Food Safety Knowledge, Attitude and Practices of Food Handlers in Restaurants in the Maldives

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Article

Food safety Knowledge, Attitude, and Practices (Self-reported and Observation) of Food Handlers in Restaurants in Male'—Maldives

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Abstract: Poor hygiene in the food services industry is a critical public health concern in the Maldives that caused by several focal issues such as limited inspections and monitoring, inadequate training and knowledge and lack of regulatory framework. Thus, this study aimed to identify the focal of all the issues which are the level of knowledge, attitude, and practice (KAP) of food handlers as well as the potential association between the variables (knowledge, attitude, and practice). A total of 290 food handlers from restaurants were surveyed, demonstrating moderate level of food safety knowledge (55.5%), moderate attitude towards food safety (3.62±0.51) and good level of food safety practice (4.18±0.54). However, it is critical the result shows that the food handlers in Male' have poor practice on the time and temperature control especially on thawing and storage resulting from a lack of training in the temperature danger zone. The work experience impacting the level of knowledge, education impacts the level of attitude and age, and education and work experience impacting practice. Association analysis identified significant relationships between knowledge, attitude, and practice of food safety of the Maldives food handlers. Despite the good score of food safety practice from the self-reported questionnaire, the observation from 102 restaurants, results showed that the actual situation reflected the confirmation of poor practices on time and temperature control and other categories of food safety that need further attention in designing the food safety trainings. This study is fundamental for policymakers to review and improve law enforcement to address the current food safety situation in the Maldives and for the businesses to selectively plan the food safety trainings based on the KAP of Maldivian food safety food handlers.

Keywords: food safety; food security; knowledge-attitude-practice; food handlers; training; Maldives; observation

1. Introduction

Consuming food contaminated with microorganisms such as bacteria, viruses, parasites, and organic and inorganic chemical substances causes over 200 diseases globally. The latest records estimate that 600 million people become ill due to eating contaminated food, resulting in 420 000 deaths annually [1] especially in developing and underdeveloped countries. Food safety ensures the proper handling, storage, and preparation of food, thus preventing foodborne illness. It is considered a major global concern [2] and is described as a critical component of sustainable development [3].

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Food establishments, such as restaurants, can cause foodborne diseases through various sources including bacteria, viruses, parasites, chemical contaminants and allergens. Among the source of food contamination such as cross-contamination, food additives, food handlers are a well-known caused of food contamination, ultimately leading to foodborne illnesses by improper storage, poor hygiene practices and improper cooking temperature [4,5]. Recently, an outbreak of Yersinia caused fifty-three people to fall sick in Sweden, with many affected individuals having visited the same restaurant chain before showing symptoms [6]. In early 2020, 63% of the cases of an outbreak of *E. coli* in the USA were related to contaminated food from a restaurant chain [7].

In developing countries, food safety has been overlooked despite several interventions put forward to manage food safety by given significance to water sanitation, and hygiene. However, studies have proven that water sanitation, and hygiene alone could not reduce the number of foodborne illnesses [8]. Hence, there is a new focus to improve food safety through technologies, training of direct and indirect food workers, and restructuring food safety governance. A study conducted in China revealed that by strengthening food safety standards and guidance, the country can improve foodborne disease events [9].

A food handler is any person involved in handling packaged or unpackaged food, equipment, and utensils, and touching food contact surfaces hence should comply with food hygiene requirements [10]. Food handlers' behaviour is a crucial factor in contaminating food due to potential improper food handlings practices, such as improper holding times and temperature, inadequate cooking, cross-contamination, and food from unsafe sources [11–13]. Several studies have evaluated the baseline knowledge, attitude, and practices (KAP) of food handlers concerning food safety [14,15] but no available study has been conducted in the Maldives.

Food safety practices and regulations in restaurants in the Maldives are overseen by the Ministry of Health and the Maldives Food and Drug Authority (MFDA). The MFDA is responsible for implementing food safety standards and regulations in the country and conducts inspections of restaurants to ensure that they comply with these standards. According to the registration list provided by the Health Protection Agency (HPA), there are 179 registered restaurants in Male', Maldives [16] and food handler training is required as per clause 23 of General Hygiene of Food Establishments and Services [23], whereby every food handler should undertake a basic food safety training programme to be an eligible food handler. Additionally, the hygiene and sanitation of food establishments and services are regularly inspected by the HPA and Ministry of Health, Maldives [17]. In the Maldives, the official statistics on foodborne outbreaks are limited due to a lack of a surveillance and reporting system [17], and the legislative framework is not established. Furthermore, under-reporting is common in third-world countries as lack of reliable statistics and information on hazards associated with the food continuum due to the deficiency of foodborne surveillance [8]. Although there is no current data regarding foodborne illnesses in the Maldives, poor hygiene in the food services industry is a major public health concern, with an average of 35 public complaints per month regarding poor hygienic conditions of the restaurants in Male', the capital city of the Maldives [17].

To address the problems concerning poor hygienic conditions and the possible consequences, this study assessed the KAP of food handlers and the association with sociodemographic characteristics of food handlers in the restaurants of Male' city, Maldives. This study can be a significant fundamental investigation of the KAP of food handlers in Male', and the potential risk of foodborne illnesses.

2. Materials and Methods

2.1. Study Design

This is a cross-sectional study to describe the knowledge, attitude, and practice of the food handlers concerning food safety in Male' restaurants. A quantitative approach was used to evaluate the level of knowledge, attitude, and practices of the food handlers, the relationship between the KAP and, the impact of sociodemographic characteristics towards KAP. A qualitative approach through

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observations of the food handling practices were conducted by five trained inspectors with a list of observations checklist following similar method in [18].

2.2. Study Area and sample size

This study was conducted in Male', the capital of Maldives which contains 179 registered restaurants [16]. However, there is no available document showing the number of food handlers working in the restaurants in Male', therefore, a census of the food handler population was made during the pilot of the questionnaire, recording an average of ten food handlers per restaurant. The target sample size of 84 was calculated using G-power software, however the total respondent for this study is 290 which exceeding the target sample size. Restaurants were selected randomly from the registration list provided by the HPA of Maldives.

2.3. Inclusion and Exclusion Criteria

The inclusion criteria are the food handlers working at the restaurant in Male', Maldives, and can communicate in the local language "Dhivehi" or English. Whilst, eligible food handlers were randomly selected and briefed about the objectives of the study, the contents of the questionnaire, and the observational checklist with the assurance that their identity would be anonymous. The exclusion criteria are the employees that do not have any direct contact with or handling the food.

2.4. Questionnaire Design and Pilot Study

A structured questionnaire was designed to assess the KAP of food handlers on a few risk factors of food safety [14,19]. The questionnaire consists of ten questions regarding socio-demographics and sixteen questions to assess knowledge. The responses were "true", "false" or "do not know" to reduce the participant's select answers by chance. Each correct answer was given a mark, while incorrect answers and the answers with "do not know" option was given no mark.

Attitude and practices were assessed by sixteen questions and scored based on a 5-point Likert scale, with the attitude section scored as "strongly disagree", "disagree", "undecided", "agree", and "strongly agree" and the practice section scored as "never", "not often", "sometimes", "most of the time", and "always". The final average score the lowest with 1 and the highest is 5 as showed in [43].

The questionnaire was piloted by fifty food handlers and the Cronbach alpha value was 0.78, 0.87, and 0.79 in knowledge, attitude, and practice respectively, indicating the stability and reliability of the questionnaire [20]. For samples of 25 – 40 per group, observed alpha should probably at least .75 in order to have reasonable confidence that the population value is at least .70 [21]. The questionnaire was modified to improve clarity and translated into Bangladeshi and English.

2.5. Data Analysis

Statistical analysis was conducted using SPSS software version 20.0.and XLSTAT 2021. Descriptive statistics were used to summarise the demographic factors, knowledge, attitude, and practices of the respondents. To detect the statistical difference in mean KAP scores based on sociodemographic characteristics, the Kruskal-Walis H test, and Mann Whitney U test were used as the distribution of the data is not normal [22]. Additionally, observational data, which was collected for further evaluation of practice dimensions, were analysed based on observations checklist consisting of personal hygiene, time and temperature control, and cross-contamination.

3. Results and discussion

3.1. Sociodemographic Characters

The sociodemographic characteristics of 290 food handlers of restaurants in Male', Maldives are characterised in Figures 1. Most respondents were male (84.8%) due to the low rate of female participants in the accommodation and food industry as shown by the population and housing census 2014 from the National Bureau of Statistics (https://statisticsmaldives.gov.mv/). More than

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half of the respondents (57.9%) are young adults (26 to 35 years old), while the majority of the respondents are Bangladeshis (47.9%), and only 15.5% were Maldivians. Approximately half of the respondents were married (53.1%) and 33.1% having a college or university education, while 19.7% had not received any formal education. Another critical characteristic is concerning food safety training and experience as shown in Figure 2. Half of the respondents had 1 to 5-years' experience as food handlers, 64.5% were food serving staff and approximately half of the respondents did not receive food safety training, which contradicts clause 23 of the Regulation on General Hygiene of Food Establishments and Services [23] of the Maldives, and only 37.9% received basic training such as handwashing.

3.2. Food Safety Knowledge

The food safety knowledge of food handlers is presented in Table 1 with average of score 60%. The knowledge related to personal hygiene were answered correctly by most respondents (93.85%), showing that the respondents could identify different occasions of handwashing (98.6%), the risk of wearing jewellery (91.7%), the importance of handwashing after using disposable gloves (87.2%) and handwashing after handling the garbage (97.9%). However, As shown in Table 1, food handler training programmes in Maldives emphasised personal hygiene could be why there was a high level of knowledge in this area [24]. Although most of the food handlers in Male' are Bangladeshi, this result shows the effect of the training programme in Maldives as the food handlers in Bangladesh were reported with poor knowledge [25]. In the Maldives, knowledge concerning personal hygiene is commonly conveyed to the public in health-promoting events, for example, the correct handwashing procedure is frequently displayed in public areas and food serving premises.

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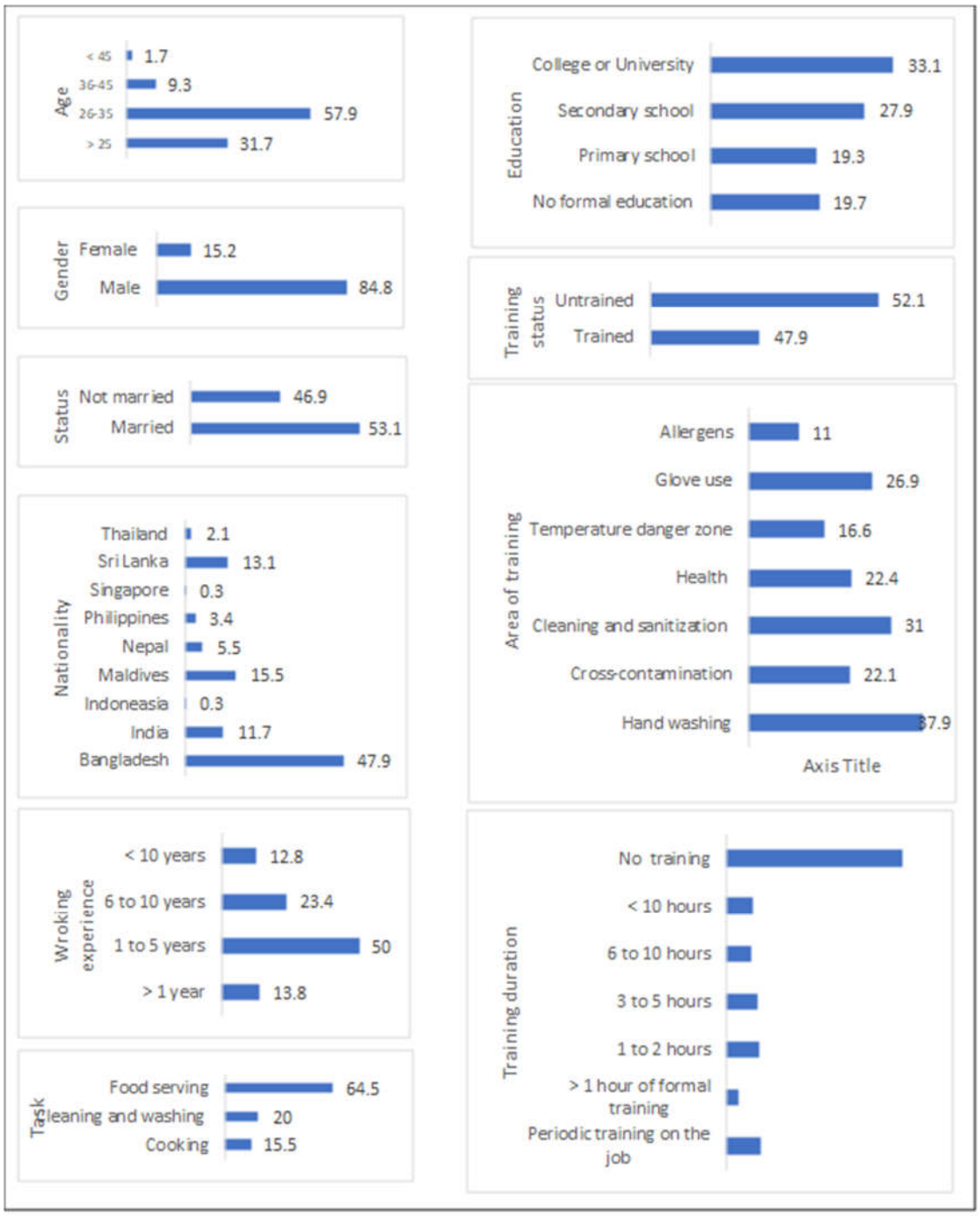

Figure 1. Sociodemographic characteristic of food handlers.

Table 1 shows the least mean food safety knowledge score of 7.6% was recorded in response to the best temperature for foodborne microorganisms to grow is between 25°C to 60°C. This means that the food handlers lacked knowledge regarding temperature and control and foodborne pathogens. Note that time and temperature control are the least training topics given to the food handlers in Maldives (Figure 1), which may have impacted the level of knowledge. This underscores the need of improving food handlers' food safety awareness by providing basic food safety training, as the majority of them have never received such training. The government is responsible for establishing and enforcing regulations, providing guidance and education, conducting inspections, and promoting compliance with food safety standards [10].

Table 1. Knowledge concerning food safety of the food handlers of restaurants in Male', Maldives. (n=290).

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Category	Questions	Response frequency (%)		
		True	False	Do not know
Personal hygiene	1- Hands should be washed before and after preparing food, using toilets, and cleaning the table	**286 (98.6%)**	2 (0.7%)	2 (0.7%)
	2- Jewellery should not be worn by food handlers when preparing food, as it can contain dirt and bacteria	**266 (91.7%)**	10 (3.4%)	14 (4.8%)
	3- It is necessary to have thoroughly washed hands if you use single-use gloves to handle food	**253 (87.2%)**	26 (9.0%)	11 (3.8%)
	4- It is essential to wash hands after handling the garbage	**284 (97.9%)**	5 (1.7%)	1 (0.3%)
Cross-contamination	5- Wiping cloths can spread microorganisms	**250 (88.0%)**	14 (4.9%)	20 (7.0%)
	6- The same cutting board can be used for raw and cooked foods if it looks clean	63 (21.7%)	**217 (74.8%)**	10 (3.4%)
	7- The ideal place to store raw fish, chicken, and beef in the refrigerator is the bottom shelf	**97 (33.4%)**	134 (46.2%)	59 (20.3%)
	8- It is necessary to wash the food contact surface with water and soap, then apply sanitiser	**214 (73.8%)**	47 (16.2%)	29 (10.0%)
Time and temperature control	9- The best way to defrost meat is by keeping the meat on a dry countertop	165 (56.9%)	**83 (28.6%)**	42 (14.5%)
	10- The correct temperature for storing easily spoiled foods such as vegetables and fruits is 10°C	136 (46.9%)	**61 (21.0%)**	93 (32.1%)
	11- Hot, ready-to-eat food should be kept above the temperature of 60°C	**166 (57.2%)**	30 (10.3%)	94 (32.4%)
	12- The refrigerator operating temperature should be between 5°C and 10°C	136 (46.9%)	**62 (21.4%)**	92 (31.7%)
Foodborne pathogen	13- Hypertension can be caused by eating contaminated food	218 (75.2%)	**29 (10.0%)**	43 (14.8%)
	14- The best temperature for foodborne microorganisms to grow is between 25°C to 60°C	163 (56.2%)	**22 (7.6%)**	105 (36.2%)

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	15- *Salmonella*, *Shigella*, Hepatitis a virus, and *Staphylococcus aureus* are related to foodborne diseases	**177 (61.0%)**	17 (5.9%)	96 (33.1%)
	16- Microbes are in the skin, nose, and mouth of healthy handlers	**101 (34.8%)**	74 (25.5%)	115 (39.7%)

Bold: Correct answer.

3.3. Food Safety Attitudes

Measuring food handlers' attitudes toward food safety is critical as it influences their behavior and practices accordingly [26]. The overall attitude of the respondents was moderate with an overall average scale of 3.62±0.5 as similar scale was used in [43].

The moderate score of food handlers related to handwashing during food preparation indicate that the food handlers' attitudes towards personal hygiene-related activities should be improved to facilitate proper food handling practices. Despite the high mean score of knowledge with regard to personal hygiene, the attitude of the food handlers in Male' restaurants towards personal hygiene issues is comparatively poor and this may be due to cultural practices [27]. Hand-washing practices are uncommon in the Maldives due to cultural norms that encourage eating with their hands many have a common attitude of using their hands to touch food without washing.

Table 2. Food safety attitude of the food handlers of restaurants in Male', Maldives. (n=290)

Question	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean±SD
1-Frequent handwashing during food preparation wastes time	55 (19.0%)	47 (16.2%)	9 (3.1%)	105 (36.2%)	74 (25.5%)	3.33±1.48
2- A simple finger ring is safe to wear during food preparation	7 (2.4%)	28 (9.7%)	14 (4.8%)	148 (51.0%)	93 (32.1%)	4.01±0.99
3- I do not need to thoroughly wash my hand if gloves are used to handle food	29 (10.0%)	58 (20.0%)	37 (12.8%)	116 (40.0%)	50 (17.2%)	3.34±1.26
4- Handling the garbage bags which are well covered does not make the hands dirty	21 (7.2%)	49 (16.9%)	7 (2.4%)	146 (50.3%)	67 (23.1%)	3.65±1.21
5- It is okay to use the same wipe cloths to clean tables and dishes	6 (2.1%)	8 (2.8%)	10 (3.4%)	111 (38.3%)	155(53.4%)	4.38±0.85

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6- It is safe if the cutting board used to cut raw chicken is washed with water before using it to cut vegetables	39 (13.4%)	32 (11.0%)	10 (3.4%)	94 (32.4%)	115(39.7%)	3.74±1.42
7- Frozen raw meat can be kept in the freezer along with other food (e.g., ice-cream/cooked food)	17 (5.9%)	21 (7.2%)	24 (8.3%)	105 (36.2%)	123(42.4%)	4.02±1.15
8- Washing food contact surfaces with water and soap, followed by the application of a sanitiser is essential to prevent cross-contamination	47 (16.2%)	165 (56.9%)	39 (13.4%)	22 (7.6%)	17 (5.9%)	3.80±1.02
9- Thawing frozen food (chicken/beef/fish) at room temperature is safe	42 (14.5%)	51 (17.6) %	48 (16.6%)	69 (23.8%)	80 (27.6%)	3.32±1.41
10- Carrot, cabbage, and other vegetables can be stored at room temperature	41 (14.1%)	96 (33.1%)	23 (7.9)	105 (36.2%)	25 (8.6%)	2.92±1.27
11- Hot ready-to-eat food should be kept at 65°C	65 (22.4%)	107 (36.9%)	95 (32.8%)	19 (6.6%)	4 (1.4%)	3.72±0.93
12- The refrigerator temperature is safe below 10°C	48 (16.6%)	117 (40.3%)	76 (26.2%)	44 (15.2%)	5 (1.7%)	2.45±0.99
13- Foodborne disease is a serious issue	111 (38.3%)	159 (54.8%)	13 (4.5%)	3 (1.0%)	4 (1.4%)	4.28±0.72
14- Foodborne pathogens can grow well at room temperature	53 (18.3%)	130 (44.8%)	93 (32.1%)	6 (2.1%)	8 (2.8%)	3.74±0.88

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15- Knowing about bacteria that cause food poisoning can help to prevent foodborne disease	89 (30.7%)	163 (56.2%)	19 (6.6%)	15 (5.2%)	4 (1.4%)	4.10±0.83
16- Food handlers are free from germs that cause food poisoning if they are not sick	41 (14.1%)	61 (21.0%)	31 (10.7%)	124 (42.8%)	33 (11.4%)	3.16±1.28

A poor attitude toward the storage temperature of perishable food (mean score, 2.92) and safe refrigerator temperature (mean score, 2.45) was identified and may be due to their poor knowledge of time and temperature control. Food safety training in temperature control is limited in the Maldives, and there is a lack of awareness about the importance of safe food storage practices (Table 1.), hence the poor attitude towards it. In the Maldives, it is a common culture to buy fresh seafood and keep it for several hours before cooking the room temperature. Cultural norms such as placing perishable food at room temperature for a long period of time might encourage the growth of hazardous bacteria [10].

3.4. Food Safety Practice

The food handler practices were evaluated through a self-reporting tool, which has the potential of desirability bias. Observations were performed at the restaurants to evaluate food handler practices as well as restaurant facilities to complement the self-reported practices. The restaurant is the venue where the observations took place, and the restaurant facilities is one of the criteria in the observation checklist referring to the structures and equipment related to the food safety practices. The observation data can be affected by the presence of the observer or the Hawthorne effect [28].

3.4.1. Self-reported Assessment

Table 3 shows a good level of practice of the respondents in this study, the overall mean score of food safety practice is 4.18±0.54. The percentage of the respondents who always performed the correct practices are shown in bold in Table 3, which remains considerably low despite the overall percentage score.

Table 3. Self-reported food safety practices of the food handlers of restaurants in Male', Maldives. (n=290)

Question	**Always**	**Most of the time**	**Sometimes**	**Not often**	**Never**	**Mean±sd**
1- I wash my hands before and during food preparation	243 (83.8%)	36 (12.4%)	9 (3.1%)	1 (0.3%)	1 (0.3%)	4.79±0.54
2- I wear jewellery like a finger ring or bracelets during the handling of food	7 (2.4%)	6 (2.1%)	20 (6.9%)	18 (6.2%)	239(82.4%)	4.64±0.89

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3- I wear gloves when I touch ready-to-eat food	90 (31.0%)	60 (20.7%)	35 (12.1%)	61 (21.0%)	44 (15.2%)	3.32±2.47
4- I wash my hands after touching the garbage	237 (81.7%)	31 (10.7%)	7 (2.4%)	3 (1.0%)	12 (4.1%)	4.65±0.92
5- I use the same towel to wipe dish plates, knives, and chopping boards	17 (5.9%)	10 (3.4%)	9 (3.1%)	28 (9.7%)	226 (77.9%)	4.50±1.11
6- I use separate cutting boards when preparing raw and cooked food	238 (82.1%)	23 (7.9%)	10 (3.4%)	6 (2.1%)	13 (4.5%)	4.61±0.99
7- I store frozen raw meat separately from other food	179 (61.7%)	66 (22.8%)	30 (10.3%)	8 (2.8%)	7 (2.4%)	4.39±0.95
8- I clean work surfaces before and after food handling	227 (78.3%)	49 (16.9%)	9 (3.1%)	3 (1.0%)	2 (0.7%)	4.71±0.64
9- I thaw frozen food (e.g., chicken, beef, and fish) by keeping it at room temperature more than 2 hours	46 (15.9%)	44 (15.2%)	54 (18.6%)	36 (12.4%)	110 (37.9%)	3.41±1.50
10- I keep vegetables and fruits in the refrigerator below 5°C	79 (27.5%)	73 (25.2%)	60 (20.7%)	17 (5.9%)	61 (21.0%)	3.32±1.47
11- I check the temperature settings of chillers or freezers regularly	109 (37.6%)	59 (20.3%)	65 (22.4%)	42 (14.5%)	15 (5.2%)	3.71±1.25
12- I avoid keeping cooked food at room temperature until served	103 (35.5%)	48 (16.6%)	72 (24.8%)	32 (11.0%)	35 (12.1%)	3.52±1.38
13- I throw away food beyond its expiry date	226 (77.9%)	38 (13.1%)	7 (2.4%)	5 (1.7%)	14 (4.8%)	4.58±0.99
14- I touch the food when I have a wound on my hand	25 (8.6%)	12 (4.1%)	16 (5.5%)	46 (15.9%)	191 (65.9%)	4.26±1.26
15- I take sick leave when I have a fever, cough or cold	154 (53.1%)	93 (32.1%)	26 (9.0%)	11 (3.8%)	6 (2.1%)	4.30±0.93
16- I read the instructions on the storage of packaged food	140 (48.3%)	67 (23.1%)	62 (21.4%)	17 (5.9%)	4 (1.4%)	4.11±1.02

The use of gloves as a method for reducing bacterial cross-contamination of food is suggested by [29,30], however, in this study, only 31% of the respondents always wear gloves when they touch ready-to-eat food. Nonetheless, the respondents demonstrated a good level of practice in other personal hygiene-related practices such as not wearing jewellery while handling food and washing

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hands after handling the garbage. These show the effectiveness of the promotion events related to hand hygiene practices by the Ministry of Health, Maldives. Storage of raw food (meat/poultry/fish) separately from other food in the freezer was reported to be always practiced by 61.7% of the respondents. Mixed storage of raw food with ready-to-eat food leads to cross-contamination [31]. The practices of respondents were good in other cross-contamination-related areas, such as cleaning the workplace, separating cutting boards, and using wipe cloths accordingly (Table 3).

Food safety practices concerning time and temperature control are alarmingly weak among the respondents of this study, with less than 40% of respondents always practicing activities such as thawing food, storage of perishables at the correct temperature, checking the temperature of the refrigerator, and keeping food at room temperature until served. These results indicate that inappropriate methods of thawing are practiced frequently, and studies commonly report these practices [32,33] due to poor knowledge and attitude concerning time and temperature control. Therefore, food prepared and stored in the chillers in Male' restaurants is highly subjected to an environment where the microbial growth is optimum, hence increasing the risk of foodborne diseases.

The practices related to unsafe food (foodborne pathogens) such as throwing away the food after the expiry date was practiced by 77.9%. There is high possibility of using unsafe food in the preparation of meals, increasing the risk of foodborne illnesses. The respondents who never touch the food when having a wound on the hand was 65.9%, with only half of the respondents (53.1%) taking sick leave when they are sick, while the respondents who always read the instruction on the label were low (48.3%). Reading labels provides critical information regarding the risk of the food such as allergens, storage temperature, and expiry date. Moreover, food handlers going to work when ill could be due to two reasons. Firstly, food handlers are not aware of the risk associated with the practice and secondly, they are not compensated for their loss of earnings when sick.

3.4.2. Observation of Food Safety Practice

The limitation of desirability bias as well as recall error is commonly reported in studies where the self-reporting method is the only assessment as an alternative [18]. Observations to evaluate the practices are believed to be a more reliable method as it prevents desirability [34,35]. The observations were done adopting the method from [36] and an analysis was done to observe the discrepancies of the self-reported and observed food safety practice at the restaurants. Inter-rater reliability was established through all observers making the same observations for two weeks (kappa=0.85, range 0.75-1.00) at 100 restaurants.

3.4.2.1. Personal Hygiene (Observations)

According to Table 4, there is a major discrepancy between the self-reported and observed food safety practices, especially in the handwashing practices. It was observed only half of the restaurants (54%) were equipped with adequate facilities for proper hand washing practice proper food safety practices despite a good level of practice reported in the self-reported questionnaire. The National Hygiene Survey 2018 in Bangladesh reveal that the poor hygiene practice by the food handlers is due to a lack of access to good hygiene practice where only 23% were observed washing their hands with soap and water before preparing food [25].

Table 4. Observation of the food safety practices at the restaurants. (n=100)

Aspects	Percentage
Personal hygiene	
Untrimmed fingernails	(57%)
Don't wear jewelry while preparing food	(78%)

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Handwashing facilities	
Washbasin damaged	(5%)
Detergent not provided	(25%)
Hand drying facilities not provided	(22%)
Functional handwashing facilities	(54%)
Thawing of meat /chicken /fish	
Kept in a bowl of water	(48%)
Kept inside the sink without a running water supply	(22%)
Kept in a tray/bowl without water	(23%)
Used microvave and chiller	(10%)
Temperature of chiller	
Temperature above 5°C	(57%)
Temperature below 5°C	(43%)
Availability of hot cupboard to keep hot food	
Not available	(72%)
Available but not used	(3%)
Available and used	(27)
Wipe cloths	
Cloth dirty/bad-smelling	(39%)
Separate clothes not identified by the food handlers	(3%)
Same cloths used	(4%)
Separation of cutting boards for raw and cooked food	
Separated but not identified by the food handlers	(8%)
Separated but not used accordingly	(25%)
Seperated completely	(69%)
Not separated	(3%)
Availability of gloves	
Not available	(17%)
Available	(89%)

Moreover, 50% of the observed food handlers had untrimmed and unclean fingernails, suggesting that the personal hygiene of the food handlers was not monitored by the management of the food businesses. However, only one of the restaurants practised daily personal hygiene inspections with a documented personal hygiene policy and well-described personal hygiene

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procedures. This is a praiseworthy practice that can considerably reduce the risk of food cross-contamination and should be a benchmark practice for other restaurants.

It was observed that in 42% of the sampled restaurants, the food handlers were not using appropriate outer garments. Protective equipment such as head covers prevents foreign objects like hair from falling into prepared food. Foreign objects in food risk cross-contamination, as well as being unappealing for consumers [37].

3.4.2.2. Time and Temperature Control

Alarmingly, there was a poor practice of time and temperature control practices, and the result reflected a poor practice thawing process and temperature for hot food storage, and this is aligned with the result from the self-reported questionnaire. The thawing conditions of meat/chicken/fish showed that the sink was used in 13 restaurants. It was also observed that in all these cases, running water was not provided and in some of the cases, dirty utensils were kept inside the sink. Moreover, there 14 restaurants thawed food in a bowl/tray at room temperature, and twenty-nine restaurants used a bowl of tap water. Observations of the time taken for thawing as well as if the water was changed adequately to address the time and temperature issues were in line with the knowledge of the respondents as most respondents said the best way to defrost meat is by keeping the meat on a dry countertop. On rare occasions, microwaves or chillers, which are scientifically proven methods for safe the thawing by United States Department of Agriculture [38].

Additionally, it was also observed the temperature of the refrigerators was above 5^{o}C in 57% of the restaurants and they failed to maintain the temperature of the freezer. In self-reporting practice, almost 37% of the food handlers reported that they check the temperature of the refrigerator or freezer, however, 21% out of all the food handlers have the knowledge of the right temperature to maintain.

It was also observed that the hot cupboard was not common in the restaurants. These observations agree with the knowledge of food handlers as the food handlers scored considerably low in the time-temperature control aspect in the knowledge section. Adequate measures are not taken by food handlers or restaurant owners to address these issues. Moreover, when considering the enforcement of food safety, the inspections mainly focus on the infrastructure and general availability of the temperature maintaining equipment, while accuracy and appropriate practices are not monitored adequately. According to the World Health Organization, temperature abuse during food processing was responsible for 45.6% of foodborne outbreaks, while poor refrigeration and inappropriate storage temperatures of leftover or recently cooked meals accounted for 23.5% and 12.6% of cases, respectively.

3.4.2.3. Cross-contamination

The observations concerning cross-contamination are shown in Table 4. Among these issues was the storage of high-risk food such as frozen meat/chicken/fish with low-risk or ready-to-eat food. Almost all restaurants have a freezer designated to store high-risk frozen food, however, practiced mixed storage of food in the freezer. Among the food items observed being stored in meat freezers were French fries, frozen vegetables, cheese, butter, frozen chapati (flatbread), cooked pasta/snack, water bottles, ice cubes, and ice-creams.

Separate cutting boards were satisfactorily practiced in 69 restaurants, 25 restaurants were observed to have separate cutting boards (different colours) the food handlers did not use them accordingly despite being aware of the colour code separation. Some food handlers are aware of the colour code separation indicating that they have some extent of knowledge concerning the separation of utensils. Related to glove usage during food handling, the observation was done to identify the availability of gloves, with fifty-two restaurants having disposable gloves available.

When the observations and the self-reporting practices are considered, in some respects, such as personal hygiene, the observations reflect the food handlers self-reporting practices. It is obvious that if an adequate facility is not available, the knowledge cannot be translated into practice effectively.

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Reviews on food safety inspections revealed that it can be a key health protection measure to prevent foodborne illnesses [24]. However, when cross-contamination is considered, the self-reporting practices are exaggerated as most respondents scored highly in self-reporting practices. For example, most respondents reported that they use separate cutting boards, while the observations revealed that the food handlers did not practice using separate cutting boards accordingly (see Table 4). This is quite similar regarding the separation of food in the freezer; hence, it is crucial for food business operators to provide adequate facilities for the food handlers to optimise food safety practices and translate the knowledge into practice.

3.5. Impact of Sociodemographic Characteristics towards food safety KAP

The difference in the level of KAP based on sociodemographic characteristics is represented in Table 5. A statistically significant difference in food safety knowledge, attitude, and practice was seen based on different education levels. The Tukey test showed that the respondents with no formal education scored the poorest food safety practices and significantly less knowledge compared to the higher education level food handlers. This underscores the importance of education and training programs in improving food safety practices in Maldives restaurant [39]. Moreover, across the different education levels, the respondents with no formal education showed significantly poor practice compared to the respondents with secondary school education as well as college and university level education (p=0.000). This indicates that the education level enhances the capacity of learning, therefore has a high possibility of translating the knowledge to practice. However, these findings disagree with studies conducted by [39],[40], and [32], where education level may not implicate food safety knowledge or practice due to several other factors such as job burnout and culture.

The work experience is determined to influence food safety knowledge and practice. The Tukey test showed that the respondents with work experience of 1 to 5 years and >10 years have a significant difference (p=0.021). The knowledge score of respondents with work experience duration of 6 to 10 years and >10 years was high compared to the other two categories, indicating that the increased duration of working in the field can increase the awareness of the individual by the accumulation of food safety protocols, problem-solving skills, awareness of the industry-specific requirements [32].

Training is identified to impact the level of knowledge, attitude, and practice of the food handlers, where effectively delivered food safety training is expected to increase the participants' food safety knowledge and improve attitude and practices [32]. Hence, the number of untrained food handlers is alarming as it affected food safety practices.

The result of this study indicated that food safety training is effective in providing appropriate information and instruction on performing practices such as correct handwashing and not wearing jewellery during food handling [22]. However, previous studies stated knowledge from training may not reflect their attitude and behaviour, possibly due to the ineffective way the knowledge was transferred for it to be translated into good practice [32,40]. Evidently, practical training is crucial to effectively enhance the knowledge and the performance of food handlers [24].

Table 5. Mean of KAP score (percentage) based on sociodemographic characteristics.

Aspects	Knowledge	p-value	Attitude	p-value	Self-reported practice	p-value
Age						
<25 (n=90)	54.38±12.48		3.56±0.47		4.27±0.45	
26–35 (n=168)	56.14±14.21	0.861	3.65±0.42	0.642	4.15±0.42	0.083
36–45 (n=27)	55.32±17.31		3.60±9.84		4.16±0.52	
>46 (n=5)	53.75±21.92		3.63±0.72		4.25±0.44	
Education levels						

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No formal education (n=57)	51.21±16.68		3.57±0.52		3.89±0.43	
Primary education (n=56)	54.71±12.44		3.70±0.52		4.10±7.75	
Secondary education (n=81)	56.70±13.84	0.045	3.53±0.43	0.009	4.25±0.46	0.000
College/university education (n=96)	57.94±13.47		3.74±0.38		4.34±0.35	
Work experience						
<1 year (n=40)	53.28±12.50		3.66±0.44		4.19±0.37	
1–5 years (n=145)	53.06±14.73		3.55±0.49		4.11±0.44	
6–10 years (n=68)	58.82±13.32	0.007	3.71±0.52	0.125	4.24±0.43	0.016
>10 years (n=37)	61.15±12.07		3.66±0.52		4.29±0.50	
Food safety training status						
Trained (n=139)	57.73±12.56	0.014	3.70±0.46	0.000	4.32±0.40	0.000
Not trained (n=151)	53.39±15.13		3.53±0.47		4.04±0.44	

Overall, the results indicate that food handlers' KAP can be greatly affected by their sociodemographic characteristics such as education level, work experience, and food safety training. The result identified in this section is able to provide the restaurants' strategy in regard to the need for training and recruitment of food handlers in their restaurants.

3.6. The Association of Knowledge, Attitude, and Practices

The association between knowledge, attitude, and self-reported practice is summarised in Table 6. A significant positive correlation was found between knowledge and attitude ($r_s = 0.414$, $p<0.01$), knowledge and self-reported practice ($r_s = 0.304$, $p<0.01$), and attitude and self-reported practice ($r_s = 0.172$, $p<0.01$). These results indicate that the food safety knowledge of food handlers influences their attitude formation as well as food handling performance. Griffith [41] indicated that food handler behaviour can be influenced by knowledge and attitude, which those two dimensions may be impacted by the food safety training.

Table 6. Association between food safety knowledge attitude, and self-reported practice level of food handlers of restaurants in Male'. (n=290)

Level	Spearmen's rho	Sig.
Knowledge – attitude	0.414**	0.000

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Knowledge – practice	0.304**	0.000
Attitude - practice	0.172**	0.003

4. Conclusions

In conclusion, the food handlers of the restaurants of Male', Maldives, have a moderate level of overall food safety knowledge and an acceptable level of attitude, and practices. A good level of food safety practices was identified except for "time and temperature control" and "foodborne pathogens". The significant positive association between level of knowledge, attitude, and practice explained the situation where most respondents did not apply the knowledge from training to their attitude and practice on the incorrect temperature control, cross-contamination storage, and thawing of frozen meat/chicken/fish. The result also shows some of the practice of food safety has a high score in the self-reporting questionnaire, but found to be poor in the observations, which may suggest the discrepancies with the self-reported practice results.

The education level, work experience, and food safety training significantly impacted the level of KAP among food handlers in Male'. The level of knowledge was significantly affected by work experience, with attitude significantly affected by the level of education, and level of practice was impacted by age, education level, and work experience. The common factor that makes a significant impact on all KAP is the existence of food safety training. The result showed most of the food handlers are foreigners and has a low level of education, which may have suggested basic and advanced food safety programmes.

Based on these findings, it is recommended that policymakers review the training module, training approaches and regulations, and implementing procedures to address the current food safety situation in the Maldives. Selective modules should include temperature control, foodborne pathogens, and correcting undesirable practices such as long fingernails wrong thawing, and cutleries hygiene. Strict legislation to address food safety-related issues is the utmost primary requirement for the safety of the consumers in Maldives. Active enforcement of food safety issues to monitor foodborne illnesses adequately and accurately is equally crucial. There is also an urgent need for a strategic training module and an effective and regulated way of educating food handlers on the five key aspects of safer food [42]. Practical training should be included to educate and culture the correct food safety attitude and knowledge among the food handlers in Male' as it influences the practice. It is crucial to the effectiveness of food safety training that supervisors, superiors, and trainers provide food handlers with encouragement, positive reinforcement, and support.

Given the discrepancies between self-reported and observed food-handling-handling behaviours, our findings show that self-reports significantly missed to assess the amount of undesired food-handling practises. This underscores the importance of using observation in future food safety research to confirm food handlers' self-reports regarding their food handling methods.

One of the limitations of this study was the use of a self-reporting tool, hence, desirability bias. Even though observations were performed to complement self-reported practices, the presence of the observer or Hawthorne effect can also be a considerable limitation. Furthermore, there is a limited population of food handlers since this study only focused on restaurants in Male, thus the findings cannot be generalised to the entire country and other food operations. Further research is needed to compare the scores of other food handlers in all states in the Maldives to consider the overall restaurant operation in the Maldives, thus complying with the food safety standards and practices. As the current study serves as baseline information on the knowledge, attitude, and practice of food handlers in the Maldives, future studies should use the findings to formulate practical training modules and programmes appropriate for food handlers in the Maldives for an effective national food safety system.

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