



## Research article

# Food safety knowledge, attitudes, and practices among food handlers in collective catering in central Morocco

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## ABSTRACT

Food safety is a significant challenge for countries worldwide due to the growing number of food poisoning outbreaks, particularly in the catering sector, which impacts consumer health and imposes additional economic costs on countries. The role of food handlers in restaurants is crucial for guaranteeing this safety and protecting the health of citizens. This pioneering study in central Morocco aimed to assess food safety knowledge, attitudes, and practices (KAPs) among food handlers and to identify key factors influencing adequate knowledge, positive attitudes, and effective practices. A cross-sectional study was conducted among food handlers in restaurants in Fez prefecture in central Morocco between July 2021 and January 2022 using a questionnaire survey. The results revealed that the 282 food handlers included in this study exhibited moderate levels of knowledge (65.31 %) and practices (62.91 %), and a high level of attitudes (75.61 %) towards food safety. A moderate positive correlation was observed between knowledge and practices ( $r = 0.291$ ,  $p < 0.05$ ), as well as between attitudes and practices ( $r = 0.327$ ,  $p < 0.05$ ). The most significant positive correlation was between knowledge and attitudes ( $r = 0.907$ ,  $p < 0.05$ ). Moreover, professional experience and age significantly influenced the level of knowledge; the nature of job and work experience influenced attitudes; gender, education level, nature of work, and marital status influenced the level of practices; and training impacted them all. Nevertheless, those surveyed have knowledge gaps, particularly about cross-contamination, personal hygiene, time and temperature control, especially the temperature danger zone (between 40 °F and 140 °F), and thawing. Training programmes that emphasize these dimensions of food safety need to be implemented. The findings of this study, carried out for the first time in Fez, will provide a solid basis for further research. They will also assist responsible authorities in better understanding food safety in Morocco by selectively planning food safety training based on KAPs to prevent food poisoning and protect consumer health.

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## 1. Introduction

Food safety remains a major concern both in developed and developing countries, given that foodborne diseases (FBDs) impede socio-economic development by straining healthcare systems and harming national economies, tourism, and trade [1]. According to the World Health Organization (WHO) estimates, almost one in ten people falls sick annually after consuming food contaminated with pathogens, such as bacteria and/or their toxins, parasites, and viruses. This represents over 600 million disease cases and 420,000 deaths worldwide every year [2,3]. The African region is the most vulnerable to FBDs, with over 91 million cases and 137,000 deaths [4].

In Morocco, data from the national epidemiological surveillance and health information system show that: (a) 1000 to 1600 cases of food poisoning occur each year, with a hospitalization rate of 30–45 %; (b) 20–25 % of food service and retail establishments monitored by health services are at risk; and (c) prepared foods for consumers are handled or stored in inappropriate hygienic conditions that do not guarantee their safety and wholesomeness [5]. Moreover, the trend of eating out has recently grown in Morocco, as in many countries, necessitating food handlers in catering establishments to serve consumers safe and healthy food [6]. In this context, food handlers' knowledge of food safety is fundamental for preventing the spread of food-borne diseases, and their attitudes and behaviours influence perceptions of food safety [7]. Several studies on food safety knowledge, attitudes, and practices (KAPs) have been conducted in various countries of the world, such as Brazil [8], Iran [9], Egypt [10], United Arab Emirates (UAE) [11], Ireland [12], Ethiopia [13], Turkey [14], and Oman [15]. These studies revealed a lack of knowledge and inappropriate food safety practices among food handlers, which could contribute to epidemics, given their essential role in preventing foodborne illnesses and serving as the first line of defence in ensuring food safety [10].

Additionally, observed food safety practices among food handlers did not correlate with their food safety knowledge and self-reported practices [8]. Particularly unsatisfactory practices were observed in the thawing of frozen foods, the correct reheating of cooked foods, and the use of separate knives and cutting boards for raw and cooked foods [9]. Areas of concern primarily involved personal hygiene, cross-contamination, and health issues that could compromise food safety [14]. Therefore, identifying the levels of food safety KAPs among food handlers is crucial for detecting food safety issues, enhancing standards, and preventing foodborne diseases [8,9,16]. Given the growth of the Moroccan food sector, documented cases of food poisoning, and insufficient information on the KAPs of food handlers in Moroccan catering establishments, it is now imperative to collect this data to highlight deficiencies and develop strategies to improve food handler safety.

Therefore, this study, conducted for the first time, aimed to evaluate the knowledge, attitudes, and practices related to food safety among food handlers in collective catering settings in central Morocco. The study provided foundational data that will significantly contribute to developing targeted training programs for food handlers by public health authorities, aimed at increasing awareness of food risk prevention measures and reinforcing the foodborne disease surveillance system.

## 2. Materials and methods

### 2.1. Study design and location

A cross-sectional study was conducted from July 2021 to January 2022 in 22 selected catering establishments across different districts of Fez, Morocco. Face-to-face interviews and a semi-structured questionnaire were employed to assess the KAPs of food handlers. Fez prefecture (34° 2' 14" N/4° 59' 59" W) is situated in the Fez-Meknes region, between the northern and southern parts of the Kingdom of Morocco. It covers an area of 332.1 km<sup>2</sup> and has a population of approximately 1,150,131, making it the largest in the region. It is subdivided into two urban communes: the commune of Mechouar Fez Jdid and the commune of Fez, which includes six urban districts (Agdal, Saiss, Zouagha, Mariniyéne, Fez Medina, and Jnane El Ward) and three rural communes (Ouled Tayeb, Aïn Bida, and Sidi Hrazem) [17].

### 2.2. Sample size and sampling technique

The registration list of catering establishments was obtained from the Chamber of Commerce, Industry, and Services of the Fez-Meknes region, which reports to the Minister of Tourism, Handicrafts, and Social Economy. The sample size was determined using a table provided by Krejcie and Morgan with the following formula:

$$S = \frac{x^2 NP(1 - P)}{d^2(N - 1) + x^2 P(1 - P)}, \quad (1)$$

Based on the following assumptions: standard normal distribution confidence interval ( $x = 1.96$ ), margin of error ( $d = 0.05$ ), population proportion ( $P$  assumed to be 0.50 to maximize sample size),  $N =$  population size (1055), and  $S =$  required sample size [18].

The total sample size was proportionally distributed across the collective catering establishments in the various districts of the Fez prefecture. A stratified random sampling method was utilized to select these establishments. This process involved: (a) stratification, in which the restaurant population was divided into strata based on geographical location (the districts of the Fez prefecture) and type of establishment; and (b) random selection, where establishments from each stratum were randomly chosen to ensure proportional representation. Additionally, the willingness of the establishments to participate in the study was considered. This approach helped minimize bias and enhance the validity of the results by ensuring that all relevant subgroups were represented in the final sample.

Therefore, the study population consisted of 282 workers from 22 catering establishments involved in food handling, serving, packaging, cleaning, and washing.

### 2.3. Study variables

The dependent variable used in the study was the score for food safety knowledge, attitudes, and practices, while the independent variables included demographic characteristics, such as education level, age, gender, marital status, job responsibility/field of duty, work experience, work schedule, and food handler training.

### 2.4. Questionnaire design and pilot study

The preliminary survey questionnaire was developed based on previous studies [9,19]. The entire questionnaire (supplementary file attached) was organized into four sections. The first part included demographic information, such as gender, age, level of education, family status, work experience, and job responsibility/field of duty. The second part consisted of 21 items assessing knowledge and hygiene using 'Yes/No/I don't know' responses. To minimize the probability of respondents choosing the correct answer by chance, this section was divided into four components: hygiene (5 items), cross-contamination and sanitation (7 items), health control and food hazards (5 items), and time and temperature control (4 items). The third part comprised nine items rated on a five-point Likert scale from "strongly disagree" to "strongly agree". The fourth part included 14 questions assessing participants' practices through 'Yes/No' responses. Scoring methods were employed to evaluate KAP levels: correct answers in the knowledge section were scored 1, and incorrect answers or 'don't know' responses were scored 0. Questions were classified into four categories to provide a comprehensive overview of food handlers' food safety knowledge. Results were presented in figures and tables, with frequencies and scores calculated based on correct answers across the 21 questions.

For the attitude section, responses of "strongly disagree", "disagree", and "neutral" were considered unsatisfactory/negative (scored 0), while "agree" and "strongly agree" were considered satisfactory/positive (scored 1). Practical questions were scored as 1 for "yes" and 0 for "no". Raw scores for knowledge, attitude, and practice ranged from 0 to 21, 0–9, and 0–14, respectively, and were converted into percentages by dividing the total score by the total number of items and then multiplying by 100. For the assessment of KAP, and based on the scores, participants were considered to have a poor level of KAP when the score was under 50 %, the level was medium between 50 and 70 %, while the level was rated good for a score above 70 %, and excellent over 80 %.

To ensure linguistic and conceptual accuracy, the questionnaire was previously translated into French and Arabic (local languages) by a bilingual translator and back-translated by an independent translator. The questionnaire's reliability was assessed by pre-testing it on 14 food handlers (5 % of the sample size) with characteristics similar to those of the study sample but not included in the survey. This process aimed to identify any confusing or imprecise questions. Internal consistency was evaluated using Cronbach's alpha, with values interpreted as follows: below 0.5 indicates low reliability, 0.6–0.7 is average, 0.7–0.8 is good, and above 0.8 is excellent. This coefficient can measure the different characteristics of the same construct [20,21]. In the present study, Cronbach's alpha values were 0.941 for knowledge, 0.855 for attitudes, and 0.777 for practices.

### 2.5. Ethical considerations

The survey was voluntary, confidential, and anonymous. Participants were informed about the study's subject and objectives and were encouraged to withdraw at any time if they wished. The purpose and focus of the research were also discussed with the restaurant's owner and/or manager, who was asked a few key questions. Permission was sought to speak to their employees in a separate area.

The consent process began with a discussion with potential participants. Verbal consent was obtained by asking participants questions and recording their agreement to each statement in field notes. Finally, participants were directly asked whether they wished to participate in the study. Verbal consent from participants who agreed to participate was recorded in the field notes along with the participant's subject number or pseudonym (see attached researcher's document on oral consent). Data was collected during face-to-face interviews with food handlers at their respective restaurants. Responses collected had no personal, social, or political consequences, and the research presented no risk of inconvenience to participants.

### 2.6. Data collection

Face-to-face interviews using a semi-structured questionnaire were conducted to collect data on food handlers' knowledge, attitudes, and practices. The questionnaire required between 15 and 20 min to complete, and each participant was assigned a specific number to ensure anonymity.

### 2.7. Statistical analysis

Study data were analyzed using the Statistical Package for Social Sciences (SPSS; Version 25.0, Inc., Chicago, IL, USA). Means and percentages of responses were presented in tabular and graphical formats. Categorical data were analyzed using the Chi-square test, with statistical significance set at  $p < 0.05$ . The Pearson correlation test was used to examine the direction and strength of correlations between mean knowledge and mean attitude scores, mean attitude and mean practice scores, and mean knowledge and mean practice

scores. One-way analysis of variance (ANOVA) was used to compare the mean scores of KAP test categories and to assess the significant relationship between KAPs and demographic variables that could influence the study results. Correlations and associations between the KAP variables were established to understand the interaction and influence of these factors on food safety among food handlers. Correlations were used to examine relationships between variables, while associations were utilized to understand the interplay between KAP components. This knowledge is invaluable for creating targeted interventions, educational programs, and policies to improve food safety practices in catering establishments.

Fig. 1 shows the overall experimental design for the present study.

### 3. Results

#### 3.1. Demographic characteristics of respondents

A total of 282 food handlers responded to the survey. Their socio-demographic characteristics are presented in Fig. 2. Most respondents were male (86.88 %), with a minority being female (13.12 %). The most frequent age group was 20–30 years (41.13 %),

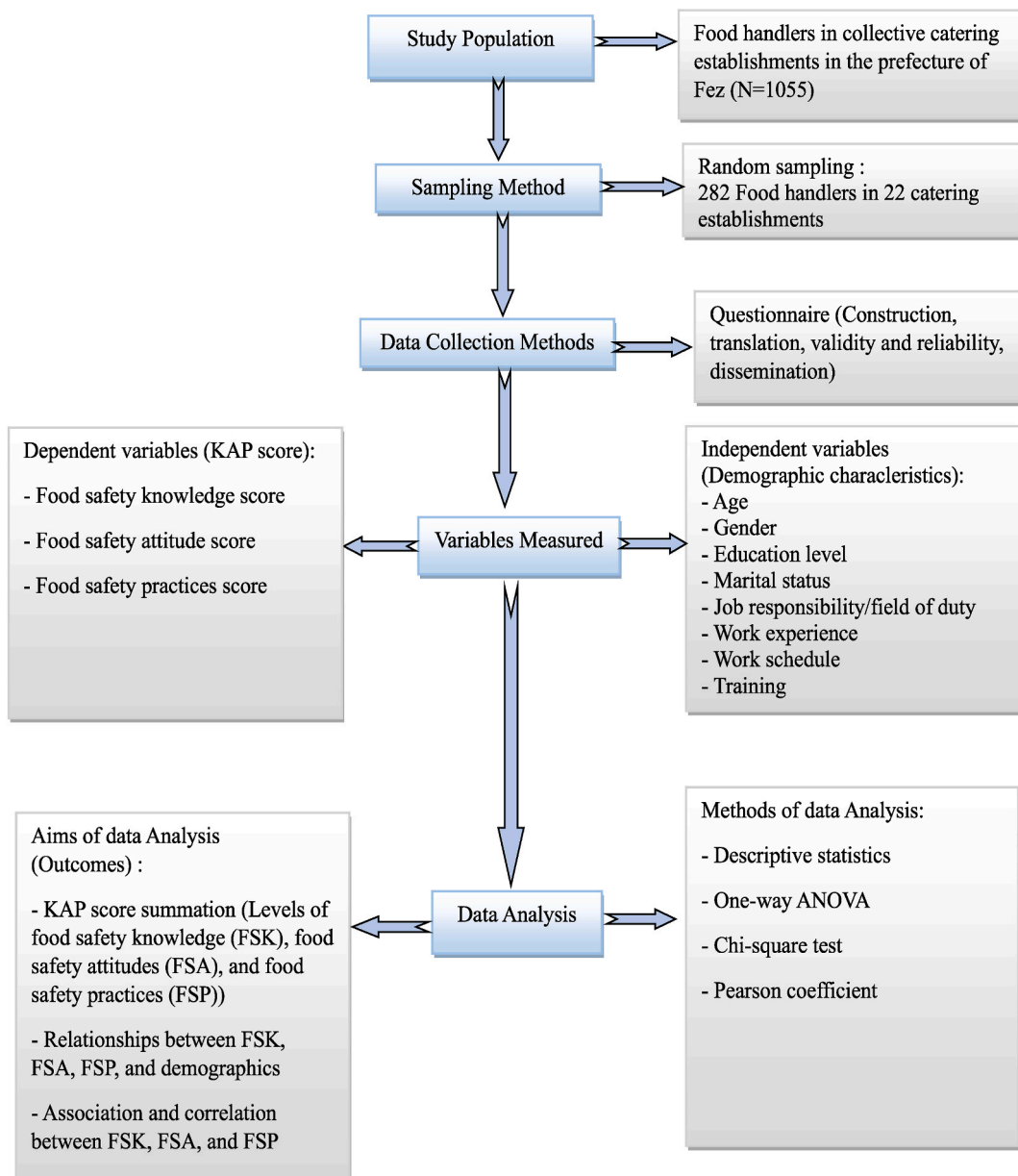


Fig. 1. Experimental study design.

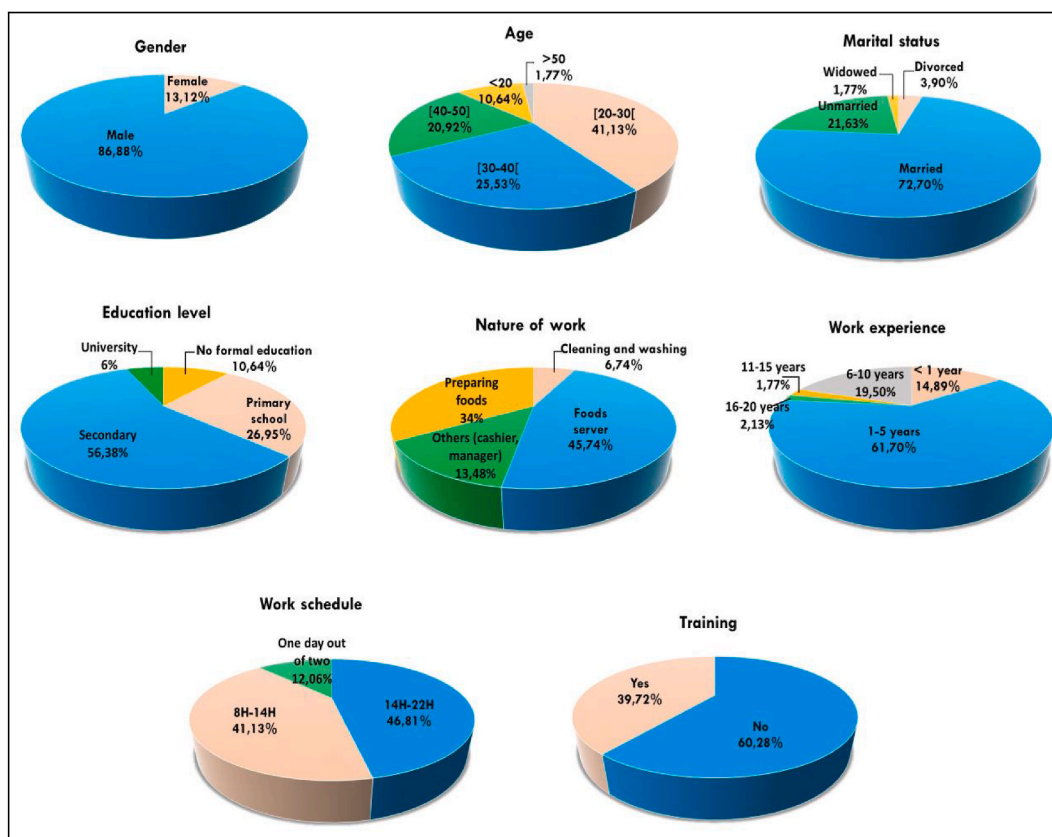


Fig. 2. Demographic characteristics of the food handlers (n = 282).

followed by 30–40 years (25.53 %). It was observed that 26.95 % of respondents had primary education, while 56.38 % had secondary education. Moreover, 61.70 % of food handlers had between 1 and 5 years of experience in the food sector. Regarding job roles, 34 % were involved in food preparation, 45.74 % were food servers, 6.74 % were employed in cleaning and washing, and 13.48 % had other duties, such as cashier or manager. Concerning marital status, 72.70 % were married, 21.63 % were unmarried, 3.90 % divorced, and 1.77 % were widowed. Additionally, over half (60.28 %) of the respondents had not attended any food safety training program. Work schedule analysis revealed that 46.81 % worked between 2 and 10 p.m., 41.13 % between 8 a.m. and 2 p.m., and a minority (12.06 %) worked on a rotational schedule.

### 3.2. Food safety knowledge of respondents

#### 3.2.1. Personal hygiene

The overall knowledge of personal hygiene among food handlers was moderate; only 68.2 % recognized its importance (Appendix A). Detailed results in Table 1 indicated that most participants (87.9 %) understood the importance of washing hands before handling food and after using the toilet. Additionally, 75.9 % knew the significance of handwashing before food preparation and after handling garbage (76.6 %). However, awareness was only moderate regarding the necessity of wearing gloves before touching ready-to-eat food (59.6 %), and just 41.1 % knew that handwashing should last at least 20 s.

#### 3.2.2. Cross-contamination and sanitation

The results revealed a high level of awareness among food handlers regarding cleaning and disinfecting work surfaces and premises (95.7 %), selecting appropriate disinfectants, and the frequency of disinfection (80.1 %). Conversely, there was limited understanding in areas such as preventing cross-contamination by changing knives (45.7 %), using separate cutting boards for raw meat or poultry and vegetables (35.8 %), and washing cutting boards or knives used for raw meat or poultry with soap and water before use with vegetables (46.5 %) and (47.5 %), respectively. Approximately 54.6 % of respondents indicated they would store leftover food and raw foods separately in the refrigerator (Table 1). Overall knowledge of cross-contamination and hygiene was low, with 57.9 % of participants demonstrating poor knowledge (Appendix A).

#### 3.2.3. Time and temperature control

Only 64.6 % of respondents highlighted the importance of time and temperature control in preventing microbial growth in food

**Table 1**  
Food handlers' knowledge toward food safety (N = 282).

Category	Item	Responses, <sup>a</sup> n (%)	
		Correct (%)	Incorrect/Don't know (%)
<b>Personal hygiene</b>	1. Is it essential to wash hands before starting to prepare food?	<b>214</b> (75.9)	68(24.1)
	2. Is it essential to wash hands after using the toilet or touching any part of the body?	<b>248</b> (87.9)	34(12.1)
	3. Is it essential to wash hands after handling the garbage?	<b>216</b> (76.6)	66(23.4)
	4. Is it essential to wear gloves before touching ready-to-eat food?	<b>168</b> (59.6)	114(40.4)
	5. Is it essential to wash your hands for at least 20 s?	<b>116</b> (41.1)	166(58.9)
<b>Cross-contamination and sanitation</b>	6. Is it essential to use a different knife for cutting raw meat or poultry and vegetables?	<b>129</b> (45.7)	153(54.3)
	7. Is it important to wash the knife used for cutting raw meat or poultry with soap and water before using it to cut vegetables?	<b>131</b> (46.5)	151(53.5)
	8. Is it essential to use different cutting boards for cutting raw meat or poultry and vegetables?	<b>101</b> (35.8)	181(64.2)
	9. Is it essential to wash the cutting board used for cutting raw meat or poultry with soap and water before using it for cutting vegetables?	<b>134</b> (47.5)	148(52.5)
	10. Is it essential to clean and disinfect work surfaces and premises?	<b>270</b> (95.7)	12(4.3)
	11. Is it essential to choose the right disinfecting products and the frequency of disinfection?	<b>226</b> (80.1)	56(19.9)
	12. Is it essential to keep leftover and raw food separate in the refrigerator?	<b>154</b> (54.6)	128(45.4)
<b>Health control and foodborne hazards</b>	13. Is it essential to know the types of risks encountered in restaurants (biological, chemical and physical)?	<b>267</b> (94.7)	15(5.3)
	14. Is it essential to have a health card for food handlers?	<b>241</b> (85.5)	41(14.5)
	15. Is it essential to be vaccinated against certain diseases before working in restaurants?	<b>241</b> (85.5)	41(14.5)
	16. Is it essential to undergo medical examinations from occupational doctors?	<b>242</b> (85.8)	40(14.2)
	17. Are foodborne illnesses related to microorganisms?	<b>225</b> (79.8)	57(20.2)
<b>Time and temperature control</b>	18. Is it important to avoid thawing frozen raw meat or poultry on the kitchen counter in an open container or under running water?	<b>141</b> (50.0)	141(50.0)
	19. Is it essential to thaw frozen raw meat or poultry in the refrigerator?	<b>224</b> (79.4)	58(20.6)
	20. Is it essential to maintain the operating temperature of the refrigerator between 1 and 5 °C and the freezer at -18 °C?	<b>115</b> (40.8)	167(59.2)
	21. Is it essential to store leftover food in the refrigerator?	<b>249</b> (88.3)	33(11.7)
<b>Total</b>	–	<b><sup>b</sup>68.4 %</b>	

The correct answers are in bold.

<sup>a</sup> (n) %: number of respondents (percentage of respondents).

<sup>b</sup> Total (correct answer percentage) score of the respondents.

(Appendix A). Half of those surveyed (50 %) recognized the importance of not thawing frozen raw meat or poultry on the kitchen counter in an open container or under running water (Table 1). Conversely, 79.4 % believed it was essential to thaw frozen meat or poultry in the refrigerator. Most respondents (79.4 %) knew the correct and safe operating temperatures for refrigerators and freezers. Regarding leftover food storage, 88.3 % knew it should be kept in the fridge.

### 3.2.4. Health control and foodborne hazards

Overall, respondents demonstrated a high level of knowledge of health control and food risks (86.1 %) (Appendix A). A significant portion (94.7 %) were aware of various risks associated with restaurant operations, and 85.5 % understood the importance of food handlers having a health card, receiving vaccinations for certain diseases before working in the catering sector, and undergoing medical examinations. Nearly 79.8 % were aware that food-borne illnesses are caused by microorganisms (Table 1).

### 3.3. Food safety attitudes of respondents

The overall level of food safety attitudes among food handlers was 75.61 %, as shown in Table 2. Most food handlers (88.7 %) agreed that safely handling food is essential to their profession, while a minority (11.3 %) showed a negative attitude. A significant

**Table 2**  
Food handlers' attitudes toward food safety (N = 282).

Statement	Responses, <sup>a</sup> n (%)	
	Strongly agree, agree (%)	Strongly disagree, disagree, neutral (%)
1. One of my job responsibilities is to handle food safely	<b>250(88.7)</b>	32(11.3)
2. I believe attending personal hygiene and food safety training will enhance my knowledge of food safety and handling	<b>269(95.4)</b>	13(4.6)
3. Food handlers should not come to work when they are sick	<b>221(78.4)</b>	61(21.6)
4. I believe that personal protective equipment and clothing reduce the risk of food contamination	<b>249(88.3)</b>	33(11.7)
5. I believe that proper food storage is essential to food safety and that thawed food should not be refrozen	<b>161(57.1)</b>	121(42.9)
6. Knowing the temperature danger zone (between 40 °F and 140 °F) is vital for reducing food safety risks	<b>100(35.5)</b>	182(64.5)
7. I separate raw and cooked foods during storage	<b>201(71.3)</b>	81(28.7)
8. I believe it is necessary to check the temperature settings of refrigerators or freezers regularly	<b>212(75.2)</b>	70(24.8)
9. I believe preparing healthy food should take precedence over preparing tasty food	<b>256(90.8)</b>	26(9.2)
— <b>Total</b>	<sup>b</sup> 75,61 %	

The correct answers are in bold.

<sup>a</sup> (n) %: number of respondents (percentage of respondents).

<sup>b</sup> Total (correct answer percentage) score of the respondents.

majority (95.4 %) also agreed that participating in personal hygiene and food safety training would enhance their knowledge in these areas. Additionally, 78.4 % agreed that they should refrain from working when ill. A smaller percentage of respondents (34.1 %) recognized the importance of knowing the temperature danger zone (between 40 °F and 140 °F) to reduce food safety risks. More than half (57.1 %) emphasized the importance of proper food storage to ensure food safety and understood that thawed food should not be refrozen. Furthermore, 88.3 % agreed that using personal protective equipment and clothing reduces the risk of food contamination. A substantial portion acknowledged the need to: separate raw and cooked foods during storage (71.3 %), regularly monitor refrigerator or freezer temperatures (75.2 %), and prioritize the preparation of healthy foods over flavourful ones (90.8 %).

### 3.4. Food safety practices of respondents

The overall level of food safety practices among food handlers was 62.89 %, as shown in Table 3. Nearly all handlers (94.0 %) reported cleaning their work clothes after handling food, while 73.4 % washed their hands before and after handling food, and 63.1 % cleaned work surfaces before, after, and during food handling. Only 37.9 % reported using protective equipment such as safety glasses, masks, or gloves when handling food. Other reported violations included coming to work while sick (fever, cough, cold, headache) by 66.0 % of handlers, wearing jewellery while handling food (47.2 %), and smoking in food preparation areas (9.6 %).

Additionally, a significant majority (86.5 %) of respondents used utensils and cutting boards for food preparation; three-quarters (75.2 %) regularly disinfected work surfaces and premises, with 68.4 % using chlorine as a disinfectant. Nearly all food handlers (98.2 %) stored food leftovers in the fridge and disposed of food that fell on the floor, and 71.6 % reported regularly checking the

**Table 3**  
Food handlers' practices toward food safety (N = 282).

Item	Responses, <sup>a</sup> n (%)	
	Yes (%)	No (%)
1. Do you wash your hands before and after handling food?	<b>207(73.4)</b>	75(26.6)
2. Do you use clean work clothes when handling food?	<b>265(94.0)</b>	17(6.0)
3. Do you use protective equipment (safety glasses, mask, gloves) when handling food?	<b>107(37.9)</b>	175(62.1)
4. Do you wear jewelry while handling food?	133(47.2)	<b>149(52.8)</b>
5. Do you smoke in food preparation areas?	27(9.6)	<b>255(90.4)</b>
6. Do you come to work when you are sick (e.g., fever, cough, cold, or headache)?	186(66.0)	<b>96(34.0)</b>
7. Do you clean work surfaces before, after and during food handling?	<b>178(63.1)</b>	104(36.9)
8. Do you disinfect work surfaces and premises regularly?	<b>212(75.2)</b>	70(24.8)
9. Do you use chlorine as a disinfectant on work surfaces and premises?	<b>193(68.4)</b>	89(31.6)
10. Do you use bare hands to handle ready-to-eat foods?	107(37.9)	<b>175(62.1)</b>
11. Do you use utensils and cutting boards to prepare food?	<b>244(86.5)</b>	38(13.5)
12. Do you regularly check the temperature settings of coolers or freezers?	<b>202(71.6)</b>	80(28.4)
13. Do you store leftover food in the refrigerator and dispose of food that falls on the floor?	<b>277(98.2)</b>	5(1.8)
14. Do you reheat food until it is steaming hot before serving?	<b>145(51.4)</b>	137(48.6)
— <b>Total</b>	<sup>b</sup> 62.89 %	

The correct answers are in bold.

<sup>a</sup> (n) %: number of respondents (percentage of respondents).

<sup>b</sup> Total (correct answer percentage) score of the respondents.

temperature of their fridge or freezer. Just over half of food handlers (51.4 %) reheated food until steaming hot before serving.

### 3.5. Association between knowledge, attitudes, and practices

Table 4 shows a statistically significant association between knowledge and attitudes ( $\chi^2 = 1006.697$ ,  $p < 0.001$ ), knowledge and practices ( $\chi^2 = 859.776$ ,  $p < 0.001$ ), and attitudes and practices (554.399,  $p < 0.001$ ).

### 3.6. Correlation between knowledge, attitudes, and practices of food handlers

A statistically significant and positive correlation was observed between knowledge and attitude scores ( $p < 0.001$ ,  $r = 0.907$ ), between attitude and practice scores ( $p < 0.001$ ,  $r = 0.327$ ) and also between knowledge and practice scores ( $p < 0.001$ ,  $r = 0.291$ ), as shown in Table 5. The most significant positive correlation was between knowledge and attitude scores.

Table 6 illustrates the relationship between the dependent variables (knowledge, attitude, and practice scores) and the independent variables (age of food handler, gender, education, job responsibility/field of activity, experience, work schedule, and training). Statistically significant differences were found between age and the knowledge, attitude, and practice scores ( $F = 118.41$ ,  $95.58$ ,  $45.24$ ,  $p < 0.05$ ). Respondents aged 30 and older exhibited significantly higher knowledge, attitude, and practice scores. Experience also showed statistical significance ( $F = 199.84$ ,  $108.46$ ,  $29.04$ ,  $p < 0.05$ ); food handlers with over six years of experience achieved higher knowledge scores. Similarly, education level was statistically significant ( $F = 4.92$ ,  $4.31$ ,  $12.64$ ,  $p < 0.05$ ), with higher mean KAP scores observed among those with primary education and above. Job responsibilities of the participants demonstrated significant differences ( $F = 85.84$ ,  $86.60$ ,  $123.23$ ,  $p < 0.05$ ); those involved in meal preparation and cleaning and washing scored higher on KAP. Additionally, marital status among those surveyed showed significant differences ( $F = 24.26$ ,  $15.20$ ,  $22.66$ ,  $p < 0.05$ ); widowed participants exhibited higher KAP scores. Furthermore, the training of the handlers had a significant impact on their KAP scores ( $F = 164.23$ ,  $124.95$ ,  $3.79$ ,  $p < 0.05$ ). Moreover, no statistically significant differences were found between gender and work schedule; and the knowledge and attitude scores, respectively ( $[F = 22.3; 11.45, p > 0.05]$  and  $[F = 22.3; 11.45, p > 0.05]$ ), but there was a statistically significant difference between gender and work schedule; and practices, respectively ( $[F = 34.17, p < 0.05]$  and  $[F = 17.6, p < 0.05]$ ).

## 4. Discussion

Food safety is a significant concern for regulatory authorities, the food service sector, and consumers due to its direct impact on public health. Numerous studies have identified inadequate food handling during preparation and service as the primary cause of foodborne illness outbreaks, posing risks to consumer health [10,22]. According to the findings of this study, the overall level of food safety knowledge among food handlers was fair at 68.4 %, suggesting an increased risk of foodborne diseases due to potential contamination, thereby endangering consumers. The findings are comparable to those from Jordan (69.4 %) [23], UAE (70 %) [11], Kuwait (70 %) [19] and three European Union countries (70.5 %) [24], and are higher than those reported in Egypt (39.2 %) [10], Iraq (43.75) [22], and Maldives (55.5 %) [25], but lower than Austria (76 %) [26].

Regarding personal hygiene, only 68.2 % of food handlers demonstrated average knowledge, which is notably lower than the 93.85, 93.20, and 89.64 % reported by Abdul Halim-Lim et al. [25], Al-Kandari et al. [19], and Osaili et al. [23], respectively. Poor personal hygiene significantly contributes to food contamination and subsequent foodborne illnesses [27]. Furthermore, 75.9, 87.9, and 76.6 % of respondents were aware of the importance of washing hands before preparing food, after using the toilet, and after handling garbage, respectively, consistent with findings in other studies [11,19,28].

Hand hygiene is critical in safe food handling practices [29], as several studies confirm that proper handwashing reduces pathogen transmission [30,31]. Consequently, to ensure food safety and protect the customers of catering establishments, emphasis should be placed on correct handwashing. Inadequate handwashing practices of food handlers have been highlighted as a cause of foodborne diseases [27]. Moreover, less than 60 % of respondents in the present study were aware that using gloves to handle ready-to-eat food reduces the risk of food contamination. This finding contrasts sharply with studies from Kuwait [19], Iraq [22], Bangladesh [32], and China [33], where awareness and regular glove use were reported much higher, at 92.8, 81.54, 70.9, and 81 %, respectively. However, other studies corroborate the present study's findings, reporting significant gaps in food safety knowledge regarding this particular issue [34,35]. This underscores the necessity for comprehensive food safety training, especially considering that 60.28 % of respondents reported never receiving such training. Additionally, 41.1 % were unaware that handwashing should last at least 20 s, a finding contrasting with Al-Kandari et al. in Kuwait (65.7 %) [19], Al-Shabib et al. in Saudi Arabia (61.1 %) [28], and Kanaan et al. in Iraq (72.31 %) [22]. Therefore, it is essential to emphasize proper handwashing practices.

Concerning cross-contamination, respondents demonstrated low to moderate knowledge (57.9 %), aligning with Al-Kandari et al.

**Table 4**  
Association between knowledge, attitudes and practices.

Variables	Chi-Square ( $\chi^2$ )	Significance
Knowledge-Attitude	1006.697	<0.001
Knowledge-Practices	859.776	<0.001
Attitude-Practices	554.399	<0.001



**Table 5**  
Correlation between knowledge, attitudes, and practices.

Variable correlation	Correlation coefficient (r-value)	Significance
Knowledge-Attitudes	<sup>a</sup> 0.907	<0.001
Knowledge-Practices	<sup>a</sup> 0.291	<0.001
Attitudes-Practices	<sup>a</sup> 0.327	<0.001

<sup>a</sup> Correlation is significant at  $p < 0.05$ .

in Kuwait, who reported similar deficiencies, but differing from studies in Indonesia [36], and the UAE [11], where higher knowledge levels were observed (81.9, and 76 %, respectively). This indicates inadequate awareness of essential procedures to prevent cross-contamination, possibly due to insufficient or ineffective training [19]. Moreover, only 46.7 % of respondents in the present study reported changing knives between cutting poultry or raw meat and vegetables, compared to 52, 73.4, and 84.54 % in the UAE, Kuwait, and Lebanon, respectively [11,19,37]. Similarly, only 35.8 % changed cutting boards between raw meat/poultry and vegetables, contrasting with 89.6 % reported by Al-Kandari et al. [19]. Using the same utensils for different food types increases the risk of foodborne pathogens [22]. Furthermore, 46.5 and 47.5 % of respondents reported washing knives and cutting boards with soap and water after cutting raw meat or poultry, compared to 74.1 and 68.7 % in previous studies [19]. Halabi et al. found that 88.18 % of food handlers in Lebanon were aware of the need to store cooked and raw foods separately in the refrigerator, compared to 54.6 % in the present study. Moreover, a significant number of respondents emphasized the importance of regularly cleaning and sanitizing food contact surfaces to prevent foodborne illnesses, in line with previous studies [19,25,38]. Routine disinfection of surfaces, equipment, and facilities promotes high environmental hygiene standards, reducing the risk of foodborne illnesses.

Regarding time and temperature control, respondents exhibited poor to fair knowledge (64.6 %), consistent with recent studies [11, 19]. Ongoing education and training should be organized to reinforce food handlers' knowledge in this area [39]. While a significant percentage knew to thaw frozen meat in the refrigerator (79.4 %) and store leftovers there (88.3 %), only 50 % knew not to thaw meat in open containers or under running water, and over 51 % lacked knowledge of proper refrigeration and freezer temperatures. These findings align with Halabi et al., where only 50.90 % knew the safest thawing method [37], contrasting with Taha et al., who reported higher knowledge percentages [11]. This highlights the inadequate emphasis on time and temperature control during food preparation, likely reflecting deficient training [7,40].

Concerning health control, approximately 85 % of respondents acknowledged the importance of health cards, vaccinations before restaurant work, and medical check-ups, consistent with previous studies [19,28,41], indicating high compliance. Respondents also demonstrated awareness of food risks and foodborne pathogens, with 94.7 % aware of restaurant risks and 79.8 % knowledgeable about foodborne diseases caused by microorganisms, contrasting with studies showing poor knowledge in these areas [10,19]. This underscores the need for continuous education and training for restaurant workers.

In addition to knowledge, attitude is a fundamental factor that could influence food safety practices and reduce foodborne illness rates [42]. In the present study, 75.61 % of food handlers exhibited positive attitudes, higher than the percentages (61.2, 70, and 71 %) reported by Hamed et al. [10], Taha et al. [11], and Iwu et al. [43], respectively. Furthermore, 88.7 and 95.4 % of participants considered safe food handling essential to their job and believed food safety training would enhance their knowledge, respectively, contrasting with lower percentages reported in Egypt (43.8 and 42.9 %) [10]. Food establishment managers should support food handlers in their food safety training [28]. Additionally, 78.4 % believed it unsafe to work while ill, lower than in previous studies (83.3 %) [19], which can contribute to foodborne illness transmission during food preparation [44]. Most respondents (88.3 %) recognized the importance of wearing protective clothing, higher than Kuwait (72.9 %) [19], yet lower than Lebanon (96.2 %) [45], and Iraq (90 %) [46]. Over 70 % of respondents acknowledged the need to separate raw and cooked foods during storage and to regularly monitor refrigerator/freezer temperatures, contrasting with lower percentages in Kuwait (59 %) [19]. However, only 34.1 % recognize that knowing the temperature danger zone is essential for reducing food safety risks. Foodstuffs must be kept outside the temperature danger zone, which is between 40 °F and 140 °F, to avoid the development of pathogens [47]. Additionally, approximately 57 % stated that thawed food should not be refrozen, consistent with studies in Iran, Kuwait, Malaysia, and Ghana [9,19,48,49].

The present study revealed moderate food safety practices among respondents (62.89 %), similar to previous findings [9,10,46], yet lower than other studies indicating effective practices [19,25]. Compliance with safety practices is paramount in preventing foodborne diseases [9,48]. However, only 62.1 % always wore gloves when handling ready-to-eat food, and only 37.9 % used protective equipment, such as safety glasses and masks. The use of gloves significantly reduces bacterial cross-contamination of foodstuffs [25,29, 50]. Nonetheless, practices such as wearing clean work clothes (94 %) and washing hands before and after handling food (73.4 %) were satisfactory. Respondents also demonstrated moderate practices in cross-contamination prevention, workplace cleaning (63.1 %), regular disinfection (75.2 %), and chlorine use as a disinfectant (68.4 %). The use of utensils and cutting boards (86.5 %) was also common. Furthermore, food safety practices concerning time and temperature control were adequate among those surveyed in this study, including checking refrigerator and freezer temperatures (71.6 %) and storing food leftovers in the refrigerator (98.2 %). However, inappropriate reheating methods are frequently used (49.6 %). Previous studies generally report such practices [25,28] due to insufficient knowledge and improper attitudes toward time and temperature control. Other violations of food safety practices, such as coming to work when ill, were reported by 66 % of those surveyed. This increases the possibility of spreading germs and, consequently, the risk of foodborne diseases. According to the Codex Alimentarius on general principles of food hygiene, personnel who are ill or carriers of a disease transmissible through food must not enter a food handling area [51]. Additionally, 47.2 % reported wearing jewelry while handling food, and 9.6 % smoked in food preparation areas. World Health Organization reveals that some foodborne

**Table 6**

ANOVA for food handlers KAP scores and age, gender, education, experience, job responsibility, marital status, work schedule, and training.

Dependent Variable	Independent Variable	Mean	Sum of Squares	Df	Mean Square	F	P Value		
<b>Knowledge Score</b>	<b>Age</b>		<b>Between Groups</b>	5157.41	4	1289.35	118.41	0.000 <sup>a</sup>	
	<20	4.30	<b>Within Group</b>	3016.23	277	10.88			
	[20–30[	13.37							
	[30–40[	15.27							
	[40–50]	19.84							
	>50	20.20							
	<b>Gender</b>			<b>Between Groups</b>	41.11	1	41.11	1.41	.235
	F	15.35	<b>Within Group</b>	8132.53	280	29.04			
	M	14.22							
	<b>Marital status</b>			<b>Between Groups</b>	1696.01	3	565.33	24.26	0.000 <sup>a</sup>
	Divorced	10.00	<b>Within Group</b>	6477.63	278	23.30			
	Married	15.62							
	Unmarried	10.40							
	Widowed	20.80							
	<b>Education level</b>			<b>Between Groups</b>	412.41	3	137.47	4.92	0.002 <sup>a</sup>
	No formal education	13.62	<b>Within Group</b>	7761.23	278	27.91			
	Primary school	14.38							
	Secondary	17.46							
	University	15.82							
	<b>Nature of work/Job responsibility</b>			<b>Between Groups</b>	3930.66	3	1310.22	85.84	0.000 <sup>a</sup>
	Cleaning and washing	12.21	<b>Within Group</b>	4242.97	278	15.26			
	Foods server	10.65							
	Others (cashier, manager)	17.85							
	Preparing foods	19.23							
	<b>Work experience</b>			<b>Between Groups</b>	6070.16	4	1517.54	199.840	0.000 <sup>a</sup>
	<1 year	4.47	<b>Within Group</b>	2103.48	277	7.59			
	1–5 years	14.70							
6–10 years	19.70								
11–15 years	20.40								
16–20 years	20.00								
<b>Training</b>			<b>Between Groups</b>	3021.84	1	3021.84	164.23	0.000 <sup>a</sup>	
Yes	18.40	<b>Within Group</b>	5151.79	280	18.39				
No	11.71								
<b>Work schedule</b>			<b>Between Groups</b>	44.74	2	22.37	0.76	.465	
8H–14H	14.76	<b>Within Group</b>	8128.90	279	29.13				
14H–22H	14.23								
One day out of two	13.52								
<b>Attitudes Score</b>	<b>Age</b>		<b>Between Groups</b>	1056.69	4	264.17	95.58	0.000 <sup>a</sup>	
	<20	2.46	<b>Within Group</b>	765.57	277	2.76			
	[20–30[	5.93							
	[30–40[	8.26							
	[40–50]	8.76							
	>50	9.00							
	<b>Gender</b>			<b>Between Groups</b>	2.10	1	2.10	0.32	.570
	F	7.02	<b>Within Group</b>	1820.17	280	6.50			
	M	6.77							
	<b>Marital status</b>			<b>Between Groups</b>	256.83	3	85.61	15.20	0.000 <sup>a</sup>
	Divorced	5.00	<b>Within Group</b>	1565.44	278	5.63			
	Married	7.30							
	Unmarried	5.26							
	Widowed	9.00							
	<b>Education level</b>			<b>Between Groups</b>	106.97	4	26.74	4.31	0.002 <sup>a</sup>
	No formal education	6.50	<b>Within Group</b>	1715.3	277	6.19			
	Primary school	6.63							
	Secondary	8.00							
	University	8.23							
	<b>Nature of work/Job responsibility</b>			<b>Between Groups</b>	880.30	3	293.43	86.60	0.000 <sup>a</sup>
	Cleaning and washing	6.05	<b>Within Group</b>	941.96	278	3.38			
	Foods server	5.00							
	Others (cashier, manager)	8.76							
	Preparing foods	8.59							
	<b>Work experience</b>			<b>Between Groups</b>	1112.18	4	278.04	108.46	0.000 <sup>a</sup>
	<1 year	2.33	<b>Within Group</b>	710.08	277	2.56			
	1–5 years	7.14							
6–10 years	9.00								
11–15 years	9.00								
16–20 years	8,70								
<b>Training</b>			<b>Between Groups</b>	562.28	1	562.28	124.95	0.000 <sup>a</sup>	

(continued on next page)

Table 6 (continued)

Dependent Variable	Independent Variable	Mean		Sum of Squares	Df	Mean Square	F	P Value
Practices Score	Yes	8.54	<b>Within Group</b>	1259.98	280	4.50		
	No	5.65						
	<b>Work schedule</b>		<b>Between Groups</b>	22.90	2	11.45	1.77	.171
	8H–14H	6.97	<b>Within Group</b>	1799.36	279	6.44		
	14H–22H	6.82						
	One day out of two	6.05						
	<b>Age</b>		<b>Between Groups</b>	480.62	4	120.15	45.24	0.000 <sup>a</sup>
	<20	6.03	<b>Within Group</b>	735.64	277	2.65		
	[20–30[	8.12						
	[30–40[	10.05						
	[40–50]	9.89						
	>50	10.40						
	<b>Gender</b>		<b>Between Groups</b>	132.31	1	132.31	34.17	0.000 <sup>a</sup>
	F	10.56	<b>Within Group</b>	1083.96	280	3.87		
	M	8.53						
	<b>Marital status</b>		<b>Between Groups</b>	239.02	3	79.67	22.66	0.000 <sup>a</sup>
	Divorced	9.54	<b>Within Group</b>	977.24	278	3.51		
	Married	9.18						
	Unmarried	7.16						
	Widowed	11.60						
	<b>Education level</b>		<b>Between Groups</b>	187.73	4	46.93	12.64	0.000 <sup>a</sup>
	No formal education	8.16	<b>Within Group</b>	1028.53	277	3.71		
	Primary school	9.32						
	Secondary	10.63						
	University	9.17						
	<b>Nature of work/Job responsibility</b>		<b>Between Groups</b>	694.24	3	231.41	123.23	0.000 <sup>a</sup>
	Cleaning and washing	9.94	<b>Within Group</b>	522.02	278	1.87		
Foods server	8.63							
Others (cashier, manager)	5.26							
Preparing foods	10.20							
<b>Work experience</b>		<b>Between Groups</b>	359.35	4	89.84	29.04	0.000 <sup>a</sup>	
<1 year	6.30	<b>Within Group</b>	856.91	277	3.09			
1–5 years	8.96							
6–10 years	10.80							
11–15 years	10.00							
16–20 years	9.89							
<b>Training</b>		<b>Between Groups</b>	16.28	1	16.28	3.79	0.049 <sup>a</sup>	
No	8.50	<b>Within Group</b>	1199.99	280	4.28			
Yes	9.00							
<b>Work schedule</b>		<b>Between Groups</b>	136.91	2	68.45	17.69	0.000 <sup>a</sup>	
8H–14H	9.34	<b>Within Group</b>	1079.36	279	3.86			
14H–22H	7.97							
One day out of two	9.52							

ANOVA: Analysis of variance; KAP: Knowledge, attitudes and practices.

<sup>a</sup> Statistically significant at  $P < 0.05$ .

illnesses are linked to poor handling practices, such as improper storage, inadequate cooking, or cross-contamination [52].

In the present study, a positive correlation between practice scores and knowledge and attitude scores was also identified, consistent with other studies [9,19]. The most significant positive correlation between knowledge and attitude scores ( $r = 0.907$ ) indicated that higher knowledge leads to more positive attitudes toward food safety. However, attitudes and knowledge have only a moderate impact on food handling practices ( $r = 0.327$  and  $r = 0.291$ , respectively), suggesting that they do not consistently translate into improved practices. This is consistent with previous studies showing that the knowledge and attitudes of food handlers have not effectively translated into their practices [53–55]. Furthermore, the gap between knowledge and practice has been identified in various studies, highlighting the complex nature of behavioural changes [10,48]. While food handlers may possess the necessary knowledge of food safety principles, translating that knowledge into consistent safe practices can be influenced by factors such as time constraints, workplace culture, and individual risk perceptions. Therefore, interventions that focus solely on increasing knowledge may not be sufficient to ensure improved food safety practices. Instead, multifaceted approaches that address both attitudes and practices could yield more effective outcomes [56]. Moreover, the attitude of food handlers was moderately correlated with their food hygiene practices, which is consistent with the previous study [57]. In contrast to the present study's findings, other studies have shown a significant correlation between attitudes and practices [58–61]. Attitudes are influenced by one's beliefs and values, which in turn motivate individuals to behave in particular ways in response to various situations [56]. Enhancing food safety attitudes and knowledge can promote safer practices among food handlers and reduce foodborne illness rates [9].

The findings also revealed that gender was not significantly associated with knowledge and attitude scores, consistent with other studies [9,25,44], while others contrast with this finding [37,62]. Furthermore, age and experience are associated significantly with KAP scores, similar to other studies [11,63], suggesting that older, more experienced handlers have developed more food safety

expertise through practice. Education level also significantly influenced KAP scores, aligning with previous research [10,37,64], despite some studies suggesting education has no impact [9,40,44]. In addition, marital status and the nature of work influenced KAP scores. Other studies contradict these findings, stating that this could be because the people surveyed, whether male or female, married or single, cooks or servers, all work under the same roof [9,40,65]. It was also observed that food handler training influenced KAP scores, consistent with previous findings reported by Osaili et al. and Al-Kandari et al. [19,63]. Conversely, work schedule was not significantly associated with knowledge and attitudes, whereas practices were. The highest scores were obtained by manipulators working every other day.

The present study revealed critical insights into food safety KAP among food handlers. It highlights a significant gap in knowledge and practices, particularly in personal hygiene, cross-contamination, and time/temperature control, emphasizing the need for targeted educational programs and regular training workshops. By enhancing their knowledge, food safety standards can be improved, benefiting public health. Additionally, food safety practices are influenced by cultural norms, suggesting that interventions should be culturally appropriate to ensure acceptance. Regular supervision should also ensure that food handlers comply with standard operating procedures, critical in preventing foodborne diseases. Furthermore, improving communication between food safety authorities and catering establishments is necessary to foster compliance. Engaging the community and stakeholders in food safety initiatives can create a supportive environment for food handlers. Community-based approaches can enhance awareness and promote effective practices, improving food safety in collective catering. This study opens avenues for further research, particularly longitudinal studies that track changes in knowledge and practices over time. Such research could provide valuable insights into the effectiveness of interventions to improve food safety. In summary, a multifaceted approach combining education, community engagement, and regulatory support is essential for improving food safety practices among food handlers in Fes restaurants and similar contexts, ultimately leading to significant public health benefits. This survey collected food safety practices via self-reporting, which is a limitation due to social desirability bias. Direct observation of hygiene practices is necessary to conclude that participants comply with food safety practices.

## 5. Conclusion

This study concludes that food handlers in restaurants in Fez, central Morocco, had a moderate level of food safety knowledge and practices and positive attitudes toward food safety, except in refreezing and dangerous temperatures. The association between knowledge, practices, and attitudes proved significant, despite the weak association between knowledge and practices. Experience, age, nature of work, education, marital status, and food safety training significantly impacted the KAP levels of food handlers. Knowledge levels were significantly influenced by experience and age; attitudes were meaningfully influenced by experience and the nature of work; and practices were substantially influenced by age, nature of work, education level, and marital status. The presence of training had the most significant impact on knowledge and positive attitudes toward food safety. These results underline the need for stakeholders in the food safety sector to review training approaches and regulations to enhance food safety in Morocco. Research on the KAP of food handlers should continue across all regions of Morocco to ensure compliance with food safety standards and practices in restaurants and to support the development of effective training programs by relevant authorities. Further studies should explore additional factors, such as working conditions and management practices, that contribute to improving food safety in restaurant settings.

## CRedit authorship contribution statement

**Rachid Amaiaich:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Abdelhakim El Ouali Lalami:** Writing – review & editing, Validation, Resources, Methodology. **Mouhcine Fadil:** Writing – review & editing, Software, Methodology, Formal analysis. **Rabia Bouslamti:** Writing – review & editing, Methodology. **Sanae Lairini:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Conceptualization.

## Ethical statement

The authors assert that the study posed no health or psychological risks to the food handlers. Informed consent was obtained from all participants after explaining the study's objectives before their interviews. Permission to conduct the interviews was obtained from the restaurant managers and owners. Food handlers aged over 18 were selected based on their interest in participating. This cross-sectional study collected descriptive data, with responses having no personal, social, or political consequences. The questionnaires used to collect information were anonymous, ensuring data confidentiality.

## Data availability

All data used during this study are included in the article.

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e40739>.

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