index (BMI). The study was conducted on 1647 volunteer university students (1243 females and 404 males) attending at various universities in Ankara, Turkey. The data was collected via a questionnaire applied face to face interview which consisted of totally 95 items on demographic information (15 items), food safety knowledge (40 items), food safety attitude (15 items), and food safety behavior (25 items). Weight and height of the students were measured by the researches, and BMI was calculated and evaluated using World Health Organization classification. Food safety knowledge scores (FSKS) (27.3±5.54 versus 25.1±5.64, $p<0.001$), food safety attitude scores (FSAS) (14.5±4.02 versus 12.6±4.36, $p<0.001$) and food safety behavior scores (FSBS) (14.5±4.02 versus 12.6±4.36, $p<0.001$) were found to be statistically higher in women than males. Total FSKS, FSAS, and FSBS were significantly higher in the students educated in the field of health compared to others. FSKS, FSAS, and FSBS of the obese group were significantly lower than normal weight and underweight groups. As BMI increased, FSKS, FSAS, and FSBS were significantly decreased ($r=-0.106$, $p<0.001$; $r=-0.130$, $p<0.001$; $r=-0.095$, $p<0.001$, respectively). The results of this study reveal the gender and BMI differences on food safety knowledge, food safety attitudes, and food safety practices, and also has shown positive impact of health education status. In order to increase food safety knowledge and to reflect this knowledge on attitudes and behaviors, it is thought that it will be beneficial to give priority to male students, students in the obese group, and students studying in the field of social and science in the trainings to be planned on the subject.

**Keywords:** Food safety, Knowledge, Attitude, Behavior, University students

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# Öz

Bu çalışmada, üniversite öğrencilerinin gıda güvenliği bilgi düzeyi, tutum ve davranışları ile bazı sosyodemografik faktörler ve beden kütle indeksi (BKİ) arasındaki ilişkinin değerlendirilmesi amaçlanmıştır. Araştırma Ankara'daki çeşitli üniversitelerde eğitim almakta olan 1243 kız ve 404 erkek olmak üzere toplam 1647 gönüllü öğrencinin katılımı ile gerçekleştirilmiştir. Çalışma verileri yüzyüze görüşme yöntemi ile demografik bilgiler (15 madde), gıda güvenliği bilgileri (40 madde), gıda güvenliği tutumu (15 madde) ve gıda güvenliği davranışları (25 madde) ile ilgili bilgileri içeren toplam 95 maddeden oluşan bir anket aracılığıyla toplanmıştır. Öğrencilerin vücut ağırlığı ve boy uzunluğu ölçümleri araştırmacılar tarafından alınarak BKİ hesaplanmış ve Dünya Sağlık Örgütü sınıflaması kullanılarak değerlendirilmiştir. Kadınlarda gıda güvenliği bilgi puanı (GGBP) (27.3±5.54 karşın 25.1±5.64, $p<0.001$), gıda güvenliği tutum puanı (GGTP) (14.5±4.02 karşın 12.6±4.36, $p<0.001$) ve gıda güvenliği davranış puanı (GGDP) (14.5±4.02 karşın 12.6±4.36, $p<0.001$) erkeklerden istatistiksel olarak anlamlı düzeyde daha yüksek bulunmuştur. Toplam GGBP, GGTP ve GGDP'nın sağlık alanında eğitim alan öğrencilerde diğer alanlara kıyasla anlamlı düzeyde daha yüksek olduğu saptanmıştır. Zayıf ve normal vücut ağırlığında olanlarla karşılaştırıldığında, obez grupta yer alan öğrencilerin gıda güvenliği bilgi, tutum ve davranışlarının her üçünden de aldıkları puan ortalamalarının istatistiksel olarak anlamlı derecede daha düşük olduğu belirlenmiştir. Beden kütle indeksi arttıkça gıda güvenliği bilgi, tutum ve davranış puanlarının tümünün istatistiksel olarak önemli düzeyde azaldığı belirlenmiştir (sırasıyla, $r=-0.106$, $p<0.001$; $r=-0.130$, $p<0.001$; $r=-0.095$, $p<0.001$). Çalışmanın sonuçları gıda güvenliği bilgi, tutum ve davranışları üzerine cinsiyet ve BKİ farklılıklarını ortaya koyduğu gibi sağlık eğitiminin pozitif etkisini de göstermiştir. Gıda güvenliği bilgisinin arttırılması ve bu bilginin tutum ve davranışlara yansıtılması için konuyla ilgili planlanacak eğitimlerde özellikle erkekler, obez grupta olan öğrenciler ve sosyal/fen alanında eğitim alan öğrencilere öncelik verilmesinin yararlı olacağı düşünülmektedir.


**Anahtar Kelimeler:** Gıda güvenliği, Bilgi, Tutum, Davranış, Üniversite öğrencileri

## 1. Introduction

Foodborne diseases are a public health concern and The World Health Organization (WHO) reports that approximately 600 million people, 1 in 10 people in the world, fall ill after eating contaminated food and 420 000 die every year (WHO, 2020). Centers for Disease Control and Prevention (CDC) estimates that 1 in 6 Americans suffer from contaminated foods or beverages, and 3000 people die from foodborne diseases each year. The US Department of Agriculture (USDA) estimates that foodborne diseases have a burden of $15.6 billion each year to the economy (CDC, 2021). In addition, foodborne diseases constitute one of the most important causes of morbidity and mortality worldwide (Havelaar et al., 2015).

Food safety knowledge is important to prevent foodborne illness. Prevention of foodborne illnesses is one of the primary responsibilities of not only food retails also for each consumer (Courtney et al., 2016; Schwartz, 1975). In some of the studies investigating the relationship between food safety knowledge, attitudes and behaviors, it has been reported that the behavior or practice of the individual depends on the knowledge of the individual, and there is a change in attitudes and behaviors by just providing knowledge (Rennie, 1995; Lim et al., 2016). On the contrary, some of the studies reported that knowledge, attitudes and behaviors are not positively related (Huang, 1995; Lima et al., 2016; Wilcock et al., 2004; Clayton et al., 2002). Recognizing that knowledge is essential to safe food handling, many studies have focused on improving the food safety education of consumers (Garayoa et al., 2005; Lin et al., 2005).

Although public awareness and concern about food related risks and diseases is increasing (Kaynarca ve Gümüş, 2020), the domestic food handlers still have not adequate food safety knowledge leading to inappropriate food handling practices (Farahat et al., 2015; McCarthy et al., 2007). Food safety knowledge and behaviors are being investigated as a priority among university youth whom are domestic food handlers and also parents of future (Lazou et al., 2012; Hassan and Dimassi, 2014; Sharif and Al-Malki, 2010; Ferk et al., 2016; Yarrow et al., 2009; Stein et al., 2010; Osaili et al., 2011; Sanlier and Konaklioglu, 2012; Garayoa et al., 2005; Al-Shabib et al., 2017; Byrd-Bredbenner et al., 2007). In a study conducted with 867 female students (mean age 20.07±1.81), it was shown that there was a positive relationship between food safety knowledge scores and class (Osaili et al., 2011). In a study conducted on totally 1340 students (18-24 years of age) in Turkey, it was determined that there was a positive correlation between attitudes and practices (Sanlier and Konaklioglu, 2012). In a study conducted in Spain with 562 university students (mainly in health sciences), it was found that students with high level of knowledge about food hygiene made better practices, but even these students were reported to show some high-risk behaviors related to food safety (Garayoa et al., 2005). In a study conducted on a total of 808 university students (average age 21.1 ± 2.9) in Saudi Arabia, it was found that both male and female students exhibited comparable food safety knowledge and practices (Al-Shabib et al., 2017). In another study, researchers at Rutgers University reported that when they go to the homes where university students live, they evaluate the food safety and that the kitchens of these houses support the development and transport of foodborne pathogens (Byrd-Bredbenner et al., 2007).

In university student's dietary habits usually depend on lecture schedules attended by students and availability of food inside or in the vicinity of the university campus (Bernardo et al., 2021). As a result of the expansion in the fast-food market and lack of appropriate food courts, students usually skip meals, have inadequate variety of foods, and unhealthy snacking that causes obesity (Vila-Martí et al., 2021; Bernardo et al., 2021; Beaudry et al., 2019; Martínez-González et al., 2014). The beginning of the university matches with more freedom and independence and is often the first time that young people assume the responsibility to choose and prepare foods (Vila-Martí et al., 2021; Bernardo et al., 2021; Obande and Young, 2020; Yahia et al., 2008)

The Turkish society is a young society. University students represent the youthful age population of a community, and are prone to unhealthy eating habits and foods which might affect their wellbeing (Konyalı, 2019). It is reported that university students are more likely to perform risky food processing practices (Smigic et al., 2021) due to their future role as home makers, cooks and food handlers (Al-Shabib et al., 2017). In addition, considering the prevalence of obesity epidemics, which are common in university students, in this study it is aimed to investigate the relationship between food safety knowledge, attitude and behavior and some sociodemographic characteristics and BMI.

## 2. Materials and Methods

### *2.1. Study design*

This cross-sectional study was conducted on 1647 university students, including 404 males and 1243 female attending at various universities in Ankara, capital of Turkey. In this study, a probabilistic sampling method was used to represent the population. The participation of students in this study was conducted on a voluntary basis. The data was collected via a questionnaire applied face to face interview which consisted of totally 95 items on demographic information (15 items), food safety knowledge (40 items), food safety attitude (15 items), and food safety behavior (25 items). The data was collected between March and June 2018. Questionnaire was constructed and divided into four parts. Part I, was used to collect data on participants' general characteristics (gender, age, income, frequency of eating out of home, and foodborne illnesses). Part II, the food safety knowledge, Part III and IV were designed for evaluating the food safety attitudes and behaviors of the participants accordingly.

This study was performed in line with the principles of the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study. Approval was obtained from Gazi University Ethics Committee for the study (Date: 06/02/2018 Decision No: 2018-05).

### *2.2. Food safety knowledge questionnaire*

Food safety knowledge questionnaire included 40 questions to test the participants' knowledge of personal hygiene (6 items), kitchenware hygiene (7 items), food hygiene (13), cross contamination (6 items) and critical temperature for food storage (8 items). The respondents were required to choose either “true” or “false” and “have no idea” for each item and the score was given for each correct answer. Total food safety knowledge score (FSKS) was converted to percentiles. Values below the 25th percentile were considered low knowledge level. Values between the 25th and 75th percentiles were considered as moderate. Values above 75th percentile were considered as high level. The confidentiality coefficient (Cronbach alpha) was found as 0.808.

### *2.3. Food safety attitude questionnaire*

Food safety attitude questionnaire was designed for evaluating the food safety attitudes of the participants. Food safety attitudes consisted of 15 questions rated with 3-point Likert scale ranging from 1 (agree) to 3 (disagree). Total food safety attitude score (FSAS) was converted to percentiles. Values below the 50th percentile were considered bad attitude and values above the 50th percentile were considered good attitude. The confidentiality coefficient (Cronbach alpha) was found as 0.549.

### *2.4. Food safety behavior questionnaire*

Food safety behavior questionnaire was designed for evaluating the food safety behaviors of the participants. Food safety behaviors included 25 questions that tested the participants' behaviors of personal hygiene (4 items), kitchenware hygiene (5 items), food hygiene (10), cross contamination (2 items) and critical temperature for food storage (4 items). Food safety behaviors rated with 3-point Likert scale ranging from 1 (practice every day) to 3 (never practice). Food safety behavior score (FSBS) was converted to percentiles. Values below the 50th percentile were considered bad behavior and values above the 50th percentile were considered good behavior. The confidentiality coefficient (Cronbach alpha) was found as 0.730.

The measurement tools related to food safety, attitudes and behaviors in the questionnaire applied to individuals were created by the researchers after a detailed literature review on the subject (Lee et al., 2017; Sanlier and Konaklioglu, 2012; Lim et al., 2016). A self-administered questionnaire was given to participants; whereas the students were assisted by a trained researches in answering the questionnaire. A pilot study was performed on 30 university students, who were not included in the actual experiment. The questionnaire was pilot tested and modified to be compatible with the community. Turkish language was used and the questionnaire took about 15 min to complete.

### *2.5. Statistical analysis*

Data analysis was conducted using the SPSS 22.0 statistics package program. The $p<0.05$ value was accepted as the determinant of significance. The mean ($\bar{x}$), standard deviation (SD), and percentage (%) values were calculated. Student’s t-test was employed to compare the two groups. One-way ANOVAs with Tamhanes T2 post-

hoc comparisons (with no assumption of equal group size or homogenity of variance) were conducted to compare the three groups. One-way ANOVAs with Scheffe post-hoc comparisons (with assumption of equal group size or homogenity of variance) were conducted to compare the three groups. The relationships between the BMI score and other variables were determined using the simple linear regression analysis test.

## 3. Results and Discussion

### *3.1. Demographic characteristics of students*

A total of 1647 university students, 404 males and 1243 female, participated in the study. Approximately half of the individuals (46.1%) are educated in health sciences, 36.5% in science and 17.4% in social areas. The average age of the subjects was 21.3±1.83. The mean BMI was found to be 22.0±3.11. The frequency of eating out of the home was 3.5±2.17 times per week.

More than half of students (56.3%) had moderate levels of food safety knowledge and 21% high level and 22.6% low level. Most of students (62.3%) had good attitude. More than half of students (57.2%) had good behavior.

### *3.2. Food safety knowledge, attitude, and behavior scores of the students according to gender*

*Table 1* shows the mean ($\bar{x}$) and standard deviation (SD) values of the knowledge, attitude and behavior scores of the individuals about food safety according to gender. The mean food safety knowledge scores of women were higher than men ($p<0.001$). In addition, women's personal hygiene, equipment hygiene, food hygiene, cross-contamination prevention knowledge scores were significantly higher than males ($p<0.001$). When the food safety behavior scores of the individuals were evaluated, it was determined that women's personal hygiene, equipment hygiene, food hygiene, keeping at a safe temperature and total behavior scores were significantly higher than males. The mean food safety attitude score was 8.5±2.31 in women and 7.1±2.48 in men ($t=-10.006$, $p<0.001$).

***Table 1. Mean ($\bar{x}$) and standard deviation (SD) values of the food safety knowledge, attitude and behavior scores of the individuals according to gender***

| | **Male (n:404)** | **Female (n:1243)** | | |
|---|---|---|---|---|
| | **$\bar{x}$±SD** | **$\bar{x}$±SD** | ***t*** | **p** |
| **Food safety knowledge score** | | | | |
| Personal hygiene score | 4.8±1.14 | 5.2±0.95 | -6.508 | 0.000* |
| Equipment hygiene score | 4.0±1.67 | 4.8±1.55 | -8.755 | 0.000* |
| Food hygiene score | 7.3±2.07 | 7.7±2.01 | -2.723 | 0.007** |
| Cross contamination score | 4.2±1.46 | 4.8±1.33 | -7.592 | 0.000* |
| Safe temperature score | 4.5±1.78 | 4.6±1.85 | -1.133 | 0.257 |
| *Total score* | 25.1±5.64 | 27.3±5.54 | -6.892 | 0.000* |
| **Food safety attitude score** | | | | |
| Personal hygiene score | 2.4±1.31 | 2.6±1.19 | -2.615 | 0.009** |
| Equipment hygiene score | 2.6±1.28 | 3.1±1.19 | -7.561 | 0.000* |
| Food hygiene score | 5.0±2.06 | 5.8±1.95 | -7.491 | 0.000* |
| Cross contamination score | 0.5±0.53 | 0.5±0.51 | 1.021 | 0.307 |
| Safe temperature score | 1.9±1.22 | 2.3±1.16 | -6.030 | 0.000* |
| *Total score* | 12.6±4.36 | 14.5±4.02 | -8.228 | 0.000* |
| **Food safety behavior score** | 7.1±2.48 | 8.5±2.31 | -10.006 | 0.000* |

***p<0.001, **p<0.01**

### *3.3. Relationship between age, BMI, food safety knowledge, attitude, and behavior scores of students*

The relationships between age, BMI, knowledge, attitude and behavior scores of the students is shown in *Table 2*. BMI values of individuals are correlated with FSKS, FSAS and FSBS inversely. FSKS, FSAS and FSBS were significantly decreased as BMI increased ($r=-0.106$, $p<0.001$; $r=-0.130$, $p<0.001$; $r=-0.095$, $p<0.001$, respectively). As FSKS increases, FSAS and FSBS increase significantly ($r=0.513$, $p<0.001$ and $r=0.433$, $p<0.001$). As FSAS increases, FSBS increases significantly ($r=0.465$, $p<0.001$).

***Table 2. The relationships between age, BMI, knowledge, attitude and behavior scores of the students (r)***

| | BMI | FSKS[a] | FSAS[b] | FSBS[c] |
|---|---|---|---|---|
| Age | 0.131* | 0.016 | -0.022 | -0.003 |
| BMI | | -0.106* | -0.130* | -0.095* |
| FSKS | | | 0.513* | 0.433* |
| FSAS | | | | 0.465* |

*p<0.001, [a] *FSKS:Food safety knowledge score,* [b] FSAS: *Food safety attitude score,* [c] FSBS: *Food safety behavior scores*

### *3.4. Food safety knowledge, attitude, and behavior scores according to students' body mass index groups*

FSKS, FSAS and FSBS were significantly lower in obese individuals according to normal body weight and underweight individuals, Food safety knowledge test subgroups scores were found to be significantly lower in obese subjects than in other groups (except when keeping food at safe temperature) (p<0.01). It was found that equipment and food hygiene scores of food safety behavior test subgroups were significantly lower in obese individuals compared to other groups (*Table 3*).

***Table 3. Mean ($\bar{x}$) and standard deviation (SD) values of the food safety knowledge, attitude and behavior scores of the individuals according to BMI groups***

| | Underweight (n:180) | Normal (n:1192) | Overweight (n:275) | Anova | | Post-Hoc Test | |
|---|---|---|---|---|---|---|---|
| | $\bar{x}$±SD | $\bar{x}$±SD | $\bar{x}$±SD | F | p | Differences (Scheffe, Tamhane T2) | p |
| **Food safety knowledge score** | | | | | | | |
| Personal hygiene score | 5.3±0.92[a] | 5.1±1.00[b] | 4.9±1.09[c] | 7.060 | 0.001** | a-c<br>b-c | 0.002<br>0.014 |
| Equipment hygiene score | 4.8±1.52[a] | 4.6±1.61[b] | 4.4±1.69[c] | 3.996 | 0.019*** | a-c<br>b-c | 0.048<br>0.041 |
| Food hygiene score | 7.8±1.92[a] | 7.6±2.04[b] | 7.3±2.02[c] | 3.935 | 0.020*** | a-c | 0.026 |
| Cross contamination score | 4.8±1.33[a] | 4.7±1.36[b] | 4.4±1.51[c] | 5.494 | 0.004** | a-c<br>b-c | 0.015<br>0.016 |
| Safe temperature score | 4.7±1.89 | 4.6±1.83 | 4.6±1.82 | 0.224 | 0.799 | | |
| *Total score* | 27.5±5.32[a] | 26.8±5.61[b] | 25.8±5.90[c] | 5.428 | 0.004** | a-c<br>b-c | 0.008<br>0.030 |
| **Food safety attitude score** | | | | | | | |
| Personal hygiene score | 2.7±1.18 | 2.6±1.23 | 2.4±1.22 | 1.804 | 0.165 | | |
| Equipment hygiene score | 3.2±1.19[a] | 3.0±1.23[b] | 2.8±1.23[c] | 6.654 | 0.001** | a-c<br>b-c | 0.002<br>0.015 |
| Food hygiene score | 5.9±1.96[a] | 5.6±1.97[b] | 5.3±2.21[c] | 5.348 | 0.005** | a-c | 0.007 |
| Cross contamination score | 0.55±0.50 | 0.53±0.51 | 0.61±0.53 | 2.271 | 0.104 | | |
| Safe temperature score | 2.3±1.11 | 2.2±1.19 | 2.1±1.22 | 1.505 | 0.222 | | |
| *Total score* | 14.8±3.77[a] | 14.1±4.18[b] | 13.4±4.39[c] | 6.081 | 0.002** | a-c<br>b-c | 0.003<br>0.039 |
| **Food safety behavior score** | 8.5±2.27[a] | 8.3±2.37[b] | 7.5±2.65[c] | 12.214 | 0.000* | a-c<br>b-c | 0.000<br>0.000 |

***p<0.001**, ****p<0.01**, *****p<0.05.** Tamhane T2 were conducted çross-contamination and safe temperature subgroups for *Food safety knowledge score* and food hygiene subgroups for *Food safety behavior scores* and *Food safety attitude score*. Scheffe were conducted all other groups.

### *3.5. Food safety knowledge, attitude, and behavior scores according to the field of education of students*

FSKS, FSAS and FSBS were significantly higher in individuals who were educated in the field of health sciences according to science and social areas. All food safety knowledge test subgroup scores were found to be significantly higher in the individuals who received education in the field of health than the other groups ($p<0.001$). It was found that equipment and food hygiene scores of the subgroups of food safety behavior test were statistically significantly higher in the health educated individuals compared to the other groups. Those who received education in the field of science were found to be higher than those in the social field ($p=0.031$) (*Table 4*).

***Table 4. Mean ($\bar{x}$) and standard deviation (SD) values of the food safety knowledge, attitude and behavior scores of the individuals according to the field of education***

| | **Health (n:759)** | **Social (n:286)** | **Science (n:602)** | **Anova** | | **Post-Hoc Test** | |
|---|---|---|---|---|---|---|---|
| | **$\bar{x}$±SD** | **$\bar{x}$±SD** | **$\bar{x}$±SD** | **F** | **p** | **Differences (Scheffe, Tamhane T2)** | **p** |
| **Food safety knowledge score** | | | | | | | |
| Personal hygiene score | 5.3±0.85[a] | 4.9±1.11[b] | 4.9±1.09[c] | 31.786 | 0.000* | a-b<br>a-c | 0.000<br>0.000 |
| Equipment hygiene score | 4.9±1.55[a] | 4.3±1.58[b] | 4.3±1.64[c] | 31.336 | 0.000* | a-b<br>a-c | 0.000<br>0.000 |
| Food hygiene score | 8.2±2.16[a] | 6.9±1.65[b] | 7.2±1.81[c] | 64.769 | 0.000* | a-b<br>a-c | 0.000<br>0.000 |
| Cross contamination score | 4.9±1.29[a] | 4.4±1.46[b] | 4.4±1.40[c] | 29.346 | 0.000* | a-b<br>a-c | 0.000<br>0.000 |
| Safe temperature score | 5.1±1.84[a] | 3.8±1.64[b] | 4.3±1.71[c] | 72.377 | 0.000* | a-b<br>a-c<br>b-c | 0.000<br>0.000<br>0.000 |
| *Total score* | 28.7±5.67[a] | 24.5±4.64[b] | 25.3±5.23[c] | 95.354 | 0.000* | a-b<br>a-c<br>b-c | 0.000<br>0.000<br>0.031 |
| **Food safety attitude score** | | | | | | | |
| Personal hygiene score | 2.6±1.19 | 2.5±1.21 | 2.6±1.26 | 2.118 | 0.121 | | |
| Equipment hygiene score | 3.1±1.19[a] | 2.9±1.25[b] | 2.9±1.26[c] | 5.924 | 0.003** | a-b<br>a-c | 0.047<br>0.008 |
| Food hygiene score | 5.9±2.00[a] | 5.4±1.95[b] | 5.3±1.99[c] | 21.166 | 0.000* | a-b<br>a-c | 0.000<br>0.000 |
| Cross contamination score | 0.52±0.51 | 0.55±0.51 | 0.58±0.53 | 2.747 | 0.064 | | |
| Safe temperature score | 2.3±1.18 | 2.1±1.22 | 2.2±1.18 | 1.605 | 0.201 | | |
| *Total score* | 14.6±4.05[a] | 13.5±4.15[b] | 13.6±4.30[c] | 11.654 | 0.000* | a-b<br>a-c | 0.001<br>0.000 |
| **Food safety behavior score** | 8.7±2.42[a] | 7.7±2.30[b] | 7.8±2.35[c] | 33.566 | 0.000* | a-b<br>a-c | 0.000<br>0.000 |

*p<0.001, **p<0.01. Tamhane T2 were conducted for *Food safety knowledge score* and all subgroups. Scheffe were conducted *Food safety behavior scores*, all subgroups and *Food safety attitude score*.

### *3.6. Regression model of food safety knowledge, attitude, and behavior scores according to BMI*

The regression model of food safety knowledge, attitude and behavior scores of the individuals according to BMI is given in *Table 5*. One point increase in FSKS, FSAS and FSBS decreased the BMI by 0.059, 0.167 and 0.071 points, respectively ($p<0.001$).

In this study, some information about food safety knowledge, attitude and behavior of a group of university students is presented. Previous studies have found that young adults deprived of important food safety information (Endres et al., 2001; Unklesbay et al., 1998). As stated in a new study on the food safety perceptions of university students (Vainioa et al., 2020), it is understood that today consumers still need to be informed about the types of food safety risks. In a recent study, university students who estimated their food safety knowledge to be good also had more scores of correct answers. Experience of food safety education statistically correlated positively with a higher number of correct answers to the knowledge questions (Marklinder et al., 2020). Although young adults report food safety attitudes and practices relatively more positively, this could not correspond to real safe food processing practices (Byrd-Bredbenner et al., 2007). The generally accepted idea is that young adults often enter unsafe food behaviors (Chuang et al., 2021; Burke et al., 2016; Osaili et al., 2011; Morrone and Rathburn, 2003). Considering that incorrect food processing behaviors are the most important cause of foodborne diseases (Wang et al., 2021), the important point here is that: it is not enough to have food safety knowledge, it is important that this information could change attitudes and be reflected in behaviors.

***Table 5. The regression model of food safety knowledge, attitude and behavior scores of the individuals according to BMI***

| | β | SE | t | p |
|---|---|---|---|---|
| FSKS[a] | -0.059 | 0.014 | -4.338 | 0.000* |
| FSAS[b] | -0.167 | 0.031 | -5.316 | 0.000* |
| FSBS[c] | -0.071 | 0.018 | -3.873 | 0.000* |

*p<0.001, [a]*FSKS:Food safety knowledge score,* [b]FSAS: *Food safety attitude score,* [c]FSBS: *Food safety behavior scores*

In order to develop effective strategies to reduce foodborne diseases, it is important to understand in detail the main reasons affecting consumer behavior (Wang et al., 2021) related to all food handling processes such as food cleaning, disinfecting, thawing, cooking, cooling and reheating. There are opinions that food safety knowledge can have a direct positive effect on behaviors or indirectly affect behaviors by changing attitudes (Kwol et al., 2020). In a study conducted with university students living in residence halls, a positive relationship was found between food safety knowledge and attitude, but no significant relationship was found with behavioral scores (Obande and Young, 2020). It has been reported that some education programs can significantly increase food safety knowledge and positively affect food safety behaviors (Marklinder et al., 2020). However, it is widely defended that the direct relationship between food safety knowledge and food safety behavior is weak and that the increase in food safety knowledge and behavior change are not always parallel (Kwol et al., 2020; Rossi et al., 2017). In a study in which the relationship between food safety knowledge, attitude and practices was investigated by structural modeling, a statistically significant relationship was found between knowledge and attitude. In addition, food safety knowledge and attitudes were found to significantly affect safe food preparation practices (Mihalache et al., 2021). Similarly, in this study, as food safety knowledge increases, attitudes and behaviors increase significantly (respectively, $r=0.513$, $r=0.433$, $p<0.001$). As food safety attitudes increases, behaviors increases significantly ($r=0.465$, $p<0.001$).

Food safety behaviors may differ according to gender, years of education and food safety knowledge level (Azanaw et al., 2021). In a study, women have high knowledge of food safety (7.66 versus 7.44 correct answers of 12 questions), but differences between men and women were not statistically significant (Marklinder et al., 2020). Although there are some studies stating that food safety knowledge and behaviors do not differ by gender (Marklinder et al., 2020; Unusan 2007), it is generally reported in the literature that women's food safety knowledge, attitudes and behaviors are better (Chuang et al., 2021; Moreb et al., 2017; Bearth et al., 2014; Mullan et al., 2015; Byrd-Bredbenner et al., 2007).Similar to previous findings in the literature, in this study, total food safety knowledge, attitude, and behavior scores were found to be statistically higher female than male students. The role of young women in the prevention of foodborne diseases is very important because of their future role as food preparers for household members (Byrd-Bredbenner et al., 2007; Subba Rao et al., 2009). Also, women have a great share in their children's learning of food safety information. In a recent study investigating the source of food safety information, 80% of students who chose "family and friends" as the primary food safety knowledge source stated that they learned food safety information from their mothers (Marklinder et al., 2020). Male students have been shown to be at significantly greater risk when handling potentially risky foods, reheating meals, and cleaning food contact surfaces. So much so that 65% of men stated that they thought that tasting raw ground beef

before cooking would not pose a risk (Lange et al., 2016). Similarly, in a study conducted with the students of the faculty of agriculture, it was shown that male students are at higher risk in food processing (Radulovic et al., 2021). Nevertheless, it is stated that training programs aimed at young men can be used to improve the food safety knowledge of men in order to eliminate this inequality between men and women.

In a study, significant correlation was shown between food safety knowledge score and education (Azanaw et al., 2021). Students' knowledge of food safety may increase over time as they have more learning opportunities. In a study found that university students aged 26 and older had a statistically significant higher knowledge of food safety compared to younger students (aged 18 to 25) (Chuang et al., 2021). In a study, it was determined that university students in 3rd and 4th grades had better attitudes about food safety compared to 1st and 2nd grade university students. It has been stated that the education given at the university is effective in raising awareness about food safety and changing behavior among young people (Radulovic et al., 2021). In another study, no statistically significant difference was found between the food safety knowledge level of university students in the 18-30 age group and adults in the 31-64 age group (Marklinder et al., 2020). Perhaps, the food safety education that young individuals will receive at the university "under the roof of a school" before they start working life will be more permanent in their memories as a wealth of knowledge that will be used throughout their lives.

It was found that total food safety knowledge, attitude and behavior scores were significantly higher in the students who were educated in the field of health (food science, nutrition and dietetics, doctors, nurses) according to others in the study. This result is not surprising since students studying in health-related departments of the universities have received information on food safety, supporting findings were also obtained in a recent study (Smigic et al., 2021). Experienced in food safety education and practice has been associated with a higher food safety knowledge score (Chuang et al, 2021; Smigic et al., 2021; Marklinder et al., 2020), which highlights the importance of educational initiatives among young adults in terms of food safety. In a systematic review of research conducted in developed countries, it was found that various food safety education interventions were effective in improving consumer knowledge, attitudes and behaviors in different contexts (Young et al., 2015). One of the examples of effective food safety education interventions targeting young adult populations is a multi-faceted social marketing campaign on university campuses (Abbot et al., 2012), and the other is a visual and instructive message on salmonellosis prevention (Trifiletti et al., 2012).

To our knowledge, there is no detailed study on the relationship between body mass index and food safety knowledge, attitude, and behaviors. In this study, all food safety scores of students in the obese group were significantly lower than other BMI groups. Based on this result, it may be say that the awareness of food safety of obese students is much less than those of normal weight and underweight students.

## 4. Conclusions

The basic information and practices of food safety of the society should be evaluated in order to prevent both health risks and economic losses caused by foodborne diseases. It is important to develop recommendations for the solution of the current problems. The data obtained from this study showed that food safety education is still needed in the target group, especially male students, obese students, and students studying science, social and engineering. The school and university environment will be the best places for an effective food safety training program giving information about personal hygiene, equipment hygiene, food hygiene, prevention of cross contamination, safe temperature applications to food as well as foodborne diseases and other factors contributing to prevention strategies. It will not only be sufficient to give education, but also to make efforts to internalize this information and to reflect it on behaviors.

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