

## Assessment of food safety knowledge, attitude and practices of the food handlers in Malaysian public universities

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### Abstract

Foodborne diseases represent a substantial public health concern. This study's objective was to validate the knowledge, attitudes, and practices (KAP) regarding individuals' handling of food regarding food safety measures. Information was gathered through structured questionnaires administered to food handlers employed in foodservice operations at public universities. Additional data were obtained via direct observation of food handlers during their daily tasks, inspection of the foodservice facilities, and testing for pathogens in randomly selected food items. A total of 260 food handlers completed the questionnaires, spanning 10 public universities across Malaysia. Most food handlers did not receive formal food safety training, resulting in low general food safety knowledge and poor corresponding practices. Attitudinal scores associated with food safety as well as personal hygiene were generally low among these foodservice workers. Observed unsafe practices included insufficient handwashing, incorrect use of gloves, improper thermometer handling, inadequate food storage and holding, poor personal cleanliness, as well as ineffective cleaning and sanitization of work surfaces. Therefore, structured training and continuous monitoring are recommended to improve food safety knowledge and practices among institutional food handlers.

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## 1. Introduction

Ensuring the safety of food, which entails managing it correctly at every stage from delivery to consumption, has become an increasingly significant public health concern. Food safety is closely linked to the quality and suitability of edibles that are safe for human intake (Jones *et al.*, 2008; da Cunha *et al.*, 2014; Adeniji *et al.*, 2025). Supplying contaminated or unsafe food can result in foodborne diseases, reduced revenue, and the loss of clientele. Key areas frequently identified as primary contributors to food-related illnesses in households include supplier oversight, monitoring of storage temperatures, adherence to personal hygiene practices, and pest management. Mistakes in preparing, storing, transporting, handling, or serving food can trigger outbreaks of foodborne illnesses.

More than 13 million individuals working within the restaurant sector are required to adhere to food safety regulations (NRA, 2008; Statista, 2025). An analysis

examining trends in the presence of risk factors regarding foodborne illnesses across US institutional foodservice, dining establishments, as well as retail food outlets identified three major contributors: i) inadequate personal hygiene; ii) improper storage or temperature control of food; and iii) contaminated surfaces or equipment used for food preparation (FDA, 2010; USDA, 2023). All of these factors stem from lapses in food safety practices, primarily due to food handlers not complying with established food safety protocols.

Knowledge, Attitudes, and Practices (KAP) concerning food safety among individuals who handle food are a significant concern due to their connection with the incidence of foodborne diseases (Angelillo *et al.*, 2000; Walker *et al.*, 2003; Medeiros *et al.*, 2004; Abdul-Mutalib *et al.*, 2012; da Vitória *et al.*, 2021; Chen *et al.*, 2024). The actions of food handlers in preventing foodborne infections throughout the stages of food preparation, manufacturing, and distribution directly

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influence the consumers' health and safety.

In Malaysia, previous research has identified a connection between the KAP of food handlers and food safety outcomes (Musa *et al.*, 2010; Abdul-Mutalib *et al.*, 2012; Chaudhary *et al.*, 2023; Porusia *et al.*, 2024). Nonetheless, most of these investigations did not focus specifically on food handlers working within institutional foodservice settings, such as those in public universities. It is recognized that university food handlers possess a pivotal role in safeguarding the well-being of a large and diverse campus community through their food preparation and hygiene behaviors. Consequently, this research aimed to assess the understanding of appropriate food handling procedures as well as attitudes toward food safety among food handlers in public universities. Note that this objective was pursued by administering questionnaires designed to measure their KAP.

## 2. Materials and methods

### 2.1 Design of study

An exploratory research guideline was employed to elucidate the problem statements, enabling the investigator to establish appropriate research goals. This framework encompasses a sequence of logical and deliberate decisions. These decisions address key aspects of the study's structure, including the formulation of research aims, the setting in which the investigation takes place, the degree of intervention and control exercised by the researcher, and the depth at which the collected data are examined.

### 2.2 Technical visit to the location

The research encompassed ten state-run universities throughout Malaysia. Throughout the site visits, the investigator examined the practices regarding food handlers during food preparation, assessed the variety of services offered, and evaluated the accessibility and condition of kitchen equipment and facilities. Additionally, the researcher analyzed the workflow of food production along the assembly line. The information gathered served as a foundation for developing the study questionnaire and guiding the observation stage.

### 2.3 Development of the questionnaires

The KAP questionnaire was established based on the principles outlined in the HACCP guidelines, drawing from the ServSafe® Coursebook (National Restaurant Association, 2012) and Serving it Safe: Trainer's Guide (USDA, 2009), with minor adjustments informed by previous research (Walker *et al.*, 2003; Medeiros *et al.*, 2004; Ramu *et al.*, 2023). In earlier work, Medeiros *et al.* (2004) showed that using questionnaires to examine food safety knowledge and attitudes may be a valuable tool

for educational interventions. They highlighted that questionnaires are effective for pinpointing key areas to emphasize during training and for assessing knowledge retention post-training. Examining employees' attitudes toward food safety may also provide insights into their food-handling behaviors. The self-administered questionnaire was developed into four sections: (i) demographic information, (ii) food safety knowledge, (iii) attitudes toward food safety, as well as (iv) food safety practices.

#### 2.3.1 Demographic profile

The population survey, designed to characterize the participants, included seven items covering age, sex, years of employment, educational background, job role, employment type, as well as whether the food service staff had received health certification along with a typhoid immunization.

#### 2.3.2 Food safety knowledge

Fifty multiple-choice questions (foodborne illnesses, foods that pose safety risks, improper handling related to time and temperature, correct hand hygiene, time-temperature management, food thawing methods, cleaning and sanitization procedures, prevention of cross-contamination, and implementation of corrective measures) were employed to assess the knowledge of food handlers. The questions were designed in two formats: binary-choice questions and single-response multiple-choice questions. Binary-choice questions present a fixed-option scenario in which participants must select one of two possible answers, whereas single-response multiple-choice questions require participants to select only one answer from a list of several options.

#### 2.3.3 Food safety attitudes

A five-point Likert-type scale, spanning from Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), to Strongly Agree (5), was employed to assess the attitudes of food handlers. The survey included items addressing topics such as their responsibilities in maintaining food safety, knowledge of foodborne diseases and cross-contamination, practices regarding personal hygiene and food safety, as well as awareness of temperature control and the use of disposable gloves in preventing foodborne illnesses.

#### 2.3.4 Food safety practices

A five-point Likert scale was displayed in a tabular layout, featuring response options of Never (N), Rarely (R), Occasionally (S), Frequently (O), and Always (A). The survey was organized to assess the following areas: taking and documenting temperature readings, correct handwashing and sanitation procedures, maintaining personal hygiene,

implementing measures to avoid cross-contamination, handling leftovers and cleaning routines, and proper food storage alongside overall food safety practices.

2.4 Statistical analysis

Data examination was carried out immediately following the collection of questionnaires from each site. Each questionnaire was carefully reviewed for inaccuracies and removed if respondents had left any responses incomplete. The information was then coded to streamline the transfer of all numerical responses from the questionnaires into the computer system. Descriptive statistical procedures, including calculation of averages, standard deviations, and frequency distributions, were guided by utilizing SPSS version 30.0 (IBM Corp., Armonk, NY, USA) as well as Microsoft Excel.

3. Results

Out of the 300 surveys that were handed out, 285 were received back. Due to being incomplete or inappropriate for analysis, 25 of these surveys (11 fully blank, 14 partially filled) were omitted from the dataset. Consequently, 260 valid surveys satisfied the initial eligibility criteria, yielding a response proportion of 92%.

The demographic profile with regard to the participants is listed in Table 1. The largest group of food handlers fell within the 21–30 years age bracket (37.3%, n = 97), whereas the smallest proportion was over 51 years old (2.7%, n = 7). Female participants

were slightly more prevalent, representing 53.8% (n = 140) of the sample. The majority of respondents had completed higher secondary education, holding either the Malaysian Certificate of Education (MCE) or Sijil Peperiksaan Malaysia (SPM) (58.8%, n = 153), continued by those with lower secondary education (20.4%, n = 53). Regarding work experience in the food industry, most had been employed for less than one year (42.3%, n = 110) or between 2 and 5 years (43.8%, n = 114). Out of the 260 respondents, 80.8% (n = 210) represent full-time workers. Meanwhile, part-time as well as contract employees make up for 13.8% (n = 36) and 5.4% (n = 14), accordingly. The participants' job roles included assistant cook (24.2%, n = 63), cook (25.8%, n = 67), as well as service staff (24.2%, n = 63). Most food handlers (68.1%, n = 177) possessed a health certificate and had received typhoid vaccination.

Table 2 presents the level of food safety awareness among food handlers. Regarding K8, the majority (60.0%, n = 156) of handlers reported being unaware of measures required to prevent foodborne illnesses. Conversely, a larger portion (71.6%, n = 186) demonstrated understanding of which are classified as potentially hazardous foods (PHFs), including poultry, seafood, red meat, as well as dairy products, as outlined in K9. A significant number of food handlers showed notable gaps in knowledge related to time and temperature misuse, with scores ranging from 61.9% to 69.2%. More than half (n = 153) were aware of the concept addressed in K19, recognizing that fingertips

Table 1. Demographic profile of the sample of the food handlers (N=260).

Demographic characteristics	Category	Number of respondents	
		Frequency	Percent (%)
Age (years)	≤ 20	42	16.2
	21-30	97	37.3
	31-40	73	28.1
	41-50	41	15.8
	> 51	7	2.7
Gender	Male	120	46.2
	Female	140	53.8
Educational level	No formal education	13	5.0
	Primary school	18	6.9
	Lower secondary school	53	20.4
	Higher secondary school	153	58.8
	Tertiary education	23	8.8
Length of service (years)	< 1	110	42.3
	2-5	114	43.8
	6-10	23	8.8
	11-15	5	1.9
	> 16	8	3.1
Worker work status	Full time	210	80.8
	Part time	36	13.8
	Contract	14	5.4
Job designation	Assistant cook	63	24.2
	Cook	67	25.8
	Beverage person	34	13.1
	Service staff	63	24.2
	Manager	33	12.7
Health certification with typhoid vaccination	Yes, I have	177	68.1
	No, I do not have	83	32.0

Table 2. Frequency distribution of food safety knowledge.

No.	Construct/Item	HK n (%)	NK n (%)
<b>Foodborne Illnesses</b>			
K1	An ill employee who reports to work should wear glove to avoid foodborne illnesses	149 (57.3)	111 (42.7)
K2	Food handler who infected with norovirus should not prepare food while they have the symptoms	129 (49.6)	131 (50.4)
K3	Salmonella organisms are likely to be found in which of the following? (Raw chicken)	138 (53.1)	122 (46.9)
K4	At body temperature (37°C), what will food poisoning bacteria do? (Grow quickly)	111 (42.7)	149 (57.3)
K5	Which of the following temperatures do bacteria readily multiply at? (18°C)	133 (51.2)	127 (48.8)
K6	Which is common symptom of food poisoning? (Diarrhoea)	188 (72.3)	72 (27.7)
K7	How may food poisoning bacteria be brought into the kitchen? (All of the above)	157 (60.4)	103 (39.6)
K8	A key factor in the control and prevention of foodborne illness is the individual food handlers who is trained and motivated to follow safe practices	104 (40.0)	156 (60.0)
<b>Potentially Hazardous Foods</b>			
K9	Food such as red meats, poultry and seafood and dairy product are considered to be potentially hazardous foods	186 (71.6)	74 (28.4)
K10	Whole eggs with clean, intact shells are safe to be kept at room temperature	81 (31.2)	179 (68.8)
K11	Potentially hazardous foods are considered high risk because they: (have properties that support rapid bacterial growth)	46 (17.7)	214 (82.3)
K12	Which of the following food items is potentially hazardous? (cooked rice)	117 (45.0)	143 (55.0)
K13	What types of food are most commonly implicated in potentially hazardous foods? (high protein foods – poultry, beef, fish and dairy products)	147 (56.6)	113 (43.5)
<b>Time and Temperature Abuse</b>			
K14	Temperature abuse occurs when foods are not cooked properly or reheated sufficiently to destroy harmful microorganisms	99 (38.1)	161 (61.9)
K15	A shipment of shrimp with ice crystals on it proves the shrimp are still frozen and therefore, should be accepted	93 (35.8)	167 (64.2)
K16	Placing hot food inside a refrigerator is a safe way to cool food quickly	80 (30.8)	180 (69.2)
K17	Freezing food to below 0°C kills pathogens	96 (36.9)	164 (63.1)
<b>Proper Hand Washing</b>			
K18	It is acceptable to use hand antiseptics in place of hand washing while preparing food	91 (35.0)	169 (65.0)
K19	The fingertips and the area under the nails harbour 80% to 90% of the bacteria on hands that can cause foodborne illness	153 (58.8)	107 (41.2)
K20	Practicing proper hand washing is sufficient to keep food from becoming contaminated	92 (35.4)	168 (64.6)
K21	Washing hands for 10 seconds will effectively remove dirt and pathogens	103 (39.6)	157 (60.4)
K22	The proper handwashing procedure included all of these steps except: (turn off water with bare hands)	190 (73.1)	70 (26.9)
<b>Time and Temperature Control</b>			
K23	Poultry must be cooked at 74°C or higher	131 (50.4)	129 (49.6)
K24	Meat must be cooked at 68°C or higher	79 (30.4)	181 (69.6)
K25	Fruits, vegetable, grains and legumes should be cooked at 50°C	103 (39.6)	157 (60.4)
K26	Product should be held at 5°C or lower for cold holding	185 (71.2)	75 (28.8)
K27	Cooling process of cooked food is from 60°C to 7°C in 4 hours	119 (45.8)	141 (54.2)
K28	For hot holding, product must be held at lower than 60°C	99 (38.1)	161 (61.9)
K29	Food must be reheated at 74°C within 2 hours	86 (33.1)	174 (66.9)
K30	The temperature danger zone for food is between 5°C - 60°C	152 (58.5)	108 (41.5)
<b>Thawing of Food</b>			
K31	Frozen food can be thawed at room temperature	88 (33.8)	172 (66.2)
K32	Frozen food can be thawed at cold running water at 21°C or below in 2 hours or less	173 (66.5)	87 (33.5)
K33	Cooking process is also part thawing food	182 (70.0)	78 (30.0)
K34	Frozen food can also be thaw in a refrigerator with above 5°C	167 (64.2)	93 (35.8)
K35	Microwave thawing is used as long as the food is cooked immediately	94 (36.2)	166 (63.8)
<b>Cleaning and Sanitizing</b>			
K36	Food contact surfaces that are in constant use should be cleaned and sanitized at the end of each day	97 (37.3)	163 (62.7)

Table 2. Frequency distribution of food safety knowledge.

No.	Construct/Item	HK	NK
		n (%)	n (%)
K38	Rinsing temperature need to be greater than 77°C	106 (40.8)	154 (59.2)
K39	Sanitizer solutions should be at 24°C to 49°C	170 (65.4)	90 (34.6)
K40	Which of the following is best at killing bacteria? (Disinfectant).	177 (68.1)	83 (31.9)
K41	When should cutting boards, knives and other utensils be sanitized? (after each use)	60 (23.1)	200 (76.9)
K42	When using wiping cloths to clean food contact surfaces, they should be (washed, rinsed and soaked in a sanitizing solution)	189 (72.7)	71 (27.3)
<b>Cross Contamination</b>			
K43	Cross contamination often occurs when different foods are prepared on the same surface without sanitizing between each use	166 (63.8)	94 (36.2)
K44	Employees can prepare raw and cooked foods in the same work area	91 (35.0)	169 (65.0)
K45	Which of the following is a potential source of cross contamination? (all of the above)	57 (21.9)	203 (78.1)
K46	Why should raw and cooked foods be separated during storage? (to avoid bacteria transfer)	95 (36.5)	165 (63.5)
<b>Establishing Corrective Action</b>			
K47	Leftover foods from the assembly line should be (discarded)	87 (33.5)	173 (66.5)
K48	If you have doubts about any food product, you should (throw it out)	165 (63.5)	95 (36.5)
K49	The manager discovers that the freezer containing meat is not working; the product temperature has reach 18°C. What is a proper corrective action? (discard the food because it has dropped down into danger zone)	82 (31.5)	178 (68.5)
K50	While frying chicken, you discover that the cook is using the same tongs for placing raw chicken in the fryer and panning the cooked chicken. What is the correct response? (Put the chicken on a sheeted pan, reheat at 74°C and instruct the cook to use separate tongs for raw and cooked products)	82 (31.5)	178 (68.5)

Note: HK = having knowledge; NK = no knowledge.

Table 3. Frequency distribution of food safety attitudes.

No.	Food Safety Responsibilities	PA	NA
		n (%)	n (%)
A1	I think safe food handling is an important part of my job responsibilities	248 (95.4)	12 (4.6)
A2	I will take an immediate action in the occurrence of foodborne illnesses that occur within the premise	180 (69.2)	80 (30.8)
A3	It is important to make sure that that prepared food is safe for the students/consumers	241 (92.7)	19 (7.4)
A4	It important to use cap, masks, protective gloves and adequate clothing to reduces the risk of foodborne illnesses	236 (90.8)	24 (9.3)
A5	I believe that cross contamination can be by prevented by using a sanitizing solution and practicing a proper handwashing procedure during all steps of line prep-at-service	234 (90)	26 (10)
<b>Foodborne Illnesses and Cross Contamination</b>			
A6	I feel that foodborne disease is more dangerous for vulnerable groups of people such as children, older people and pregnant women	171 (65.8)	89 (34.3)
A7	It is necessary to keep raw foods separately from cooked foods to prevent cross contamination	248 (95.4)	12 (4.6)
A8	It is crucial to have a proper storage system in order to prevent bacterial growth and cross contamination	43 (16.5)	217 (83.5)
<b>Food Safety and Personal Hygiene</b>			
A9	I am concerned that if I am sick, I may transmit foodborne diseases while working with other employees	63 (24.2)	197 (75.8)
A10	It is important that I should not touch unwrapped foods with abrasions or cuts on fingers, since I may also have the potential risk to contaminate the foods	74 (28.4)	186 (71.5)
A11	I believe that I can possibly transfer harmful pathogens to foods/other employees when I take out the trash or touch any parts of my body	131 (50.3)	129 (49.5)
<b>Foodborne Illnesses Related to Temperature and Disposable Gloves</b>			
A12	It is important that I constantly educate myself about food safety	211 (81.2)	49 (18.9)
A13	It is also necessary to check thermometer settings of refrigerators and freezers once per day so that foodborne disease can be minimized	212 (81.5)	48 (18.4)
A14	I believe that by wearing disposable gloves when handling either fresh or cooked food products can minimize the incident of foodborne illnesses	228 (87.7)	32 (12.3)

Note: PA = positive attitudes; NA = negative attitudes.

and the areas beneath nails contain 80% to 90% of the bacteria responsible for foodborne diseases. Proper control concerning time and temperature is crucial to preserve the microbiological safety and food quality and to minimize the risk of foodborne illnesses. Nonetheless, over 66% (n = 174) of the handlers lacked correct knowledge regarding the appropriate reheating temperature for foods, as indicated in K29. Correct thawing of frozen products is critical for ensuring they remain safe to eat. On a positive note, most food handlers were informed about proper thawing techniques and the correct temperatures, as reflected in K32, K33, and K34. Maintaining cleanliness and proper sanitation is vital for keeping all food-contact surfaces free of harmful microorganisms. However, 76.9% (n = 200) of respondents were unaware that knives, cutting boards, as well as other kitchen tools should be sanitized after each use. Instead, most believed these items only needed cleaning at the start of the workday. The majority (more than 60%) of food handlers lack the knowledge to answer the section on cross-contamination and establishing corrective action.

Table 3 presents the perspectives of food handlers

regarding food safety. The majority of food handlers indicated a favorable outlook on their responsibility for maintaining safe food practices in item A1 (95.4%, n = 248). Conversely, 83.5% (n = 217) of participants felt that having an appropriate storage system to inhibit bacterial proliferation and prevent cross-contamination was not essential, as indicated in A8. Note that a negative viewpoint was reported by 75.8% (n = 197) with regard to food handlers for statement A9. Overall, over 80% of the respondents showed positive perceptions concerning the influence of temperature control and the use of disposable gloves on the prevention of foodborne illnesses.

Table 4 illustrates the food safety behaviors of the handlers. The majority of food handlers, with over 65% did not utilize thermometers to monitor or log food temperatures. Hands can act as vectors for transferring foodborne pathogens to food items (Souza and Santos, 2009; Wong *et al.*, 2020). Regarding this investigation, 95.8% (n = 249) concerning the food handlers consistently washed their hands after attending personal activities, for example, eating, smoking, sneezing, drinking, coughing, or utilizing the restroom (as

Table 4. Frequency distribution of food safety practices.

No.	Construct/Item	GP	BP
		n (%)	n (%)
<b>Measuring and Recording Temperature</b>			
P1	Take and record end-point temperatures of all cooked food	73 (28.1)	187 (71.9)
P2	Take and record temperature of food on the cooling	85 (32.7)	175 (67.3)
P3	Take and record temperature of food on the reheating	69 (26.5)	191 (73.5)
P4	Take and record temperature of cold food on the service	76 (29.2)	184 (70.8)
<b>Proper Hand Washing and Cleaning Practices</b>			
P5	I wash my hand: Before using disposable gloves	211 (81.1)	49 (18.9)
P6	I wash my hand: After using disposable gloves	196 (75.4)	64 (24.6)
P7	After performing personal needs – smoking, eating drinking, sneezing, coughing or using the toilet	249 (95.8)	11 (4.3)
P8	Store chemical sanitizers away from the food production Good personal hygiene practices	238 (91.6)	22 (8.4)
P9	I wash my hand: Before touching unwrapped raw foods	240 (92.3)	20 (7.7)
P10	Follow appropriate personal hygiene practices	248 (95.4)	12 (4.6)
P11	Practice a proper handwashing guideline procedure while on duty	246 (94.7)	14 (5.4)
<b>Prevention of Cross Contamination Practices</b>			
P12	Food is properly labelled and dated	241 (92.7)	19 (7.3)
P13	Food is covered to protect from overhead contamination	189 (72.7)	71 (27.3)
P14	I wash my hand: After touching unwrapped raw foods	249 (95.8)	11 (4.3)
P15	I wash my hand: After touching anything i.e. telephone, money, raw or fresh foods, utensils, trash, chemicals	235 (90.4)	25 (9.6)
P16	Use utensil or disposable gloves when handling food	181 (69.6)	79 (30.4)
P17	Store raw meats below cooked foods or food that will no longer be cooked Managing leftovers and cleaning practices	237 (91.1)	23 (8.9)
P18	I wash my hand: Before starting work	185 (71.2)	75 (28.9)
P19	Throw leftovers was once reheated and held for service	197 (75.7)	63 (24.3)
P20	Mix leftovers with fresher products	94 (36.1)	166 (63.9)
<b>Storage of Foods and Food Safety Practices</b>			
P21	When storing food, I will: Check the expiration date	87 (33.4)	173 (66.5)
P22	When storing food, I will: Store food in first in, first out (FIFO)	151 (58.1)	109 (41.9)
P23	When storing food, I will: Check refrigerator-freezer temperatures at least daily	154 (59.2)	106 (40.7)
P24	Store raw food and cooked foods in separate areas	215 (82.7)	45 (17.3)
P25	Work surfaces are washed and sanitized between uses	54 (20.8)	206 (79.2)

Note: GP = good practices; BP = bad practices.

referenced in P7). More than 90% of the food handlers maintained satisfactory personal hygiene practices. Concerning measures to avoid cross-contamination, most handlers (91.1%,  $n = 237$ ) placed raw meat below cooked items or foods that would not undergo further cooking (as referenced in P17), as well as 72.7% ( $n = 189$ ) covered food to shield it from contamination from above (as referenced in P13). Safe management of leftovers is crucial for preventing foodborne diseases. In this research, 75.7% ( $n = 197$ ) with respect to handlers consistently disposed of leftovers that were reheated and served once (as referenced in P19). Conversely, 63.9% ( $n = 166$ ) of handlers regularly combined leftover foods with freshly prepared items (as referenced in P20). Correct storage practices help maintain food freshness and safety. Only 20.8% ( $n = 54$ ) with regard to food handlers consistently cleaned and sanitized their work surfaces between tasks, while a large majority, 79.2% ( $n = 206$ ), did not follow this procedure (as referenced in P25).

Table 5. Mean scores for food safety knowledge, attitudes and practices.

Level	Range	Food handlers (N = 260)	
		n	(%)
For knowledge:			
High	80-100%	1	0.4
Moderate	60-79%	71	27.3
Low	< 59%	188	72.3
For attitude:			
Positive	80-100%	29	11.2
Neutral	60-79%	230	88.5
Negative	< 59%	1	0.4
For practice:			
Good	80-100%	24	9.2
Fair	60-79%	236	90.8
Poor	< 59%	-	-

= 206), did not follow this procedure (as referenced in P25).

Table 5 displays the average values for respondents' KAP associated with food safety, which were classified mainly as low level of knowledge (72.3%,  $n = 188$ ), neutral level of attitudes (88.5%,  $n = 230$ ), and fair level of practices (90.8%,  $n = 236$ ), respectively.

#### 4. Discussion

The demographic analysis revealed that most participants were aged between 21 and 30 years old, suggesting that they had recently entered the food service sector on a temporary basis to acquire practical experience while awaiting a permanent position aligned with their professional qualifications. The findings regarding educational attainment are consistent with previous research conducted in Brazilian foodservice establishments (Nunes *et al.*, 2010), as well as similar investigations in developing nations (Abdul-Mutalib *et al.*, 2012; Mohamad Fauzi and Abdul Mutalib, 2024) and in developed countries (Angelillo *et al.*, 2000; McIntyre *et al.*, 2013). Within the foodservice workforce,

particularly in public university settings, personnel are generally categorized as either permanent or temporary staff. According to Lenard and Strahle (2011), temporary employees, who encompass contract and part-time workers, typically occupy low-skilled, low-paid roles to help alleviate workforce shortages. The possession of a health certificate and typhoid vaccination shows that these individuals completed an annual medical assessment prior to employment in the university's foodservice operations. The Ministry of Health (MOH) mandates that all food handlers receive a typhoid vaccine before commencing work in the foodservice sector. As stipulated in the Food Hygiene and Regulation (2009), any food handler who fails to undergo vaccination and a medical examination conducted by a registered healthcare professional is committing a legal violation and may face a penalty of imprisonment or up to RM10,000 for a period not exceeding two years. Therefore, it is essential that foodservice employees are immunized against typhoid, as this measure helps prevent typhoid fever, which is associated with contaminated food, and ultimately reduces the risk of foodborne illnesses.

The food service personnel demonstrated limited understanding of various risk factors, including foodborne illnesses, PHFs, improper handling times and temperatures, hand hygiene practices, temperature management, food thawing methods, cleaning and sanitization protocols, cross-contamination, as well as implementation of corrective measures. These findings align with previous research (EFSA, 2007; Jones *et al.*, 2008; Madaki and Bavorova, 2019; Ahmed *et al.*, 2021; Evelyn *et al.*, 2025). In contrast, Sharif *et al.* (2013) reported that food handlers with regard to Jordanian military hospitals possessed considerable knowledge regarding high-risk foods, foodborne pathogens, appropriate food storage temperatures, and contamination sources. Notably, a substantial proportion regarding food handlers were unaware of the recommended handwashing duration. Inadequate hand hygiene allows microorganisms to transfer from improperly cleaned hands to Ready-to-Eat (RTE) foods, directly causing foodborne illnesses. Minimizing cross-contamination is essential, and food handlers should ensure that kitchen surfaces are sanitized before use, between different food preparations, when handling RTE items, and whenever contamination is questioned (Cogan *et al.*, 2002; National Restaurant Association Educational Foundation, 2008; Dhaliwal *et al.*, 2025).

Most food handlers (95.4%) acknowledged the significance of wearing caps, protective gloves, face masks, as well as suitable clothing to minimize the likelihood of foodborne infections. This observation

aligns with the results of a study conducted by Tokuç *et al.* (2009), in which all participating food handlers (100%) concurred with the statement. Similarly, other researchers (Ansari-Lari *et al.*, 2010; da Cunha *et al.*, 2014; Asha'ari and Kamarulzaman, 2023) reported that over 90% of food handlers exhibited favorable attitudes toward maintaining food safety.

The practices involved in managing food that are commonly linked to foodborne illnesses have been highlighted in previous studies (Obande *et al.*, 2023; Begum *et al.*, 2025), including proper cooking and storage temperatures, personal cleanliness, cross-contamination, as well as contamination from unsafe surfaces. On the other hand, Sharif *et al.* (2013) reported that food handlers with respect to a Jordanian military hospital adhered to critical control points concerning general hygiene measures such as handwashing, handling high-risk foods, understanding foodborne illnesses, monitoring storage temperatures, and identifying contamination sources. In a related research, it was discovered that time limitations affected the food safety behaviors of managers and food handlers, including glove changes, hand hygiene, checking food temperatures, sanitizing cutting boards, as well as procedures for cooling or reheating food (Green and Selman; Yusoff *et al.*, 2022; Gemeda *et al.*, 2025). Earlier, Sneed *et al.* (2004) examined the food handling routines of staff in assisted-living facilities and found that while participants possessed strong knowledge about food safety, their actual practices often fell short of recommended standards. This highlights a disconnect between awareness and application. Many employees in foodservice settings fail to implement their knowledge in daily practice, indicating a clear need for further education and training on proper food handling techniques (Sneed *et al.*, 2004; Azanza and Zamora-Luna, 2005; Tan *et al.*, 2025).

## Conclusion

This research has a number of constraints that may limit the applicability of its findings to other foodservice operations within public universities. In addition, the proportion of food handlers who had completed a food safety course was comparatively low in comparison to those without any formal training. Consequently, a larger sample of trained food handlers might have yielded deeper insights into how their KAP influences food safety outcomes. Recommendations such as food safety training programs should be conducted to promote behavioral improvements and foster positive attitudes among food handlers.

## Conflict of interest

The authors stated no conflict of interest.

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