

ORIGINAL ARTICLE

Factors Associated With Knowledge, Awareness, and Hygiene Practices Among Food Handlers: A Cross-sectional Study at Tourist Attractions in the Upper Tapi River, Thailand

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ABSTRACT

Introduction: Thailand has some of the world's tastiest food. However, food safety is important for foodborne disease prevention and control and to build confidence in food safety measures among consumers, tourists, and the general population. **Materials and methods:** The study as a cross-sectional survey was conducted among food service at tourist attractions in the Upper Tapi basin from October 2023 to May 2024. Purposive sampling was applied, and the study questionnaire was given to the 135 food handlers. Coliform bacteria samples were collected from food handlers hands (n=135), water used in drinking (n=57), water used in cooking (n=89), ice (n=118), and kitchen utensils (n=332) for testing as part of the SI-2 indicator assessment, which SI-2 initial coliform bacteria testing solution for fieldwork. **Results:** The food handlers in this study were 48 males (35.56%) and 87 females (64.44%). Seventy-two (53.33%) food handlers were younger than or equal to 28 years old (SD 28.21±7.65 years). Food handlers' education level was found to be either secondary school (35 persons, 25.93%) or above secondary school (64 persons, 47.40%). Eighty-six restaurants (63.70%) were operational status initiated more than six days per week. Ninety-six restaurants (71.11%) had more than five years of experience. Forty-seven (34.81%) employees had passed the clean food good test; 88 (65.19%) had not passed the clean food good test training. The results showed that food handlers' overall knowledge of food safety was moderate (average score 7.20, SD 0.20, max 10.00, min 5.89). It was found that food handlers had a high level of awareness of food sanitation (average score 2.52, SD 0.24, max 2.89, min 1.68). The overall level of food sanitation hygiene practices was moderate (average score 1.93, SD 0.14, max 2.09, min 1.45). The results for coliform bacterial contamination with SI-2 test kits from 731 samples across 135 sites showed contamination of 206 samples (28.18%). **Conclusions:** Food entrepreneurs and food handlers must promote and support food sanitation knowledge to develop their potential for knowledge and understanding of food sanitation and to comply with laws or regulations.

Malaysian Journal of Medicine and Health Sciences (2025) 21(6): 1-12. doi:10.47836/mjmhs.v21.i6.1399

Keywords: Knowledge, Awareness, Hygiene practices, Food handlers, Upper Tapi River

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INTRODUCTION

Safe food supplies benefit national economies, trade, and tourism, help to ensure food and nutrition security, and enable long-term development.¹⁻² The tourism industry in Thailand was one of the industries most negatively affected by the COVID-19 pandemic.³ In 2023, the number of tourist arrivals amounted to around 28.15 million, drastically increasing from the previous years, which numbered approximately 11 million.

Thailand has some of the world's tastiest food, with exotic spices that sometimes come with an equally exotic list of local germs that could make travellers sick. So, visitors need to be careful about what they eat and how they eat because it is difficult to get sick while travelling. Encouraging tourist attractions to raise food sanitation standards is one of the Thai government's important policies to create an overview of the national drive in terms of both Sanitation, Accountability, Network standards (SAN&SAN Plus), and environmental health criteria.⁴ Therefore, restaurant operators and food handlers are an important mechanism to prevent potential health effects on tourists, as they are perhaps the most important source of illness. Ensuring that a person

receives proper food handler training protects travellers from food safety incidents such as allergic reactions and foodborne illness outbreaks.⁴ Connor⁵ discovered that the incidence of diarrhoea among tourists ranged from 30% to 70% depending on the circumstances. Thailand was previously listed as a high-risk nation for travelers' diarrhea (TD), having previously been labeled a high-risk country.⁶⁻⁷ Additionally, the incidence of traveler's diarrhea (TD) among foreign adult travelers to Thailand. According to Sharma et al.,⁸ the cumulative incidence of participants developing TD was 14.0% (49/349) at seven days, 23.5% (82/349) at 14 days, and 33.0% (115/349) at 28 days. The study identified young age, eating street food, and not routinely washing hands after using a toilet as risk factors significantly associated with the incidence of TD using the log-rank test in the survival analysis.

Tapi River originates in the Nakhon Si Thammarat mountain range in Pipun District, Nakhon Si Thammarat Province; it flows north through Chawang district, Nakhon Si Thammarat Province, and enters Surat Thani Province. With an area of about 13,562 square kilometres or 8,476,131 rai, accounting for 2.62 per cent of the total area of the country, and with a total length of 232 kilometres, it is the longest river in the southern part of Thailand.⁹ The Upper Tapi River basin in southern Thailand has been a popular tourist destination in the past ten years. Meanwhile, local restaurant and accommodation operators have integrated modern services for more convenience to attract tourists. According to the survey, the number of food and beverage entrepreneurs has increased, many of the people involved having not yet undergone food hygiene training according to the Clean Food Good Test (CFG T) set by the Department of Health and Ministry of Public Health.⁴

Food handlers in Thailand are integral to maintaining the safety and quality of food across a broad spectrum of establishments, including restaurants, street vendors, and food processing facilities. Their duties encompass a wide range of tasks, from food preparation and cooking to serving and processing. To mitigate the risk of foodborne illnesses, food handlers are required to comply with stringent hygiene and food safety protocols, which are regulated by authorities such as the Thai Food and Drug Administration (FDA) and the Ministry of Public Health⁴. Adherence to these regulations ensures the protection of public health and the preservation of the food industry's standards in Thailand. Through such practices, food handlers play a vital role in safeguarding the integrity of the food supply and the well-being of consumers⁴. In Thailand, food handler training and certification are vital parts of Thailand's food safety system. Before being issued a food license, food handlers must demonstrate knowledge about food safety practices. In 2023, the

Ministry of Public Health's Department of Health¹⁰ reported that a substantial number of restaurants had successfully met the established standards for cleanliness and food quality. Through the "Clean Food Good Taste" program, 45,710 restaurants were upgraded to meet the hygiene and taste standards set by the initiative. Additionally, 446 restaurants received the "Clean Food Good Taste Plus" certification, which acknowledges their compliance with the Ministry's Hygiene Regulation on Food Outlets B.E. 2018. This reflects a considerable effort by food establishments to uphold high standards of hygiene and food quality, aligning with governmental health regulations.

Addressing the current gap in research on the knowledge, attitudes, and practices (KAP) of food handlers in Thailand is essential for advancing food safety efforts. Further studies are needed to understand how food handlers' knowledge and attitudes towards food safety and hygiene impact their daily practices. By exploring these factors, it will be possible to assess their role in preventing foodborne illnesses and enhancing public health. Expanding the research base in this area will contribute to improving food safety protocols and guide the development of targeted interventions, ultimately leading to safer food handling practices and better health outcomes for the public.

Food safety is important for foodborne disease prevention and control and to build confidence in food safety measures among consumers, tourists, and the general population.¹¹ Therefore, in line with the tourism policy that focuses on the readiness of the service and tourism sectors and enhances tourism in food sanitation, the objective of this study was to evaluate the situation of food sanitation management among entrepreneurs and to investigate the knowledge, attitude, and practice (KAP) among food handlers. The study is a case study of tourist attractions in the Upper Tapi basin. Thailand is an interesting case in terms of upgrading the food sanitation management system to support Thai tourism under the new way of life.

METHODS

Study area and study participants

The study as a cross-sectional survey was conducted among food service at tourist attractions in the Upper Tapi basin (Figure 1) from October 2023 to May 2024. All the food service premises (n = 135) located in the tourist attractions in the upper Tapi Basin included Pipun District, Chawang District, Tham Phannara District, Thung Yai District, Lan Saka District, Chang Klang District, and Na Bon District, Nakhon Si Thammarat province. Purposive sampling was applied, and samples were collected from food handlers, food, and kitchen utensils for SI-2 indicator testing.



The 135 food handlers came from different establishments, including: The establishment is located in the Upper Tapi Basin area, with its origin in Pipun District, Nakhon Si Thammarat Province and the other 6 districts as follows: Chawang District, Tham Phannara District, Thung Yai District, Lan Saka District, Chang Klang District, and Na Bon District, Nakhon Si Thammarat province. The researcher initially used cluster sampling by dividing the topography of Nakhon Si Thammarat province based on the Nakhon Si Thammarat mountain range, which runs longitudinally along the peninsula. As a result, the topography of Nakhon Si Thammarat can be divided into three areas: 1) the central mountain range area, 2) the eastern coastal plains, and 3) the western plains area. The researcher then randomly selected samples from the area that is the Tapi River's source, located in the western plains. Next, the researcher used purposive sampling by selecting data from the area that is the source of the Tapi River, which includes the Pipun District and the surrounding areas through which the Tapi River flows. These areas include Chawang District, Tham Phannara District, Thung Yai District, Lansaka District, Chang Klang District, Nakhon Si Thammarat District, and Wiang Sa District in Surat Thani Province. The researcher then used purposive sampling to select data from the top three most popular ecotourism attractions in each district. Following this, the researcher used accidental sampling to collect data from the following sample groups: 1) Accommodation providers in the selected areas and 2) Restaurant and beverage operators in the selected areas. The researcher ultimately used purposive sampling to select participants from local government organizations (LGO) and communities. Specifically, the researcher chose 1) officials from local government organizations where the top 1-3 most popular tourist attractions in each district are located and 2) community leaders from areas where the top 1-3 most popular tourist attractions in each district are located. As a result, the total population for the study consisted of the following sample groups: 70

The survey was performed by questionnaire, which consisted of five components: general information about restaurants (5 items), general characteristics of food handlers (9 items), knowledge of food safety (10 items), food sanitation awareness (10 items), and food hygiene practices (10 items). The self-administered questionnaire was given to the 135 food handlers participating in this study: all 135 completed and returned it, giving a response rate of 100 per cent. The data collected were checked by researchers. The questionnaire was tested for internal consistency and had a very high Cronbach's α value of 0.987.¹²

This questionnaire aims to assess the knowledge, attitudes, and practices of food handlers concerning food safety. The section related to food safety knowledge consists of 10 closed-ended questions with three possible responses. The scoring criteria are as follows: true = 1 point and false or don't know/uncertain = 0 points. These questions assess the respondent's knowledge on topics such as personal hygiene, cross-contamination, foodborne diseases, microorganisms, temperature control, and hygienic practices. The interpretation of knowledge scores based on the average score is as follows: a score of ≥ 8 (80% or higher) indicates a high level of knowledge, a score between 6 and 7.99 (60% to 79%) indicates a moderate level of knowledge, and a score of < 6 (below 60%) indicates a low level of knowledge.^{13 11}

The attitude-related questions are designed to assess food handlers' understanding of food safety. In this context, "attitude" refers to the complex psychological state involving beliefs, feelings, values, and habits that influence behavior in certain ways. There are 10 questions in this section, with three possible responses: agree, disagree, and don't know/don't remember. The scoring for attitude-related questions is as follows: positive attitudes were included; strongly agree = 3 points, agree = 2 points, and disagree = 1 point. The interpretation of attitude scores based on the average score is as follows: an average score of 2.50–3.00 indicates a good attitude, an average score of 1.50–2.49 indicates a moderate attitude, and an average score of 1.00–1.49 indicates a poor attitude.¹³

The questions related to the behavioral practices of food handlers assess the frequency with which respondents adhere to proper food safety practices. There are 10 questions in this section, each with three possible responses: sometimes, often, and always.

The interpretation of scores based on the average score is as follows: an average score of 2.50–3.00 indicates high practice, an average score of 1.50–2.49 indicates moderate practice, and an average score of 1.00–1.49 indicates low practice.¹³

Coliform bacterial testing

The coliform bacteria screening kit (SI-2) was developed by the Laboratory Research and Development Center, Department of Health.¹⁴ SI-2 is a field test kit designed to screen for contaminated coliform in food. The SI-2 reagent contains a lactase solution with purple bromocresol as an indicator, as coliform bacteria can ferment lactose, producing acids and gases at a temperature of 35–37°C.¹⁵ Therefore, if the solution is acidified, bromocresol changes the color of the medium from purple to yellow, indicating the presence of coliform contamination. The discoloration occurs within 17–24 hours, indicating a positive result.¹⁴ In this study, the collection and analysis of cooking water samples using the SI-2 test kit provide valuable insights into water quality, food safety practices, and hygiene standards among food handlers. This process helps ensure that the water used in food preparation is safe and does not pose a risk to public health. The coliform bacteria test kit for water is easy to use and convenient for field testing. In addition, the collection and analysis of cooking water samples using the SI-2 test kit provide valuable insights into water quality, food safety practices, and hygiene standards among food handlers. This process helps ensure that the water used in food preparation is safe and does not pose a risk to public health.¹⁴

The researcher conducted a random sampling from food-serving establishments, including accommodation providers that offer food and beverage services, as well as food and beverage entrepreneurs within the study area. A total of 3 samples per establishment were collected. The samples were tested for the presence of coliform bacteria contamination in drinking water, food, and utensils/equipment. The utensils and equipment collected for the study consisted of 112 glass samples, 42 chopstick samples, 89 spoon samples, and 89 plate or bowl samples. The researcher collected 5 samples from each type of utensil or equipment. Additionally, the researcher collected 57 samples of drinking water, clean water used in food preparation, 118 ice samples, and 135 samples from the hands of food handlers. In total, 731 samples were collected for the coliform bacteria test kit in the study.

The procedure for testing with the SI-2 coliform test kit is as follows¹⁴:

1. Dip a cotton swab into the SI-2 reagent and gently squeeze it to remove excess liquid (use 1 cotton swab per bottle of reagent and 5 items per type of utensil/equipment).
2. Swab the surface of the utensil, equipment, or hands to be tested, rotating the swab repeatedly.
3. Re-dip the cotton swab into the reagent, rotate it several times, gently squeeze to remove excess liquid, and then apply the swab to the next utensil or equipment item, continuing until all 5 items have been tested.
4. Break the swab by pulling it out of the bottle until it reaches about halfway, then snap the swab at the bottle neck. Leave the swab at room temperature for 17–24 hours before reading and reporting the results.

Data analysis

The questionnaire data and fecal indicator tests were analyzed using descriptive statistics, including frequency and percentage, to summarize and interpret the distribution and prevalence of responses and contamination levels within the sample. Inferential statistics in finding correlations include multiple logistic regression offered with a value odds ratio and 95% confidence interval (CI).

ETHICAL CLEARANCE

This study was approved by Research Ethics Committee, Thaksin University COA No.TSU 2023_035/REC No.0058

RESULTS

General information about the restaurant and food handlers

A general survey of 135 restaurants found that 80 restaurants (59.26%) had an area exceeding 200 square metres and 48 (35.56%) had more than 20 tables. The restaurants had an average of 16.42 tables (SD 4.30). The restaurants' food sales patterns showed that 25 (18.52%) were restaurants in accommodation/hotels/resorts, 22 (16.30%) were in food parks, 42 (31.11%) were general restaurants, and 46 (34.07%) were beverage outlets. Overall, the average number of employees was 12.25 (SD 2.58). Among the restaurants, 28 (20.74%) had been operational status for less than 1 year, 32 (23.70%) had been operational status for 1–5 years, 52 (38.52%) had been open for 6–10 years, and 23 (17.04%) had been operational status for more than 10 years (Table I).

Table I : General information of restaurants (n=135 food premises)

Issue	n	%
Food restaurant area size		
200 square metres	55	40.74
> 200 square metres	80	59.26
Number of service desks		
No desk (Takeaway)	22	16.30
< 10 tables	35	25.93
10-20 tables	48	35.56
>20 tables	30	22.21
Average (SD) = 16.42(4.30) tables		
Food sales patterns		
Accommodation/hotels/resorts	25	18.52
Food parks	22	16.30
General restaurant	42	31.11
Beverage outlets	46	34.07
Number of employees		
1-5 persons	52	38.52
6-10 persons	36	26.67
>10 persons	47	34.81
Average (SD) = 12.25 (2.58) persons		
Open period (years)		
< 1 year	28	20.74
1 – 5 years	32	23.70
6-10 years	52	38.52
>10 years	23	17.04
Average (SD) = 10.05 (2.35) years		

The distributions of general characteristics of the food handlers were 48 males (35.56%) and 87 females (64.44%). Seventy-two (53.33%) food handlers were younger than or equal to 28 years old, and 63 (46.67%) were over 28 years old (SD 28.21±7.65 years). Food handlers' education level was found to be either secondary school (35 persons, 25.93%) or above secondary school (64 persons, 47.40%).

Forty-nine restaurants (36.30%) were open/selling food for equal or fewer than six days per week, and 86 (63.70%) were open more than six days per week. Thirty-nine restaurants (28.89%) had less than or equal to five years of experience and 96 (71.11%) had more than five years of experience. Forty-seven (34.81%) employees had passed the clean food good test; 88 (65.19%) had not passed the clean food good test training (Table II).

Table II : Frequency distributions of general characteristics of the food handlers (n = 135)

General characteristics	n	%
Sex		
Male	48	35.56
Female	87	64.44
Age (years) (average $\bar{x} \pm$ standard deviation = 28.21±7.65 years)		
≤28 years	72	53.33
>28 years	63	46.67
Education level		
Secondary school	71	52.60
>Secondary school	64	47.40
Cigarette smoked		
Yes	25	18.52
No	160	81.48
Alcohol consumption		
Yes	47	34.81
No	88	65.19
Occupational lifestyle		
Hours worked per day		
≤8	51	37.78
>8	84	62.22
Days worked per week		
≤6	49	36.30
>6	86	63.70
Duration of work (years) (5.32±2.10 years)		
≤ 5	39	28.89
>5	96	71.11
Green Food Good test training		
Yes	47	34.81
No	88	65.19

Coliform bacterial contamination

The results for coliform bacterial contamination with SI-2 test kits from 731 samples across 135 sites showed contamination of plates/bowls (37/89, 41.57%), spoons (29/ 89, 32.58%), chopsticks (7/42, 16.67%), water glasses (38/112, 33.93%), ice (33/118, 27.97%), water used for cooking (3/89, 7.87%), food handlers' hands (92/135, 68.15%). Water for drinking was not contaminated with coliform bacteria (Figure 2).

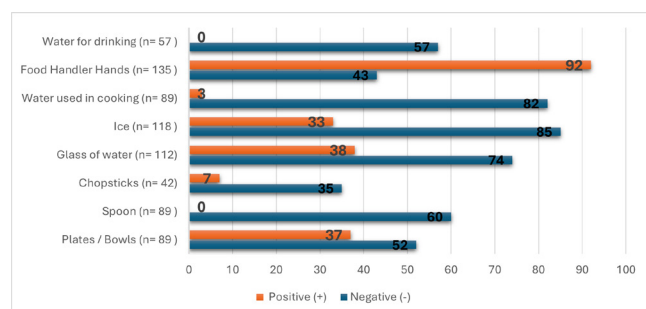


Figure 2 : Coliform bacterial contamination detected using SI-2 test kits

Level of knowledge, awareness, and food hygiene among food handlers

The results of the study of 135 people who were in contact with food showed that food handlers' overall knowledge of food safety was moderate (average score 7.20, SD 0.20). It was found that food handlers had a high level of awareness of food sanitation (average score 2.52, SD 0.24). The overall level of food sanitation hygiene practices was moderate (average score 1.93, SD 0.14). In addition, the study on the knowledge levels of food handlers, involving 135 participants, found that the three questions with the lowest correct response rates were as follows: The question, "Food handlers should maintain personal hygiene and undergo health checks at least once a year," was answered correctly by 58 participants (42.96%). The next question, "Aprons should be full-body, white, to make it easier to spot dirt," was answered correctly by 72 participants (53.33%). The third question, "Plastic containers should not be

used with hot food or fats," was answered correctly by 75 participants (55.56%). In contrast, the question that received 100% correct responses was, "Food sanitation refers to ensuring the safety of food intended for consumption."

For the attitude-related questions for food handlers, the three questions with the lowest levels of agreement were as follows: The question, "If onions or garlic develop mold, they should be discarded immediately," had 22 participants (16.30%) disagreeing. The next question, "Coughing, sneezing, wiping the nose, and talking while preparing food can spread germs to the food," had 16 participants (11.85%) disagreeing. The third question, "If cockroaches are found in food, the food should be discarded immediately," had 13 participants (9.63%) disagreeing. Regarding the practices of food handlers, the three questions with the most significant deficiencies in adherence were as follows: The question, "Wear a shirt with sleeves, an apron, and a hat or hairnet while preparing food," was answered with "sometimes" by 52 participants (38.52%). The next question, "Wash raw ingredients before storing them in the refrigerator," was answered with "sometimes" by 39 participants (28.89%). The third question, "Separate pets, such as dogs and cats, from the food preparation area," was answered with "sometimes" by 29 participants (21.48%). Additionally, the question "Do not wear rings or watches while preparing/cooking food" was answered with "sometimes" by 29 participants (21.48%) (Table III).

Table III : Levels of knowledge, awareness, and practices of those in contact with food (n= 135)

Item	Correct	n (%)		Average (SD)
		Wrong	Not sure	
1. Food sanitation means making food to be consumed safe.	135 (100.00)			10.00 High
2. Food condiments must have a food label that shows nutritional information.	89 (65.93)	15 (11.11)	31 (22.96)	6.78 (0.58) Moderate
3. Plastic containers should not be used for hot and fatty foods.	75 (55.56)	50 (37.04)	10 (7.41)	6.81 (0.62) Moderate
4. Borax, if it accumulates in the body, will cause cancer.	95 (70.37)	8 (5.93)	32 (23.70)	7.52 (0.105) Moderate
5. The main factors that cause food to be dirty are food, utensils, kitchens, cooks, and disease-carrying insects.	100 (74.07)	12 (8.89)	23 (17.07)	8.57 (0.10) High
6. Ceramic utensils can be contaminated with heavy metals.	82 (60.74)	15 (11.11)	38 (28.15)	7.22 (0.14) Moderate
7. Aflatoxin is caused by fungal toxins that can cause liver cancer.	72 (53.33)	24 (17.78)	39 (28.89)	7.42 (0.11) Moderate
8. People who come into contact with food should maintain body cleanliness and have a health check-up at least once a year.	58 (42.96)	35 (25.93)	42 (31.11)	5.89 (0.12) Low
9. Monosodium glutamate is an additive that is allowed to be added to food.	80 (59.26)	14 (10.37)	41 (30.37)	7.12 (0.10) Moderate
10. Fresh meat can be stored in a meat freezer or refrigerator compartment where the temperature is 0–7 °C for 3–5 days.	92 (68.15)	23 (17.04)	20 (14.81)	7.32 (0.15) Moderate
Max=10.00, Min=5.89, Average 7.20, SD 0.20. Moderate				

CONTINUE

Awareness	Strongly agree	Moderately agree	Disagree	Average (SD) Interpretation
1. Wearing a hat or hair cover while cooking is essential to reduce contamination in food.	79 (58.52)	48 (35.56)	8 (5.92)	2.42 (0.12) Moderate
2. Coughing, sneezing, and talking while cooking can transmit germs to food.	89 (65.93)	30 (22.22)	16 (11.85)	2.58 (0.18) High
3. Washing your hands with plain water keeps your hands clean enough.	32 (23.70)	92 (68.15)	11 (8.15)	2.78 (0.19) High
4. Picking up food with your bare hands can be done if the food is dry or fried.	29 (21.48)	87 (64.44)	19 (14.09)	2.75 (0.18) High
5. Preparation of raw meat and fresh vegetables can be done using a combination of cutting boards.	48(35.56)	75 (55.56)	12 (8.88)	2.14 (0.24) Moderate
6. If there are cockroaches mixed in the food, the food must be discarded immediately.	112 (82.96)	10 (7.41)	13 (9.63)	2.81 (0.09) High
7. Used oil can be reused 3–4 times.	49 (36.29)	84 (62.22)	2 (1.48)	1.68 (1.20) Moderate
8. If insects are found in the cooking area, wet food scraps must be disposed of neatly.	115 (85.19)	12 (8.89)	8 (5.92)	2.89 (0.09) High
9. If cockroaches are found in the cooking area, they must be sprayed with insecticide immediately to reduce their reproduction.	26 (19.26)	94 (69.63)	15 (11.11)	2.24 (0.15) Moderate
10. Onions, artificial tubers, and mould must be disposed of immediately if there is mold contamination.	88 (65.19)	25 (18.52)	22 (16.30)	2.89 (0.11) High
Max=2.89, min=1.68, Average 2.52, SD 0.24. High				
Food hygiene practices	Sometimes	Often	Always	Average (SD)
1. Food handlers must shower with soap at least twice a day.	8(5.92)	14(10.37)	113(83.71)	2.89(0.09) High
2. Wear a shirt with sleeves, an apron, and a hat or net covering your hair while cooking.	52 (38.52)	34 (25.19)	49 (36.29)	1.46 (0.15) Low
3. Separate pets such as dogs and cats from the cooking area.	29 (21.48)	58 (42.96)	48 (35.56)	1.45 (0.12) Low
4. Always wash raw materials before storing them in the refrigerator.	39 (28.89)	49 (36.29)	47 (37.18)	1.48 (0.19) Low
5. food handlers must Use a medium spoon to scoop food when taste the food.	18 (13.33)	59 (43.70)	58 (42.96)	1.97 (0.14) Moderate
6. Do not wear rings or watches while assembling/cooking.	29 ((21.48)	69 (51.11)	37 (27.41)	1.87 (0.12) Moderate
7. Do not use a cloth to wipe a container after washing it completely.	26 (19.26)	25 (18.52)	84 (62.22)	1.99 (0.17) Moderate
8. Use a food cover to cover the food to prevent contamination by flies.	12 (8.89)	29 (21.48)	94 (69.63)	2.14 (0.16) High
9. The wet trash can must be closed at all times to facilitate the disposal of garbage.	29 (21.48)	32 (23.70)	74 (54.81)	2.09 (0.15) High
10. If you have a cough, sneeze, or fever, take time off work to see a doctor.	19 (14.07)	42 (31.11)	74 (54.82)	1.96 (0.11) Moderate
Max=2.09, Min=1.45, Average 1.93, SD 0.14. Moderate				

Personal factors related to food handlers

Binary logistic regression showed that personal factors related to food handlers' knowledge of food safety were age ($p<0.001$), education level ($p<0.001$), cigarettes smoked ($p<0.001$), hours worked per day ($p<0.001$), years of work ($p<0.001$), and food sanitation training ($p<0.001$). Personal factors related to food sanitation awareness among the food handlers at tourist attractions in the Upper Tapi River in southern Thailand included age ($p<0.011$), education level ($p<0.001$), cigarettes smoked ($p<0.001$), alcohol consumption ($p<0.008$),

hours worked per day ($p<0.001$), days worked per week ($p<0.037$), years of work ($p<0.001$), and food sanitation training ($p<0.001$). In addition, personal factors related to food hygiene among the food handlers at tourist attractions in the Upper Tapi River included age ($p<0.001$), education level ($p<0.027$), cigarettes smoked ($p<0.001$), alcohol consumption ($p<0.001$), hours worked per day ($p<0.001$), days worked per week ($p<0.001$), years of work ($p<0.001$), and food sanitation training ($p<0.001$), as shown in Table IV.

Table IV : Distribution of factors and binary logistic regression of factors influencing with knowledge of food safety, food sanitation awareness, and food hygiene of the food handlers (n=135)

Items	Number	(%)	Knowledge of food safety, average (SD)	Crude OR (95% CI), p-value	Food Sanitation Awareness, average (SD)	Crude OR (95% CI), p-value	Food Hygiene, average (SD)	Crude OR (95% CI), p-value
Sex								
Male	48	53.33	7.58(2.04)	1.10(0.80-1.49), 0.542	2.42(0.40)	1.10 (0.53-1.40), 0.820	2.59(0.47)	0.90 (0.77-1.26), 0.815
Female	87	46.67	7.95(2.15)		2.46(0.42)		2.63(0.41)	
Age (years) (average $\bar{x} \pm$ standard deviation = 28.21 $\pm$ 7.65 years)								
≤ 28 years	72	35.56	5.67(1.05)	1.66 (1.23-1.91), $<0.001^*$	2.33(0.75)	1.69(1.41-1.78), 0.011*	2.45(0.55)	1.29 (1.34-1.92), $<0.001^*$
>28 years	63	64.44	7.89(2.10)		2.64(0.94)		2.70(0.61)	
Education level								
Secondary school	71	52.60	5.86(1.15)	2.19 (1.52-3.57), $<0.001^*$	2.24(0.54)	3.39 (2.18-5.54), $<0.001^*$	2.48(0.28)	2.95 (2.14-5.49), 0.027*
$>$ Secondary school	64	47.40	8.24(2.19)		2.64(0.49)		2.79(0.54)	
Cigarette smoked								
Yes	25	18.52	5.34(2.13)	3.45 (2.48-5.82), $<0.001^*$	2.24(0.35)	3.51 (2.38-5.78), $<0.001^*$	2.41(0.31)	3.41 (2.29-5.74), $<0.001^*$
No	160	81.48	7.45(1.74)		2.65(0.47)		2.79(0.21)	
Alcohol consumption								
Yes	47	34.81	7.57(1.23)	0.90 (0.51-1.34), 0.750	2.30(0.30)	1.57(1.43-1.71), 0.008*	2.45(0.29)	3.24 (2.12-4.52), $<0.001^*$
No	88	65.19	7.70(1.34)		2.63(0.51)		2.76(0.35)	
Occupational lifestyle								
Hours worked per day								
≤ 8	51	37.78	5.70(1.65)	3.52 (2.48-5.79), <0.001	2.19(0.45)	3.59 (2.28-5.83), $<0.001^*$	2.83(0.39)	3.48 (2.45-4.99), $<0.001^*$
>8	84	62.22	7.80(1.54)		2.59(0.29)		2.42(0.27)	
Days worked per week								
6 days/week	49	36.30	7.54(1.13)	1.19 (0.87-1.32), 0.585	2.43(0.35)	1.89 (0.95-3.39), 0.037*	2.39(0.25)	3.42 (2.47-4.83), $<0.001^*$
>6 days/week	86	63.70	7.60(1.25)		2.79(0.41)		2.87(0.30)	

CONTINUE

Items	Number	(%)	Knowledge of food safety, average (SD)	Crude OR (95% CI), p-value	Food Sanitation Awareness, average (SD)	Crude OR (95% CI), p-value	Food Hygiene, average (SD)	Crude OR (95% CI), p-value
Duration of work (years) (5.32±2.10 years)								
≤ 5 years	39	28.89	5.73(1.40)	1.91 (1.20-3.75), <0.001*	2.46(0.32)	1.29 (1.09-1.68), <0.001*	2.42(0.29)	1.35 (1.22-1.78), <0.001*
>5 years	96	71.11	7.58(1.39)		2.79(0.41)		2.84(0.36)	
Food sanitation training								
Yes	47	34.81	5.82(1.59)	1.78 (1.28-2.49), <0.001*	2.96(0.42)	1.59 (1.24-2.47), <0.001*	2.38(0.31)	1.81 (1.27-2.73), <0.001*
No	88	65.19	7.85(1.75)		2.29(0.47)		2.87(0.42)	

*Significantly association at 0.05.

These variables were analysed using multiple logistic regression while controlling for other variables. It was found that personal factors of food handlers at tourist attractions in the Upper Tapi River related to knowledge of food safety included education level ($p=0.024$), hours worked per day ($p<0.001$), years of work ($p<0.001$), and food sanitation training ($p<0.001$). Personal factors related to food sanitation awareness among the food handlers included age ($p<0.001$), education level

($p<0.001$), hours worked per day ($p<0.001$), days worked per week ($p<0.001$), years of work ($p<0.001$), and food sanitation training ($p<0.001$). In addition, personal factors related to food hygiene among the food handlers included age ($p<0.001$), education level ($p<0.001$), hours worked per day ($p<0.001$), days worked per week ($p<0.001$), years of work ($p<0.001$), and food sanitation training ($p<0.001$), as shown in Table V.

Table IV : Multiple logistic regression of factors associated with knowledge of food safety, food sanitation awareness, and food hygiene of the food handlers residing at tourist attractions in the Upper Tapi River in southern Thailand

Variables	Knowledge of food safety			Food sanitation awareness			Food hygiene practices		
	Adjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Age									
≤28 years	0.62	0.21-1.24	0.51	1.56	1.19-2.45	<0.001*	1.71	1.32-1.51	<0.001*
>28 years	1			1			1		
Education level									
Secondary school	1			1			1		
>Secondary school	2.30	1.15-4.59	0.024*	2.18	1.29-3.87	<0.001*	2.20	1.61-2.74	<0.001*
Cigarette smoked									
Yes	1			1			1		
No	0.68	0.32-1.38	0.63	0.73	0.39-1.01	0.520	0.98	0.69-1.51	0.82
Alcohol consumption									
Yes	1			1			1		
No	0.60	0.22-1.19	0.84	0.85	0.52-1.84	0.74	0.92	0.69-1.43	0.71

CONTINUE

Variables	Knowledge of food safety			Food sanitation awareness			Food hygiene practices		
	Adjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Hours worked per day									
8	1			1			1		
>8	3.09	1.28-3.52	<0.001*	2.36	1.39-3.60	<0.001*	2.28	1.20-3.49	<0.001*
Days worked per week									
6 days/week	1			1			1		
>6 days/week	0.95	0.38-1.52	0.85	2.45	1.42-3.98	<0.001*	2.51	1.49-3.58	<0.001*
Duration of work (years) (5.32±2.10 years)									
≤ 5 years	1			1			1		
>5 years	2.15	1.34-3.75	<0.001*	2.50	1.40-3.81	<0.001*	2.37	1.38-3.56	<0.001*
Food sanitation training									
Yes	1			1			1		
No	2.87	1.41-4.62	<0.001*	3.21	2.57-4.25	<0.001*	3.32	2.60-4.10	<0.001*

*Statistical significance at $p < 0.05$.

CONCLUSION

The study did not collect food samples due to the service format of the sample group, where 100% of the food served was freshly prepared, and water for drinking was not contaminated with coliform bacteria. The results for coliform bacterial contamination with SI-2 test kits showed contamination of food handlers' hands. It was found that 68.15% (92/135) of food handlers were contaminated with coliform bacteria. Observations by the researcher revealed that most contamination was due to the personal hygiene practices of food handlers or improper sanitation practices. These included inadequate handwashing, direct hand contact with food, improper dishwashing, and improper food storage. For example, in situations with a high volume of customers, food handlers had to directly handle raw ingredients, both cleaned and uncleaned, with their hands. Additionally, most food handlers used cloths that were repeatedly reused to wipe their hands, which could be a contributing factor to the contamination of coliform bacteria.¹⁴

The top three items found to be contaminated with coliform bacteria were plates/bowls (41.57%, 37/89), drinking glasses (33.93%, 38/112), and spoons (32.58%, 29/89). Observations revealed that these items, including plates, drinking glasses, and spoons, were cleaned with detergents and water and then wiped with cloths, which were reused multiple times. Therefore, the reuse of cloths to wipe these utensils may be a source of coliform bacteria contamination. According to food sanitation principles, utensils and equipment should be left to dry by placing them upside down on a drying rack or allowing them to air dry before being stored.¹⁴

Coliform bacteria contamination was found in ice (38/112, 33.93%). Upon inquiry, it was revealed that establishments source their ice from local ice production facilities distributed throughout the districts. However, observations indicated that the ice samples contaminated with coliform bacteria were

those collected from beverage shops, where the ice was stored in containers awaiting sale. It was found that in these establishments, the ice was stored alongside other items, such as pre-made syrup, which could contribute to the contamination.¹⁴

This study reported on the food safety knowledge, food sanitation awareness, and practice of food handlers. Overall, food handlers had moderate knowledge (average 7.20, SD 0.20), high food sanitation awareness (average 2.52, SD 0.24), and moderate food hygiene practice (average 1.93, SD 0.14). This is similar to the study by Banna et al.,¹⁶ who reported that participants possessed a moderate level of knowledge and adherence to food safety practices. Only one previous study has been conducted on the food safety knowledge and practice of hospital food service workers in Bangladesh. This study's results indicated that food handlers aged less than 28 years had higher scores for knowledge of food safety and hygiene practices compared to food handlers aged 28 years and older ($p < 0.001$, $p < 0.001$). Siddiky et al.¹⁷ found that food handlers aged 18-25 had significantly higher ratings in food safety practices compared to those aged 46 years and older ($\beta = 0.16$, $p = 0.040$). The present study reported that food handlers with higher secondary education levels had greater proficiency in food safety knowledge, food sanitation awareness, and food hygiene practices than food handlers whose education was at lower secondary education level ($p < 0.001$, $p < 0.001$, $p = 0.001$, respectively). This result is supported by Alemayehu et al.,¹⁸ and Moreb et al.,¹⁹ who reported that food handlers with only primary education were less likely to possess sufficient understanding of food safety than those with at least a secondary education.

This study showed that those who worked more than 8 hours per day and more than 6 days per week had higher knowledge of food safety, food sanitation awareness,

and food hygiene practices. This result is supported by Siddiky et al.,¹⁷ who reported that food handlers who worked more than 10 hours per day had higher knowledge, higher food safety authority knowledge, and better food safety practices.

In this study, the results indicated that food handlers who had work experience of more than five years had higher scores in knowledge of food safety, food sanitation awareness, and food hygiene practices when than food handlers who had worked for five years or fewer ($p < 0.001$, $p < 0.001$, $p = 0.001$, respectively). These results are supported by Farahat et al.,²⁰ who reported that a longer term of employment provides a base for the continuous improvement of safe food hygiene practices, considering that there is a significant positive correlation between food handlers' food safety knowledge and their years of working experience.

The results of this study showed that 34.81 per cent of the food handlers had received food sanitation training. This result is similar to that in the study by Alemayehu et al.,¹⁸ who reported that about 15.7 per cent of food handlers in Northwest Ethiopia had received training. An in-depth inquiry revealed that some of the subjects were new entrepreneurs who had not been trained, because government agencies had been focusing on the prevention of COVID-19. The same goes for the results of in-depth interviews with this food handlers group: there were no training activities on food sanitation due to the previous COVID-19 pandemic. However, entrepreneurs are of the opinion that COVID-19 prevention, such as wearing a mask to help prevent the spread of germs from coughing and sneezing, is one way to prevent the occurrence of contagious diseases that are mediated by food and water.

The results of this study reported that food handlers who had received training had higher scores in knowledge of food safety and food hygiene practices than food handlers who had not received training ($p < 0.001$, $p < 0.001$, $p = 0.001$, respectively). However, the results of the study showed that overall food handlers had moderate knowledge and moderate hygiene practices. Uzoama et al.,²¹ reported that training received by food handlers might be responsible for higher knowledge among food handlers. In addition, Odipe et al.,²² reported that training may not be a routine practice in Nigeria but is usually occasioned by funding or the outbreak of a food-borne disease.

CONCLUSION

This study found moderate knowledge of food safety and food hygiene practices among food handlers. In addition, their food sanitation awareness was high. The results of the study showed that personal factors including age, education level, hours worked per day, days worked per week, years of work, and training in

food sanitation affect the knowledge awareness and good hygiene of those who come into contact with food. Therefore, the promotion and support of food sanitation knowledge is required among food entrepreneurs and food handlers to develop their potential for knowledge and understanding of food sanitation and to comply with laws or regulations. In addition, it is necessary for building confidence among tourists that the food served to them is not only delicious but also clean and safe.

ACKNOWLEDGEMENT

This study was supported by Office of National Higher Education Science Research and Innovation Policy Council as of fiscal year 2024 and Thaksin University, Thailand with the financial Number: 4708174.

REFERENCES

1. The world bank. Food-borne Illnesses Cost US\$ 110 Billion Per Year in Low- and Middle-Income Countries. 2018 [cited 2024 May 20]. Available from: <https://www.worldbank.org/en/news/press-release/2018/10/23/food-borne-illnesses-cost-us-110-billion-per-year-in-low-and-middle-income-countries>
2. The World Health Organization (WHO). Food safety. 2018 [cited 2024 May 22]. Available from: <https://www.who.int/news-room/fact-sheets/detail/food-safety>
3. Statista Research Department. Foreign tourist arrivals Thailand 2015-2023. 2024 [cited 2024 May 22]. Available from: <https://www.statista.com/statistics/994693/thailand-number-international-tourist-arrivals/#:~:text=In%202023%2C%20the%20number%20of,by%20the%20COVID%2D19%20pandemic.>
4. Department of Health Ministry of Public Health. Handbook of Clean Food Good Taste. 2011 [cited 2024 May 22]. Available from: https://asean-eh.anamai.moph.go.th/uploads/txt_1565692864.pdf
5. Connor BA, 2020. Part 2: traveler's diarrhea. Brunette GW, Nemhauser JB, eds. CDC–Yellow Book. Health Information for International Travel. Atlanta, GA: Oxford University Press, 2020;114–120.
6. Heather CS. Travellers' diarrhoea. BMJ Clin Evid : 2015[cited 2024 May 20]. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4415508/pdf/2015-0901.pdf>
7. Steffen R, Hill DR, DuPont HL. Traveler's diarrhea: a clinical review. JAMA. 2015; 313: 71–80.
8. Sharma C, Poovorawan K, Piyaphanee W, Soonthornworasiri N, Angsuwatcharakon P, Phumratanaprapin W et al. Incidence of Travelers' Diarrhea among Adult Foreign Travelers in Thailand: A Prospective Study. Am J Trop Med Hyg. 2020; 102(5): 1009–1015.
9. World map. Nakhon Si Thammarat Map.

- 2024[cited 2024 May 28]. Available from: <https://www.mapsofworld.com/thailand/provinces/nakhon-si-thammarat-map.html>
10. Department of Health Ministry of Public Health. The restaurant meets the Clean Food Good Taste criteria. [cited 2025 Much 27]. Available from: <https://www.anamai.moph.go.th/th/news-anamai/43309>
11. Kibret M, Abera B. The sanitary conditions of food service establishments and food safety knowledge and practices of food handlers in Bahir Dar town. *Ethiopian Journal of Health Sciences*.2012; 22(1): 27-35.
12. Cronbach L J. *Essential of psychological testing*. (5th ed.). New York: Harper Collins.1990
13. Likert R. *The human organization: Its management and value*. New York: McGraw-Hill.1967.
14. Bureau of Food and Water Sanitation. *Principles of food sanitation inspector*. Thailand: Bureau of Food and Water Sanitation, 2013b. [cited 2024 May 25]. https://foodsan.anamai.moph.go.th/web-upload/13x34cba8a8c311038000343e8ab441d5ff/m_magazine/32630/910/file_download/3ad66a5b2d5f5730f427ff3ddb7eb2d4.pdf
15. Patel A K, Singhanian RR, Pandey A, Joshi VK, Nigam PS, Soccol CR. Enterobacteriaceae, Coliforms and E. Coli: introduction. In Batt CA & Tortorello ML (Eds.), *Encyclopedia of food microbiology* (2nd ed., Vol. 1, pp. 659-666). London: Elsevier. 2014[cited 2024 May 25]. Available from: <http://dx.doi.org/10.1016/B978-0-12-384730-0.00096-3>.
16. Banna MHAI, Khan MSI, Rezyona H, Seidu AA, Abid MT, Ara T Kundu, et al. Assessment of food safety knowledge, attitudes and practices of food service staff in Bangladeshi hospitals: a cross-sectional study. *Nutrients*. 2022; 14 (12): 1-18.
17. Siddiky A, Mollick K, Aktarujjaman MD, Islam F, Mamun MA, Roy N. Determinants of food safety knowledge and practices among food handlers in Bangladesh: An institution-based cross-sectional study. *Heliyon*. 2024; 10 (2024): e25970.
18. Alemayehu T, Aderaw Z, Giza MG. Diress, Food safety knowledge, handling practices and associated factors among food handlers working in food establishments in debre markos town, northwest Ethiopia, 2020: institution-based cross-sectional study. *Risk Manag Healthc Pol*. 2021; 14:1155–1163.
19. Moreb NA, Priyadarshini A, Jaiswal AK. Knowledge of food safety and food handling practices amongst food handlers in the Republic of Ireland. *Food Control* 2017; 80: 341–349.
20. Farahat MF, Ei MM, Shafie MI. Waly Food safety knowledge and practices among Saudi women. *Food Control*. 2015; 47: 427-435.
21. Uzoama JO, Heejin Kimm H, Konlan KD. Factors associated with food safety practices among food handlers in Abuja municipal area council, Nigeria. *J Glob Health Sci* 2023; 5(1):e9.
22. Odipe OE, Raimi MO, Deinkuro NS, Funmilayo AA, Edewor OP& Lateefat HM, et al. Assessment of environmental sanitation, food safety knowledge, handling practice among food handlers of bukateria complexes in Iju Town, Akure North of Ondo-State, Nigeria. *Acta Sci Nutr Health*. 2019; 3(6):186–200.