



A Study on the Mediating Role of Food Safety Attitudes in the Transformation of Food Handlers' Knowledge into Behaviors in Hospital Food Service

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HIGHLIGHTS

- Higher food safety knowledge leads to improved attitudes and behaviors
- Food handlers in production sector show higher safety behavior than in service
- Knowledge directly impacts food safety behavior in hospital food handlers

Abstract

(1) Background: The aim of this study is to examine the food safety knowledge, attitudes, and behaviours of food handlers in hospital food service system. (2) Methods: A total of 215 food handlers participated in the study. The researchers asked the participants questions with a questionnaire including demographic data and food safety knowledge, attitudes, and behaviours. The researchers used the SPSS Process Macro 4.0 (Model 4) to determine whether participants' food safety attitudes play a mediating role in how their knowledge levels turn into behaviour and SPSS software for statistical analysis. (3) Results: Most male and female employees in this study (78.5% and 66.0%, respectively) worked in the production department ($p<0.05$). As the participants' food safety knowledge score increased, their attitude ($r=0.378$, $p<0.001$) and behaviour ($r=0.304$, $p<0.001$) scores also increased significantly. Food handlers working in the production sector demonstrated significantly higher food safety behaviours scores than those in the service sector (OR=0.747, 95% CI: 0.560-0.997). Although knowledge significantly predicted both attitudes ($p<0.001$) and behaviours ($p=0.003$), food safety attitudes did not mediate the relationship between knowledge and behaviour (indirect effect: $\beta=0.034$, 95% CI: -0.001 to 0.074). (4) Conclusions: Turning accurate knowledge into attitudes and behaviours will help food handlers in hospital to produce and serve safe food and facilitate the access of patients to safe food. Future studies should use larger samples and longitudinal or observational designs to better understand the mechanisms underlying behavioural change.

Keywords: Food safety; Food hygiene; Food safety knowledge; Food handlers

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1. Introduction

Food safety refers to the assurance that when an individual prepares and/or eats food according to its intended use, it will not harm to his/her health or will not create adverse health effects (Alimentarius 2020). Given its critical role in public health, food safety has become an issue of increasing global concern, affecting population worldwide (Gizaw 2019). However, when food safety regulations are not properly followed during processing, microbial contamination can occur, which in turns leads to foodborne diseases (Malavi et al. 2021).

Foodborne diseases affect one in 10 people worldwide. Every year, more than 600 million people contract foodborne diseases and 420.000 people lose their lives from consuming contaminated food (WHO 2023). The World Health Organisation (WHO) has identified five components to ensure that individuals have access to safe food: following hygiene rules, preventing the contamination of raw and cooked food, storing food at the appropriate temperature, obtaining water from clean sources for food processing, and using safe raw materials (Todd 2020; Onyeaka et al. 2021).

Food handlers play an important role in food safety during the production and service of food, and any error can lead to foodborne diseases (McFarland et al. 2019). The majority of foodborne diseases are caused by improper food processing practices, health problems among food handlers, and a lack of hygiene among food handlers (Angelo et al. 2017). Therefore, structured training programmes that enhance food handlers' knowledge and promote safe on the job practices are recognised as effective strategies to reduce the incidence of foodborne diseased (Young et al. 2019a). Given the critical influence of food handlers on food safety outcomes, understanding the factors that shape their knowledge and behaviours has become increasingly important.

Previous research indicates that food safety knowledge can directly affect food safety attitudes and can have direct and indirect effects on behaviour. Although it has been reported that individuals' behaviours depend on their knowledge and attitudes and behaviours can improve as knowledge levels rise, it is also suggested that knowledge levels cannot be effective on behaviour and attitude (Sanlier and Baser 2020). Moreover, several studies highlight that food handlers often possess inadequate knowledge and demonstrate limited adherence to safe practices (Hamed and Mohammed 2020; Aljasir 2023). These inconsistencies underline the need to examine how knowledge, attitudes, and behaviours interact and reinforce the importance of continuous and targeted training programmes to prevent foodborne diseases (Young et al. 2019a; Disanto et al. 2020; Ali et al. 2022).

Hospital food service systems function under special circumstances where vulnerable populations—such as the elderly, immunocompromised, or clinically fragile patients—are at a markedly increased risk of foodborne infections, in contrast to restaurants, school cafeterias, or other commercial food service environments. Therefore, even minor errors in food safety practices can lead to more serious consequences in hospitals than in other settings. Previous studies carried out in restaurants or institutional catering report varying degrees of food safety knowledge and inconsistent adherence to safe practices due to variations in workflow, hygienic procedures, organizational structure, and patient-specific requirements. In this regard, assessing hospital food handlers' knowledge, attitudes, and behaviours about food safety provides a crucial and underexplored perspective. Moreover, the knowledge-attitude-behaviours pathway examined in this study is conceptually supported by the Theory of Planned Behaviour (TPB), which proposes that individuals' behavioural intentions and actions are shaped by knowledge, attitude, and perceived control (Efendioglu et al. 2023). TPB-based models indicate that food safety knowledge alone may not directly predict behavioural intentions but instead influences behaviour indirectly by shaping attitudes and perceived behavioural control, highlighting the importance of motivational and cognitive factors in health-sensitive contexts (Mucinhato et al. 2022).

Given this information, food handlers who work in food service system and have contact with food have been considered to hold great importance in ensuring food safety and implementing the principles of healthy nutrition. In Türkiye, hospital food service systems are predominantly operated by contracted catering companies, where staff often differ in educational background and may receive inconsistent training, making

it essential to evaluate their food safety competencies within this specific national context. Accordingly, the aim of this study is to examine the food safety knowledge, attitudes, and behaviours of individuals who work in hospital food production and service.

2. Materials and Methods

2.1. Research design, protocol approvals and subject characteristics

The Ankara Medipol University (AMU) Non-Interventional Ethics Committee granted the required approval for the project, which was designed in compliance with the Declaration of Helsinki (27/11/2023, Decision Number: 158). The researcher collected data from volunteer subjects through face-to-face interview technique. The data collection technique was a questionnaire about demographic characteristics and food safety related to knowledge, attitudes, and practice was developed based on items reported in previous studies conducted among food (Ko 2013; Faour-Klingbeil et al. 2015; Liu et al. 2015; Kunadu et al. 2016; Moreb et al. 2017). Given the descriptive and information-based nature of the items, this tool has been used as a structured assessment tool rather than a psychometric scale. To ensure clarity and content appropriateness, the researchers firstly conducted a pilot study with 30 individuals and revised the questions that were not fully comprehended. The researchers then handed out the questionnaires to the participants, and it took approximately 15 minutes for them to complete the questionnaires. Each participant signed a consent form indicating that they agreed to participate voluntarily, in accordance with the Declaration of Helsinki (World Medical Association), and then completed the questionnaires.

To determine the appropriate sample size, G*Power 3.1 software was used. Based on an anticipated medium effect size ($f^2 = 0.15$), a power level of 0.95, and an alpha level of 0.05, the required sample size was calculated as $N = 145$ for regression analysis. Participants were recruited using a non-probability convenience sampling method, as data were collected from food handlers who were available during the study period and voluntarily agreed to participate. However, to increase representativeness and account for potential non-responses, data was collected from 222 participants.

2.2. Study design

Initially, 215 individuals (M=121, F=94) aged 19-65 years participated in the study. All participants were informed about the study at the beginning and volunteers were included in the study. A total of 222 individuals (126 men and 96 women) initially participated in the study. However, individuals who refused to continue were excluded from the study and incomplete forms were excluded from the evaluation and the study was completed with 215 individuals.

Individuals who did not volunteer to participate in the study and were not personnel of public nutrition systems and were not in contact with food were excluded.

There were four main topics in the study. These were:

- (1) Demographic data questionnaire (age, gender, educational level, the institution, length of employment in the food service system) (9 statements)
- (2) Food Safety Knowledge (13 questions)
- (3) Food Safety Attitude (13 statements)
- (4) Food Safety Practices (11 statements)

The questions on the questionnaire, designed to assess individuals' knowledge, attitudes, and behaviours was developed based on items reported in previous studies conducted among food handlers and were classified under four sub-headings: personal hygiene, food hygiene, equipment hygiene, and legal practices. As in the previous studies, considering the descriptive and information-based nature of the items, this tool has been used as a structured assessment tool rather than a psychometric scale (Ko 2013; Faour-Klingbeil et al. 2015; Liu et al. 2015; Kunadu et al. 2016; Moreb et al. 2017).

2.3. Demographic Data

The participants' demographic information, such as age, gender, marital status, educational level and their professional position for place of work, department, and length of service were questioned.

2.4. Food Safety Knowledge

The researchers assessed the participants' knowledge levels about food safety by asking them knowledge questions. In the section consisting of a total of 13 questions, the correct answer was assessed as 1 point and incorrect answer was assessed as 0 point according to the answers given to the questions. The total score of this section ranges from 0 to 13 points (Faour-Klingbeil et al. 2015).

2.5. Food Safety Attitude

The third section assesses the participants' food safety attitudes. This section consists of thirteen statements. The researchers scored the answers to the statements as follows: agree = 1, disagree = 0, and have no idea = 0. The reverse-scored items are 3, 4, 10, and 13, and the total score of this section ranges from 0 to 13 (Liu et al. 2015).

2.6. Food Safety Practices

The fourth and final section assesses the participants' behaviours towards food safety and consists of a total of 11 statements. The researchers scored the assessment as follows: agree = 1, disagree = 0, and have no idea = 0. Questions 3, 5, and 11 are reverse-scored. The total score of this section ranges from 0 to 11 (Ko 2013; Kunadu et al. 2016; Moreb et al. 2017).

2.7. Statistical Analysis

The researchers determined each participant's percentage of correct answers to the food safety knowledge questions and attitude and behaviour statements, and considered participants with more than 70% correct answers to have achieved a pass rate. The participants were considered to have a good level of knowledge, attitude, or behaviour if they achieved a pass rate of 70.0% or higher (Moreb et al. 2017).

The SPSS (IBM SPSS Statistics 26) packaged software was used for statistical analyses. The mean and standard deviation were used to summarize quantitative variables, whereas frequencies and percentages were used to portray qualitative variables. The χ^2 (Chi-square) test was performed to analyze categorical variables. Normality of the quantitative variables was assessed using the Kolmogorov-Smirnov test due to the sample size being greater than 50. Accordingly, parametric tests (Student's t-test, one-way ANOVA) or non-parametric tests (Mann-Whitney U, Kruskal-Wallis) were applied for comparisons of quantitative variables according to the distribution of the data. Moreover, Pearson correlation analysis was used for normally distributed data, and Spearman rank correlation was used for non-normally distributed data to assess the relationships between variables.

The bootstrapping method in the SPSS Process Macro 4.0 programme (Model 4) was used to analyse the mediating role of food safety attitudes in turning participants' food safety knowledge levels into behaviours (Baron and Kenny, 1986; Hayes, 2017). This model requires that the correlation between the independent variable and the mediator (path a), between the mediator and the dependent variable (path b), and between the independent and dependent variables (path c) be statistically significant (Preacher and Hayes 2008). The statistical significance value was considered as $p < 0.05$.

3. Results

Table 1 shows the distribution of demographic data of the participants according to their employment in production and service departments. 56.3% of the participants were male and 43.7% were female. The majority of male and female participants (78.5% and 66.0%, respectively) worked in the production department, and this difference was statistically significant ($\chi^2(1, N = 215) = 4.23, p = 0.040$). Moreover, the majority of those who worked in the production department were male, while the majority of those who worked in the service department were female. The half of the participants (51.2%) were 31–45 years old and the distribution of age

groups differed significantly between production and service staff ($\chi^2(2, N = 215) = 6.46, p = 0.040$); more than half (67.9%) of them held secondary and high school degrees; and most of them (73.0%) worked in the private sector. While 65.6% of the participants were working for less than 10 years, 34.4% were working for 10 years or more. 66.7% and 85.1% of those who had been working for less than 10 years and 10 years or more, respectively, worked in the production department, and this difference was statistically significant ($\chi^2(1, N = 215) = 8.40, p=0.004$).

Table 1. Distribution of Demographic Data of the Participants (n= 215)

Demographic Data	Production n (%)	Service n (%)	Total n (%)	P
Gender				
Male	95 (78.5)	26 (21.5)	121 (56.3)	0.040*
Female	62 (66.0)	32 (34.0)	94 (43.7)	
Age (year)				
19-30	41 (65.1)	22 (34.9)	63 (29.3)	0.040*
31-45	79 (71.8)	31 (28.2)	110 (51.2)	
46-65	37 (88.1)	5 (11.9)	42 (19.5)	
Marital Status				
Married	121 (77.6)	35 (22.4)	156 (72.6)	0.015*
Single	36 (61.0)	23 (39.0)	59 (27.4)	
Educational Level				
Primary School	19 (86.4)	3 (13.6)	22 (10.2)	0.278
Secondary and High School	106 (72.6)	40 (27.4)	146 (67.9)	
Bachelor's Degree	32 (68.1)	15 (31.9)	47 (21.9)	
Place of Work				
Public sector	41 (70.7)	17 (29.3)	58 (27.0)	0.639
Private sector	116 (73.9)	41 (26.1)	157 (73.0)	
Duration of working				
< 10 years	94 (66.7)	47 (33.3)	141 (65.6)	0.004**
10 years and more	63 (85.1)	11 (14.9)	74 (34.4)	

* $p < 0.05$, ** $p < 0.01$, Pearson χ^2

The food safety knowledge mean scores of the participants were 9.3 ± 2.03 , while the mean scores of those who worked in the production and service departments were 9.4 ± 2.07 and 9.1 ± 1.90 , respectively, and this difference was not statistically significant ($p > 0.05$). 50.7% of the total participants exceeded the pass rate. Moreover, the pass rate of the handlers who worked in the production department (52.9%) was higher than the pass rate of those who worked in the service department (44.8%) ($p > 0.05$) (Table 2). The highest pass rate in the questions on food safety knowledge of the participants (Table 2) was 95.8% and belonged to "know that frozen foods should not be frozen again after being thawed, while the lowest pass rate was 27.0% and belonged to the question 'appropriate storage temperature required for dry food storage'. 58.0% and 34.5% of those who worked in the production and service sectors, respectively knew that HACCP is a method used for hazard analysis and critical control points of ($p < 0.01$), and 89.8% and 79.3% respectively knew the safest way to thaw frozen raw meat ($p < 0.05$). Furthermore, the majority of the participants (80%) knew that there was an applicable food law in Türkiye. Nearly half of the participants (56.7%) also knew that it is not safe to touch food if their hands have open wounds (Table 2).

Table 2. Distribution of Food Safety Knowledge Level (n=215)

	Food Safety Knowledge	Production n (%)	Service n (%)	Total n (%)	P
Legal Practice	1. Is there an applicable food law in our country?	127 (80.9)	45 (77.6)	172 (80.0)	0.591
	2. Is HACCP a method used for hazard analysis and critical control points?	91 (58.0)	20 (34.5)	111 (51.6)	0.002*
Food Hygiene	3. Is it possible to kill bacteria in food by freezing at -18 °C?	65 (41.4)	31 (53.4)	96 (44.7)	0.115
	4. Is it possible to freeze the frozen food again for use after being thawed?	150 (95.5)	56 (96.6)	206 (95.8)	0.743

	5. Which of the following is the safest way to thaw frozen raw meat?	141 (89.8)	46 (79.3)	187 (87.0)	0.042*
	6. What happens to unserved leftover food?	107 (68.2)	43 (74.1)	150 (69.8)	0.396
	7. What is the appropriate storage temperature for dry foods?	50 (31.8)	8 (13.8)	58 (27.0)	0.008**
	8. What do you think is the best way to avoid food poisoning?	121 (77.1)	40 (69.0)	161 (74.9)	0.224
	9. Which of the following is true about food poisoning?	146 (93.0)	54 (93.1)	200 (93.0)	0.978
Equipment Hygiene	10. Which of the following is the proper way to clean the kitchen counter and stove?	139 (88.5)	48 (82.8)	187 (87.0)	0.264
	11. A person chops vegetables with a knife and then wants to process meat with this knife. Which of the following is the correct way?	141 (89.8)	52 (89.7)	193 (89.8)	0.974
Personal Hygiene	12. Is it safe to touch food if someone sustains an open wound on his/her hand?	87 (55.4)	35 (60.3)	122 (56.7)	0.517
	13. People with which of the following symptoms are not suitable for cooking?	111 (70.7)	47 (81.0)	158 (73.5)	0.128
Total Score ($\bar{x} \pm SD$)		9.4±2.07	9.1±1.90	9.3±2.03	0.263
Pass Rate (%)		52.9	44.8	50.7	0.295

* $p < 0.05$, ** $p < 0.01$, Pearson χ^2 ; Independent t-test

Food safety attitudes were summarised by domain and were similarly high across production and service staff (Figure 1). The mean score of the handlers who worked in the production department was 11.3 ± 1.29 and the pass rate was 89.8%, while the mean score of the handlers who worked in the service department was 11.5 ± 1.19 and the pass rate was 94.8% ($p > 0.05$). The pass rate in food safety attitude statements was 91.2% for all participants (Supplementary 1).

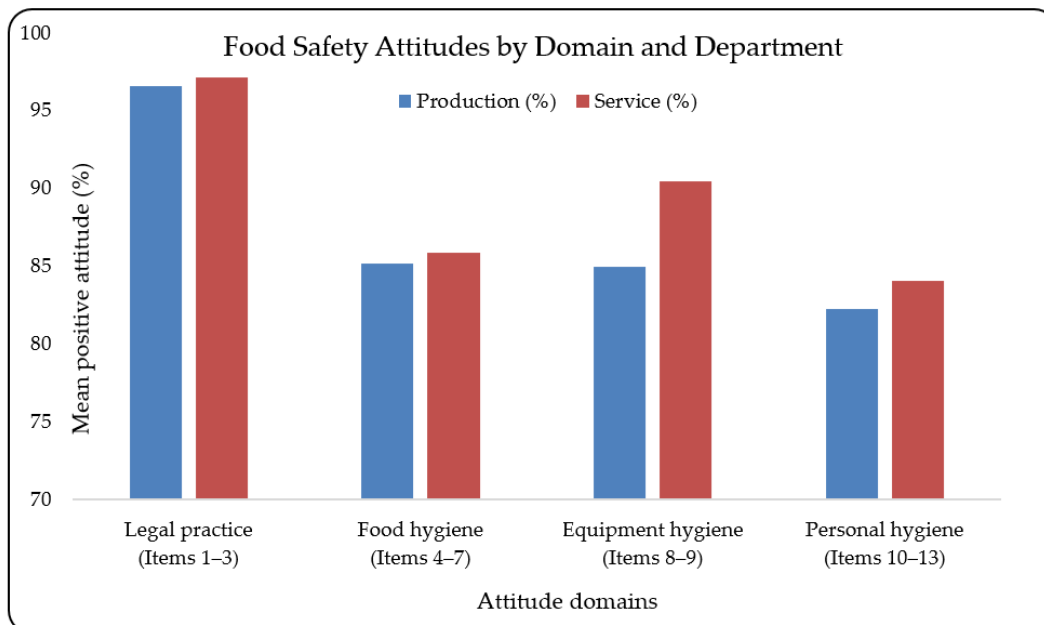


Figure 1. Food safety attitude domains by department. Bars represent the mean percentage of positive responses within each attitude domain (Legal practice: items 1–3; Food hygiene: items 4–7; Equipment hygiene: items 8–9; Personal hygiene: items 10–13) for production and service staff.

The food safety practice mean scores of the participants were 8.8 ± 1.08 . The mean scores were 8.9 ± 1.04 and 8.6 ± 1.17 for those who worked in the production and service sectors, respectively; this difference was statistically significant ($p < 0.05$). The pass rate for the questions on food safety practices was 88.8% for all participants and 89.8% and 86.2% for those who worked in the production and service sectors, respectively; this difference was not statistically significant ($p > 0.05$) (Table 3). The highest pass rate in this section was washing hands before cooking or serving food, which accounted for 100% of the participants. 7.6% of those who worked in the production sector and 22.4% of those who worked in the service sector had not kept replicate samples in daily storage for 72 hours ($p < 0.01$). 61.8% of those who worked in the production sector and 36.2% of those who worked in the service sector had not thawed frozen food at room temperature ($p < 0.01$). 92.4% of those who worked in the production sector and 82.8% of those who worked in the service sector avoided using the same kitchen utensils when processing raw and cooked foods ($p < 0.05$) (Table 3).

Table 3. Distribution of Food Safety Practices (n=215)

	Food Safety Practices	Production n (%)	Service n (%)	Total n (%)	P
Legal Practice	1. I usually follow the HACCP plan to ensure food safety.	122 (77.7)	41 (70.7)	163 (75.8)	0.286
	2. I store replicate samples in daily storage for 72 hours.	12 (7.6)	13 (22.4)	25 (11.6)	0.003**
Food Hygiene	3. I thaw frozen food at room temperature.	97 (61.8)	21 (36.2)	118 (54.9)	0.001**
	4. I check the shelf life of food products before handling them.	152 (96.8)	57 (98.3)	209 (97.2)	0.564
	5. I check the packaging for integrity before handling food products.	150 (95.5)	57 (98.3)	207 (96.3)	0.347
Equipment Hygiene	6. Before preparing food, I wash the surfaces that come into contact with food, such as cutting boards, tables, and knives, with antibacterial soap.	136 (86.6)	49 (84.5)	185 (86.0)	0.688
	7. I use the same kitchen utensils when handling raw and cooked food.	145 (92.4)	48 (82.8)	193 (89.8)	0.039*
Personal Hygiene	8. I wash my hands before cooking or serving food.	157 (100)	58 (100)	215 (100)	nc
	9. I neither cook nor serve food when I am ill.	124 (79.0)	42 (72.4)	166 (77.2)	0.308
	10. When I cough or sneeze, I always use disposable tissues and wash my hands immediately thereafter.	155 (98.7)	56 (96.6)	211 (98.1)	0.295
	11. After washing my hands with soap, I turn off the faucet without touching it.	144 (91.7)	54 (93.1)	198 (92.1)	0.739
Total Score ($\bar{x} \pm SD$)		8.9 ± 1.04	8.6 ± 1.17	8.8 ± 1.08	0.049*
Pass Rate (%)		89.8	86.2	88.8	0.457

* $p < 0.05$, ** $p < 0.01$, Pearson χ^2 ; Mann-Whitney U

nc: not calculated (The p-value was not calculated because the rates were the same)

As the participants' ages increased, their working time and food safety knowledge scores rose, and the correlation was significant (respectively: $r = 0.508$, $r = 0.173$, $p < 0.05$), whereas behaviour scores decreased ($p > 0.05$). As the participants' food safety knowledge scores increased, their attitude and behaviour scores also increased significantly (respectively: $r = 0.378$, $r = 0.304$, $p < 0.05$). Also, as the participants' food safety attitude scores increased, their behaviour scores also increased significantly ($r = 0.214$, $p < 0.05$) (Table 4).

Table 4. The relationship between individuals’ food safety knowledge, attitude and behaviour scores and age and duration of working (r)

		Age	Duration of working	Knowledge	Attitude	Behaviour
Age	r	1				
	P					
Duration of working	r	0.508				
	p	0.000**				
Knowledge	r	0.173	0.065			
	p	0.011*	0.345			
Attitude	r	0.060	-0.002	0.378		
	p	0.381	0.975	0.000**		
Behaviour†	r	-0.117	0.212	0.304	0.214	1
	p	0.086	0.002*	0.000**	0.002*	

*p<0.05, ** p<0.001, Pearson correlation test, †Spearman rank correlation test

In this study, it was found that the food safety behaviour score of those who worked in the production sector was 0.747 times higher than those who worked in the service sector (p<0.05) (Table 5).

Table 5. The effect of individuals’ working place in the food sector on their food safety knowledge, attitude, and behaviour

	B	OR	95% CI	p-Value
Knowledge	-0.107	0.899	0.760-1.063	0.211
Attitude	0.258	1.295	0.984-1.704	0.065
Behaviour	-0.291	0.747	0.560-0.997	0.048*

*p<0.05, Binary logistic regression

When examining the mediating effect of food safety attitudes on the effect of food safety knowledge levels of the food handlers on behaviour related to food safety, no mediating effect of attitude on the effect of knowledge levels on behaviour was found ($\beta=0.034$, 95% CI: [-0.001, 0.074]; **Figure 2.**).

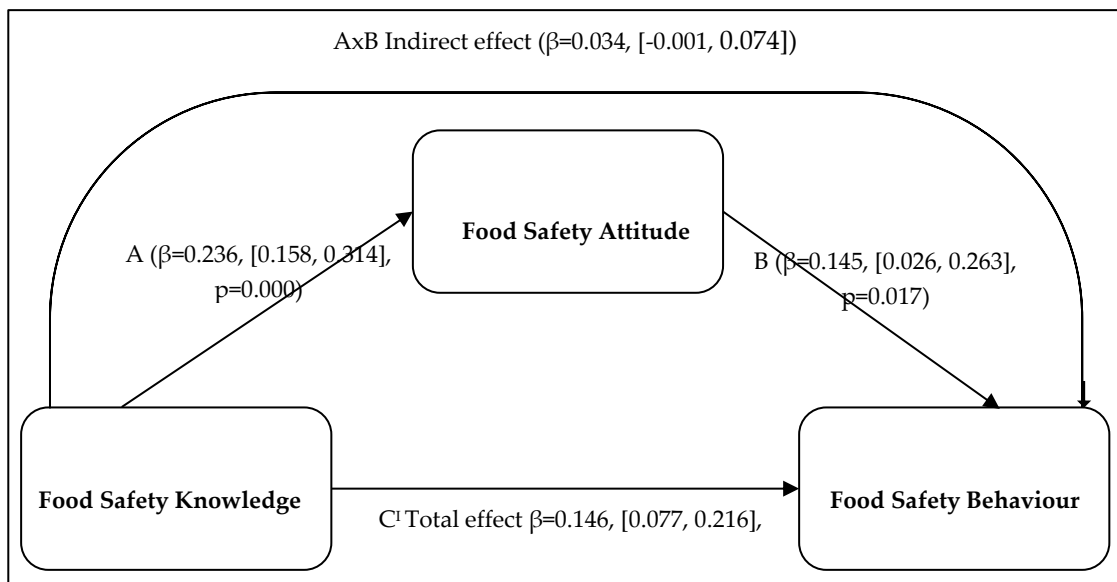


Figure 2. The mediating role of individuals’ food safety attitude in the effect of their knowledge level on behaviour

On the other hand, the direct effect of the knowledge level of food handlers on behaviour was statistically significant ($\beta=0.112$, 95% CI [0.038, 0.187]; p=0.003). The effects of food safety knowledge levels on food safety attitudes ($\beta=0.236$, 95% CI: [0.158, 0.314]; p<0.001) and the effects of food safety attitudes on behaviour ($\beta=0.145$, 95% CI: [0.026, 0.263]; p=0.017) of the same group were statistically significant (Table 6).

Table 6. The mediating role of individuals' food safety attitude in the effect of knowledge levels on behavior

Path		β	Standard error	p	95% CI	R ²
A	Knowledge→Attitude	0.236	0.040	0.000**	[0.158, 0.314]	0.143
B	Attitude→Behaviour	0.145	0.060	0.017*	[0.026, 0.263]	
C	Knowledge→Beheviour	0.112	0.038	0.003*	[0.038, 0.187]	0.099
	Direct effect					
C ^I	Knowledge → Beheviour	0.146	0.035	0.000**	[0.077, 0.216]	0.075
	Total etki					
A x B	Knowledge → Beheviour	0.034	0.019		[-0.001, 0.074]	
	Indirect effect					

R²: Adjusted coefficient of determination β : Regression coefficient

SE: Standard error

95% CI: Bias corrected and accelerated intervals

** p<0.001

* p<0.05

4. Discussion

This study showed that food knowledge was positively associated with both attitudes and behaviours, and production staff demonstrated higher behavioural scores than service staff. The mediation analysis revealed that attitudes did not significantly mediate the effect of knowledge on behaviours, even though attitudes and behaviours were also related. Instead, knowledge directly predicted behaviour, suggesting that behavioural improvements may occur independently of attitudinal change in hospital setting.

The pass rate of the handlers who worked in the production department (52.9%) on food safety knowledge questions was found to be higher than the pass rate of those who worked in the service department (44.8%) ($p>0.05$). Moreover, 50.7% of the total participants had adequate levels of food safety knowledge (Table 2). Similar studies have indicated inadequate knowledge on safe food processing and general hygiene among handlers in traditional food processing and supply chains in low- and middle-income countries (Fariba et al. 2018; Abdi et al. 2020; Makhunga et al. 2023). The complexity of the food chain and increasing global food safety concerns have highlighted the necessity of food safety laws and integrated management systems such as ISO 22000, HACCP, and ISO 9001:2000. In this study, 80% of participants knew that there is an applicable food law in Türkiye, and production staff (58.0%) knew much more about HACCP than service staff did (34.5%) ($p<0.01$) (Table 2). The knowledge of food quality and safety has been shown to improve after organisations have implemented HACCP system methods (Chen et al. 2022; Radu et al. 2023). The safest way to thaw frozen raw meat was mostly known (89.8% and 79.3%, respectively) by participants who worked in production and service ($p<0.05$). In a study, it was found that 38.2% of the participants knew the correct answer for thawing raw meat (Gong et al. 2016). 31.8% and 13.8% of the staff who worked in the production and service areas, respectively, knew the appropriate temperature for the storage of dry foods ($p<0.01$). This study also revealed that the food safety behaviour score of those who worked in the production sector was 0.747 times higher than those who worked in the service sector ($p<0.05$) (Table 5). This finding suggests that the handlers in the production department can be more effective in providing hygiene conditions (equipment hygiene, personnel hygiene, raw material hygiene, environmental hygiene, etc.) necessary for healthy and safe food production, as well as in identifying and eliminating factors that may pose a health hazard at the production and service levels.

Food handlers in this study showed generally positive attitudes toward food safety, with high adequacy levels in both production (88.8%) and service staff (94.8%) ($p>0.05$) (Supplementary 1). This pattern is consistent with earlier studies demonstrating high attitudinal endorsement of safe food-handling concepts despite varying levels of knowledge (Liu et al. 2015; Makhunga et al. 2023). Attitudes represent an important precursor to behavioural change, and the literature suggests that food handlers who hold more positive food safety attitudes and risk perceptions engage in safer food handling behaviours (Young et al. 2019a, 2019b).

However, conversely, Adetunji et al. (2018) found that food handlers who achieved high attitude scores lacked good practices, indicating that the knowledge they acquired would not always lead to the expected changes in their attitudes and practices. Behaviour scores were higher among production staff than service staff, which might be explained by their different job responsibilities and increased participation in food preparation procedures. While the majority of participants reported they avoided using the same utensils for raw and cooked foods, production staff were more likely to do so (92.4%) than service staff (82.8%) ($p < 0.05$) (Table 3), indicating that adherence to cross-contamination procedures varies. A study on the hand hygiene of food handlers in contact with food suggested that hand washing was the most effective and convenient way to eliminate pathogens on the hands. The findings from a similar study reported that almost all of the participants (90%) always washed their hands after touching waste/garbage or after using the toilet (Faour-Klingbeil et al. 2015). All of the participants in this study stated that they washed their hands before cooking or serving food. On the other hand, the persistence of some risky behaviours, like thawing food at room temperature, raises the possibility that positive attitudes may not be sufficient to ensure consistent and safe practices. This disparity suggests that, in addition to personal attitudes, structural factors like workload, supervision, and institutional safety culture may have an impact on behavioural performance in hospital settings.

As the participants' scores on food safety knowledge increased, their attitude and behaviour scores also increased significantly (respectively: $r = 0.378$, $r = 0.274$ $p < 0.05$). Also, as the participants' scores on food safety attitudes increased, their behaviour scores also increased significantly ($r = 0.248$ $p < 0.05$). These results consistent with previous findings indicating that individuals with greater knowledge or more positive attitudes toward food safety tend to exhibit better hygiene practices (Lestantyo et al. 2017; Akabanda et al. 2017; Legesse et al. 2017; Abdi et al. 2020). However, despite the associations, compared to much higher food attitude and behaviour scores, the relatively low knowledge level presented in this study suggests the ineffectiveness of food safety training programmes. An effective training programme on food safety knowledge should, at a minimum, include material on high-risk populations, safe storage temperature, and proper cleaning and hygiene procedures. It is difficult to implement and maintain a functional food safety system unless well-trained employees are aware of the importance of safety procedures in food processing.

Recent literature on food safety has emphasised the importance of understanding the behaviour of food service workers to initiate and promote food safety behaviours (De Boeck et al. 2019; Lin and Roberts 2020). This study also revealed that production staff had significantly higher knowledge of food safety laws and regulations ($p = 0.010$) and food hygiene behaviour ($p = 0.013$) than service staff. However, the difference between the knowledge, attitude, and behaviour scores on the equipment hygiene and personal hygiene was not statistically significant ($p > 0.05$), suggesting that institutional policies rather than job-specific tasks may have a uniform influence on certain practices (Supplementary 2).

The knowledge-attitude-behaviour pathway was shown in a more complex light by the mediation analysis. Higher knowledge levels of the food handlers significantly predicted more positive attitudes ($\beta = 0.236$; 95% CI: 0.158–0.314; $p < 0.001$) and better behavioural outcomes ($\beta = 0.145$; 95% CI: 0.026–0.263; $p = 0.017$). However, attitude had no mediating effect on the relationship between knowledge and behaviour, as indicated by the non-significant indirect effect ($\beta = 0.034$, 95% CI: [-0.001, 0.074]; Figure 2.). This implies that rather than coming from a shift in attitude, behavioural gains could come directly from knowledge. The findings of another study showed significant gaps in knowledge, attitudes, and practices related to safe food processing (Kunadu et al. 2016). Similar TPB-based findings have shown that even when attitudes strongly predict behavioural intentions, intentions do not always translate into actual behaviour, particularly when perceived control, resources, or institutional constraints limit behavioural execution (Bagheri et al. 2021). Moreover, previous research has shown that while attitudes may represent the strongest predictor of behavioural intention in crisis-driven or consumer-based contexts, such as during the COVID-19 pandemic, knowledge may exert a more direct effect on behaviour in highly regulated and protocol-driven environments (Mucinhato et al. 2022). In hospital food service system, routine practices are often dictated by institutional protocols rather than personal preferences, which may account for why certain behaviours are carried out appropriately even when attitudes are only somewhat favourable. This finding suggests that improving food safety performance focus

not only on strengthening knowledge but also on enhancing organisational structures that support consistent behavioural performance.

5. Conclusions

This study demonstrated that food safety knowledge, attitudes, and behaviours among hospital food handlers are closely interrelated. Knowledge levels were significantly associated with both attitudes and behaviours, and food handlers working in the production department exhibited higher behaviour scores than those in the service department. Although knowledge positively influenced attitudes and behaviours, attitudes did not mediate the relationship between knowledge and behaviour, highlighting the direct impact of knowledge on safe food handling practices. To minimise foodborne hazards significantly and to protect the consumer, it is necessary to control the contamination sources, whether technical or environmentally. Concordantly, any contamination in the food handler can be transmitted to food very quickly. Therefore, the awareness of the personnel should be raised first. To raise awareness, they should be trained on food safety and public health effectively and continuously. These trainings should be put into practice, repeated at regular intervals, and audited. In other words, the knowledge acquired should be turned into attitudes and behaviours, and procedures and processes should be checked regularly. Food handlers trained in hygiene and food safety must adhere to these principles and monitor their implementation in daily practice. Ultimately, food safety is not achieved only by the awareness of food staff and their adherence to hygiene rules. The food staff factor—the most crucial link in the food safety cycle—only fully achieves food safety when it collaborates with the other links in the chain in accordance with a common principle. It should be noted that achieving food safety requires teamwork. Education of all age groups and employees throughout life should be the duty of national administrations, ministries of health and education, the food industry, universities, formal and non-formal educational institutes, and all kinds of media to provide accurate information on food safety, avoid information pollution, and turn knowledge into attitudes, behaviours, and habits.

Limitation

The study has some limitations that should be considered when interpreting the results. The first is a relatively small sample size, which could restrict the generalisability of the results. Therefore, future research should use multi-center designs and larger, more varied samples—ideally employing stratified or probabilistic sampling to increase representativeness. Another limitation is the possibility of biased answers in the behavioural statements, while the participants may have been unbiased in answering the knowledge questions. Observational or mixed-method approaches may assist shed light on the mechanisms behind the knowledge-attitude-behaviours link in institutional food service contexts and offer a more thorough understanding of actual behaviours.

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References

- Abdi, A. M., Amano, A., Abraham, A., Getahun, M., Ababor, S., & Kumie, A. (2020). Food hygiene practices and associated factors among food handlers working in food establishments in the Bole Sub City, Addis Ababa, Ethiopia. *Risk Management and Healthcare Policy*, 13: 1861-1868. <https://doi.org/10.2147/RMHP.S266342>
- Adetunji, H., Baothman, M., Alserhan, F., Almunyif, A., Alsharbe, G., & Samaren, H. (2018). Knowledge, attitude, and practice (KAP) of personal hygiene among food handlers in the south region of Makkah, Saudi Arabia. *International Journal of Medical Research and Health Sciences*, 7(5): 96–102.
- Akabanda, F., Hlortsi, E. H., & Owusu-Kwarteng, J. (2017). Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana. *BMC Public Health*, 17: 1–9. <https://doi.org/10.1186/s12889-016-3986-9>
- Ali, S. W., Ahmad, M., Asif, M., Amir, R. M., & Ali, A. (2022). Assessment of food safety knowledge, attitude, practices of food handlers and microbial contamination in foods at the canteens of a University in Pakistan. *Italian journal of food safety*, 11(3), 10051. <https://doi.org/10.4081/ijfs.2022.10051>
- Alimentarius, C. (2020). *Codex Alimentarius General Principles of Food Hygiene CXC 1–1969*. Revision, 5: 2–6. Available at: https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fstandard.s%252FCXC%2B1-1969%252FCXC_001e.pdf [Accessed 10 February 2024]
- Aljasir, S. F. (2023). Food safety knowledge and practices among food handlers and consumers in Gulf countries: An integrative review. *Glob Public Health*, 18(1): 2287584. <https://doi.org/10.1080/17441692.2023.2287584>
- Angelo, K., Nisler, A., Hall, A., Brown, L., & Gould, L. (2017). Epidemiology of restaurant-associated foodborne disease outbreaks, United States, 1998–2013. *Epidemiol Infect*, 145(3): 523–534. <https://doi.org/10.1017/S0950268816002314>
- Bagheri, A., Emami, N., & Damalas, C. A. (2021). Farmers' behavior towards safe pesticide handling: An analysis with the theory of planned behavior. *Science of the total Environment*, 751: 141709. <https://doi.org/10.1016/j.scitotenv.2020.141709>
- Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6): 1173. <https://doi.org/10.1037//0022-3514.51.6.1173>
- Chen, H., Chen, Y. J., Yang, H. T., Hsu, K. C., Zhou, M., Chen, C. S., & Chuang, P. T. (2022). Implementation of food safety management systems that comply with ISO 22000: 2018 and HACCP: A case study of a postpartum diet enterprise in Taiwan. *Journal of Food Safety*, 42(2), e12965. <https://doi.org/10.1111/jfs.12965>
- De Boeck, E., Jacxsens, L., Vanoverberghe, P., & Vlerick, P. (2019). Method triangulation to assess different aspects of food safety culture in food service operations. *Food Research International*, 116: 1103–1112. <https://doi.org/10.1016/j.foodres.2018.09.053>
- Disanto, C., Celano, G., Dambrosio, A., Quaglia, N. C., Bozzo, G., Tritto, A., & Celano, G. V. (2021). Food safety in collective catering: knowledge, attitudes and correct application of GHP/GMP knowledge among foodservice workers. *Italian journal of food safety*, 9(4), 8453. <https://doi.org/10.4081/ijfs.2020.8453>
- Efendioğlu, İ. H., Akel, G., Elmasoğlu, K., Aydoğdu, D., & Koç, O. (2023). İnternet Alışverişlerinde Organik Gıda Satın Alma Niyetinin Planlı Davranış Teorisi Açısından İncelenmesi. *Alanya Akademik Bakış*, 7(3), 1241-1266. <https://doi.org/10.29023/alanyaakademik.1280289>

- Faour-Klingbeil, D., Kuri, V., & Todd, E. (2015). Investigating a link of two different types of food business management to the food safety knowledge, attitudes and practices of food handlers in Beirut, Lebanon. *Food Control*, 55: 166–175. <https://doi.org/10.1016/j.foodcont.2015.02.045>
- Fariba, R., Gholamreza, J. K., Saharnaz, N., Ehsan, H., & Masoud, Y. (2018). Knowledge, attitude, and practice among food handlers of semi-industrial catering: a cross sectional study at one of the governmental organization in Tehran. *Journal of Environmental Health Science and Engineering*, 16: 249–256. <https://doi.org/10.1007/s40201-018-0312-8>
- Gizaw, Z. (2019). Public health risks related to food safety issues in the food market: a systematic literature review. *Environmental Health and Preventive Medicine*, 24: 1–21. <https://doi.org/10.1186/s12199-019-0825-5>
- Gong, S., Wang, X., Yang, Y., & Bai, L. (2016). Knowledge of food safety and handling in households: A survey of food handlers in Mainland China. *Food Control*, 64: 45–53.
- Hamed, A., & Mohammed, N. (2020). Food safety knowledge, attitudes and self-reported practices among food handlers in Sohag Governorate, Egypt. *East Mediterr Health J*, 26(4). <https://doi.org/10.26719/emhj.19.047>
- Hayes, A. F. (2017). Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. *Guilford Publications*.
- Ko, W. H. (2013). The relationship among food safety knowledge, attitudes and self-reported HACCP practices in restaurant employees. *Food Control*, 29(1): 192–197. <https://doi.org/10.1016/j.foodcont.2012.05.076>
- Kunadu, A. P. H., Oforu, D. B., Aboagye, E., & Tano-Debrah, K. (2016). Food safety knowledge, attitudes and self-reported practices of food handlers in institutional foodservice in Accra, Ghana. *Food Control*, 69: 324–330. <https://doi.org/10.1016/j.foodcont.2016.05.011>
- Legesse, D., Tilahun, M., Agedew, E., & Haftu, D. (2017). Food handling practices and associated factors among food handlers in Arba Minch town public food establishments in Gamo Gofa zone, Southern Ethiopia. *Epidemiology (Sunnyvale)*, 7(2): 302. <https://doi.org/10.4172/2161-1165.1000302>
- Lestantyo, D., Husodo, A. H., Irvati, S., & Shaluhayah, Z. (2017). Safe food handling knowledge, attitude and practice of food handlers in hospital kitchen. *International Journal of Public Health Science*, 6(4): 324–330. <http://doi.org/10.11591/ijphs.v6i4.10778>
- Lin, N., & Roberts, K. R. (2020). The normative beliefs that form individual food safety behavioral intention: A qualitative explanatory study. *Food Control*, 110: 106966. <https://doi.org/10.1016/j.foodcont.2019.106966>
- Liu, S., Liu, Z., Zhang, H., Lu, L., Liang, J., & Huang, Q. (2015). Knowledge, attitude and practices of food safety amongst food handlers in the coastal resort of Guangdong, China. *Food Control*, 47: 457–461. <https://doi.org/10.1016/j.foodcont.2014.07.048>
- Makhunga, S. E., Macherera, M., & Hlongwana, K. (2023). Food handlers' knowledge, attitudes and self-reported practices regarding safe food handling in charitable food assistance programmes in the eThekweni District, South Africa: cross-sectional study. *BMJ Open*, 13(4): e065357. <https://doi.org/10.1136/bmjopen-2022-065357>
- Malavi, D. N., Abong, G. O., & Muzhingi, T. (2021). Effect of food safety training on behavior change of food handlers: A case of orange-fleshed sweetpotato purée processing in Kenya. *Food Control*, 119: 107500. <https://doi.org/10.1016/j.foodcont.2020.107500>
- McFarland, P., Checinska, Sielaff, A., Rasco, B., & Smith, S. (2019). Efficacy of food safety training in commercial food service. *Journal of Food Science*, 84(6): 1239–1246. <https://doi.org/10.1111/1750-3841.14628>
- Moreb, N. A., Priyadarshini, A., & Jaiswal, A. K. (2017). Knowledge of food safety and food handling practices amongst food handlers in the Republic of Ireland. *Food Control*, 80: 341–349. <https://doi.org/10.1016/j.foodcont.2017.05.020>

- Mucinhato, R. M. D., da Cunha, D. T., Barros, S. C. F., Zanin, L. M., Auad, L. I., Weis, G. C. C., ... & Stedefeldt, E. (2022). Behavioral predictors of household food-safety practices during the COVID-19 pandemic: Extending the theory of planned behavior. *Food Control*, 134, 108719. <https://doi.org/10.1016/j.foodcont.2021.108719>
- Onyeaka, H., Ekwebelem, O. C., Eze, U. A., Onwuka, Q. I., Aleke, J., Nwaiwu, O., & Chionuma, J. O. (2021). Improving food safety culture in Nigeria: a review of practical issues. *Foods*, 10(8), 1878.
- Preacher, K. J., & Hayes, A. F. (2008) Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 40(3): 879–891. <https://doi.org/10.3758/BRM.40.3.879>
- Radu, E., Dima, A., Dobrota, E. M., Badea, A. M., Madsen, D. Ø., Dobrin, C., & Stanciu, S. (2023). Global trends and research hotspots on HACCP and modern quality management systems in the food industry. *Heliyon*, 9(7). <https://doi.org/10.1016/j.heliyon.2023.e18232>
- Sanlier, N., & Baser, F. (2020). The relationship among food safety knowledge, attitude, and behavior of young Turkish women. *Journal of the American College of Nutrition*, 39(3), 224-234. <https://doi.org/10.1080/07315724.2019.1639084>
- Todd, E. (2020). Food-borne disease prevention and risk assessment. *International journal of environmental research and public health*, 17(14), 5129. <https://doi.org/10.3390/ijerph17145129>
- WHO. (2023). *World Health Organization: Food standards save lives*. Available at: <https://www.who.int/news-room/events/detail/2023/06/07/default-calendar/world-food-safety-day-2022-safer-food-better-health> [Accessed 10 February 2024]
- Young, I. A. N., Greig, J., Wilhelm, B. J., & Waddell, L. A. (2019). Effectiveness of food handler training and education interventions: A systematic review and meta-analysis. *Journal of food protection*, 82(10), 1714-1728. <https://doi.org/10.4315/0362-028X.JFP-19-108>
- Young, I., Thaivalappil, A., Waddell, L., Meldrum, R., & Greig, J. (2019). Psychosocial and organizational determinants of safe food handling at retail and food service establishments: a systematic review and meta-analysis. *International journal of environmental health research*, 29(4), 371-386. <https://doi.org/10.1080/09603123.2018.1544611>