



## Research article

## Assessment of food safety knowledge, attitudes and practices of fish farmers and restaurants food handlers in Bangladesh



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## ABSTRACT

The study was conducted to assess the present status of knowledge, attitudes and practices (KAP) concerning the food safety and hygiene issues among fish farmers and food handlers in Noakhali, Bangladesh. Data were collected from 100 respondents (50 fish farmers and 50 food handlers) through face to face interviews. All the respondents agreed that training on hygiene practices was necessary and they were interested to attend training in their spare time. Food handlers (88%) agreed that raw foods must be kept separate from prepared foods and 68% of them believed that improper preservation of foods is harmful to health. About 52% of farmers used a face mask when spreading insecticides, fertilizers, and chemicals. Food handlers were wearing protective clothing (32%) and masks (12%) when touching and distributing unwrapped foods, however no handlers used a cap. A significant strong correlation coefficient ( $r_s$ ) was found between knowledge with attitudes, knowledge with practices and attitudes with practices of 0.73–0.99 among the three domains for fish farmers and food handlers. The correlation among the three levels was satisfactory, however, some food safety concepts and practices regarding hygiene were still insufficient. Therefore, an effective and appropriate training program on food safety and hygiene should be launched in a holistic approach for all fish farmers and food handlers to increase awareness and ensure safe food for consumers with a view to reducing the possibility of disease outbreak.

## 1. Introduction

Over the past decades food production and consumption patterns have seen tremendous progress in the global south. Nevertheless, agricultural commodity chains are poorly regulated. Nowadays, consumers, across the globe, spend a significant amount of money to consume food outside of their homes (Choi and Rajagopal, 2013). Increasing purchasing power (Kearney, 2010) and modern life-styles (Taha et al., 2020) of consumers led to growth of food service outlets such as cafeterias and restaurants (Sani and Siow, 2014). People in developing countries including Bangladesh consume food in public places like hotels, restaurants, hospitals and also in ordinary street vending locations. In the early 1990s, eating out of home at least once or twice per month was a middle-class trend in Bangladesh. The tendency to dine outside the home has now been extended widely among different classes of people in the megacities and small towns of the country. People of some small towns in the country, for instance Noakhali, are famous for outside dining as many people visit the towns for shopping, banking, hospital treatment, and

entertainment purposes. The current progress of digitalization lures many restaurants to fad of eating in rather than eating out. Outside dining is common in daily life, however, it is anticipated to be a major source of food-borne diseases (Todd et al., 2007; Rebouças et al., 2017). Food service establishments were found to be the key sources of various food-borne diseases, their contribution to disease occurrence was 61% in European Union countries and 78% in the United States of America (EFSA, 2018). It is assumed that more than one-third of the world population has been affected by food-borne diseases (Bager and Halgaard, 2002; Mohammed et al., 2020). The risks of such diseases in developing countries are due to poor handling, partial surveillance, and fragmented control policies as well as unavailability of reliable data on food safety issues (WHO, 2006; Martins et al., 2012).

Animal-source foods, such as meats, fish and their products tend to be the most susceptible to food-borne diseases due to their higher pathogen contents, other possible contaminants and natural toxins, and adulterants (Lekshmi et al., 2017; Anal et al., 2020). Among animal-source foods, fish are the most significant protein-rich food items in many countries of the

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global south including Bangladesh. Aquaculture has emerged as a rapidly growing food production sector globally, but its impact is particularly important in fish-dependent countries where fish may provide up to 60% of animal protein (Belton and Thilsted, 2014; DoF, 2018). It is evident that fish is the most frequently consumed animal item at household level in Bangladesh (Belton et al., 2014) and is gaining popularity at restaurants in many parts of the world (Kim et al., 2019). To meet the ever-increasing demand of fish, both farming area and production volumes have been increased over the last three decades in Asia (Little et al., 2018).

Such intensification in fish farming brought many cross-cutting issues including occupational health risks in fish farming systems (Little et al., 2018). It is evident that about half of food-borne illnesses is derived from food production premises (EFSA, 2010). This is due to the use of various chemical products for the welfare of food-stock, disease control and optimized production which are common in aquaculture systems (Rico et al., 2013; Ali et al., 2016). Though occupational risks are lower than other terrestrial food products (Watterson et al., 2012), poor knowledge on farming technologies including health issues are associated with failure of such systems (Cousteau, 2014). Infected farmers and handlers are common sources of food-borne viruses (Hepatitis A virus, diarrhoea) which are released in large amounts in the surrounding environment through the excreta of the infected individuals, which may be the cause of food-borne virus infections (Velebit et al., 2019; Bozkurt et al., 2020). Again, in the farm various types of fish disease are caused because of poor knowledge of food use, handling and transportation (Thongpalad et al., 2019).

In addition to poor sanitation practices, insufficient regulatory systems, weak food safety laws, inappropriate ambient temperature during preservation of food; improper financial resources to spend on proper equipment and inadequate education are linked to foodborne diseases (WHO, 2004; Odeyemi et al., 2019; Mun, 2020). Food poisoning outbreaks can be caused by insufficient temperature and time control of food and secondary contamination (Mun, 2020). These safety measures are poorly maintained in many parts of the world (Al-Shabib et al., 2016; Thongpalad et al., 2019) which can be attributed to poor knowledge, attitudes and practices.

Food safety knowledge of food handlers is mainly associated with proper handling, storage of food and preparation (Kwol et al., 2020). Gaining food safety knowledge is essential as it could potentially minimize the outbreak of food-borne diseases (Jianu and Goleţ, 2014). The level of food safety knowledge is related to the food handlers' attitudes and practices (Zanin et al., 2017). Their attitude is a fundamental factor that could influence food safety behaviour and practices (Al-Shabib et al., 2016; Kwol et al., 2020). A positive attitude will assist to imply the knowledge of safety to ensure safe food for all (Akabanda et al., 2017). The use of knowledge, attitudes and practices (KAP) model is commonly used to identify food safety issues at various nodes of the food value chain. To the best of our knowledge there has been no studies conducted in Bangladesh evaluating food safety issues of both producers and food service providers. Thus, the main purpose of the present study is to assess the level of food safety knowledge, attitudes and practices of fish farmers and food handlers in the restaurants in the Noakhali region of Bangladesh.

## 2. Materials and methods

### 2.1. Study design and site

Present study was carried out from February to December, 2019 in ten fish farms of Noakhali and ten food restaurants of urban regions of Noakhali, Bangladesh (Figure 1). To select fish farms, we undertook an extensive field based "rapid reconnaissance" to identify the main fish farming clusters adjacent to Noakhali town (Hernandez et al., 2018). The cluster selection was confirmed by crosschecks with the fisheries officials at district level. Stratified random sampling was used and 10 semi-intensive (Use of artificial feed and addition of fertilizers for and natural feed production) (Amir et al., 2019) commercial fish farms operated for commercial purpose with at least four labours were selected. Additionally, we followed a simple structural method to randomly select food restaurants which served both lunch and dinner. Irrespective of size and volume of sale 10 food restaurants were randomly selected where at least four workers were involved.

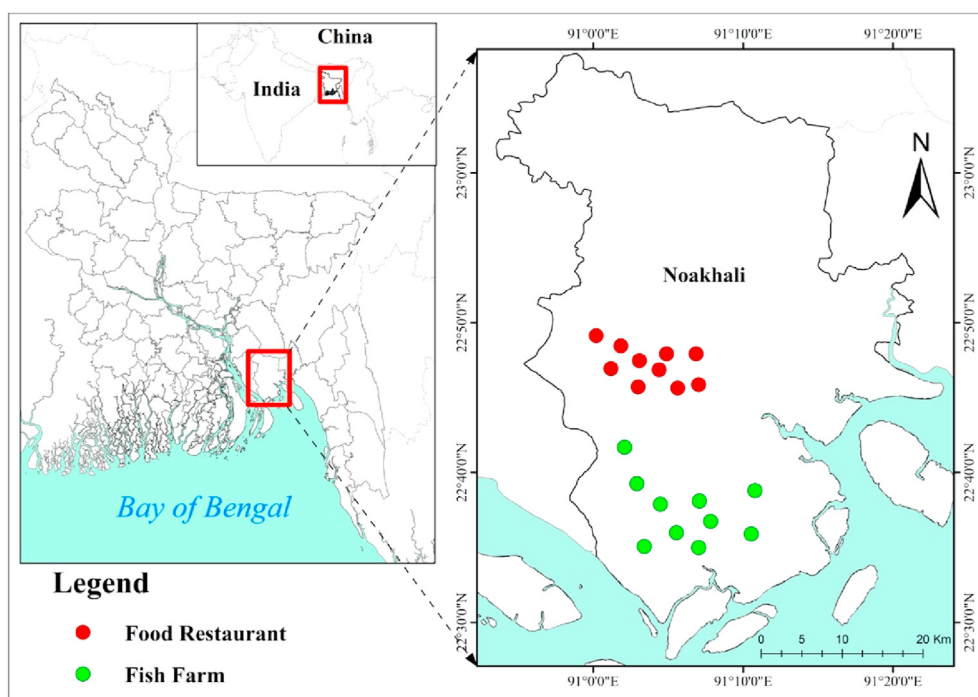


Figure 1. Map showing the sampling sites of the Noakhali region, Bangladesh.

## 2.2. Participant selection

This descriptive, cross-sectional study was conducted among 50 fish farmers from ten fish farms and 50 food handlers from ten food restaurants. The participants of both fish farms and food restaurants were randomly selected. The range of participant from each fish farm and food restaurant were 4–6.

## 2.3. Questionnaire preparation and validation

The survey questionnaire was designed by a group of multidisciplinary researchers and academics following a robust literature review and personal experiences. The theme of the questionnaire was adopted from World Health Organization (WHO) which previously used by [Al-Kandari et al. \(2019\)](#). Questions related to the fish producers were adopted from the Good Aquaculture Practice (GAP) guideline, also used by [Watterson \(2018\)](#). A questionnaire was designed, prepared and validated accordingly ([de Vet et al., 2006](#); [Peer and Gamliel, 2011](#)).

Precautions including pre-testing/piloting of the questionnaire, training of the enumerators, modifying questionnaire and local interpretation terminologies were taken to avoid any shortcomings in the research design. Piloting was conducted in adjacent Kabirhat sub-district at similar setting of both fish farms and food restaurants. A total of 15 fish farmers and 17 food handlers participated from three fish farms and four food restaurants respectively during piloting. After piloting, the questionnaire was reframed and maintained chronology to obtain data in a consistent way. Direct observations were integral to the survey as it ensures accumulation of data on actual practice ([da Cunha et al., 2019](#)). The questionnaire was prepared in English and translated into Bengali (local language) for easy process.

The survey included different thematic areas of food outlet and farming systems. The questionnaire had two segments and the first segment entailed of socio-demographic variables including age, sex, occupations and income level. In the second part, questions regarding knowledge, attitudes and practices were included. Scoring systems were applied to understand the level of KAP (Knowledge, Attitudes, Practices) and the relationship among the three domains both in farms and restaurants. Level of agreement to the statements of all participants was considered by using an agree, disagree, and uncertain rating scale. The answers of participants were rated on 0 to 2 points, for each right answer 2 points were given, while an uncertain answer and wrong answer were marked as 1 and 0 points respectively. Finally, participants were considered to have poor knowledge, an acceptable level of knowledge and good knowledge of food safety based on obtained scores of  $n \leq 14$ ,  $14 < n \leq 18$  and  $18 < n \leq 22$  points respectively.

## 2.4. Data collection

Data from fish farmers and food handlers were collected through a face to face interviews at their respective fish farms and restaurants. Fish farmers and food handlers voluntarily participated in the survey and after being given details of the study and were guaranteed the confidentiality. The survey was voluntary, confidential and anonymous. Informed consent to carry out this survey was given by the Chairman of Department of Fisheries and Marine Science, Noakhali Science and Technology University, Noakhali. The participants were also ensured about the voluntary nature of the present study and if they like to withdraw themselves, they were encouraged to do so. The purpose and the theme of the research were also discussed with the fish farm/food restaurants owner and/or the manager. Some key questions were also asked to the owner/manager and then took permission to talk to their employee at a separate place.

## 2.5. Statistical analysis

Data were analysed through SPSS (Statistical package for the social sciences) version 20. The knowledge, attitudes and practices about food

safety were summarized and presented in tabular form and  $p < 0.05$  significant level was applied to evaluate the correlation among the knowledge, attitudes and practices of respondents.

## 3. Results and discussion

### 3.1. Socio-economic and demographic conditions of respondents

The socio-economic and demographic characteristics regarding age, family size, religion, education, working experience, electricity facilities, sanitation facilities and monthly income of fish farmers and food handlers are presented in [Table 1](#). The majority of the farmers (60%) were above 40 years of age whereas 68% of the food handlers were between 21 and 40 years of age. Most of the respondents were Muslims (80%). Among the respondents, 40% and 36% of the fish farmers and food handlers, respectively, were illiterate. The majority of fish farmers (52%) and food handlers (48%) had a monthly income ranging between BDT 5000–15000.

### 3.2. Food safety knowledge of respondents

The food safety knowledge of fish farmers and food handlers are presented in [Table 2](#). Respondents from both groups unanimously agreed that washing hands before eating and after using toilet can reduce food contamination. All of them were aware that it is necessary to stay away from farms/restaurants when they were affected by diseases like diarrhoea, dysentery and cholera. Almost similar responses were obtained on personnel hygiene knowledge of handlers in Saudi Arabia ([Al-Shabib et al., 2016](#)). [Sani and Siow \(2014\)](#) and [Rebouças et al. \(2017\)](#) found most of the respondents had good knowledge on food safety and believed that it might be due to the training received on food safety knowledge. However, in the present study fish farmers and food handlers had inadequate knowledge in terms of food safety knowledge which may be due to most of the respondents lacking food safety training. In addition, [Zhang et al. \(2015\)](#) found their respondents failed to answer food safety questions correctly, which suggested there was lack of training and sufficient food safety documents, this result supports the outcome of the present study. However, several studies claim that training programs can increase the food safety knowledge of stakeholders, generating a positive culture of food safety and should take place periodically in order to incorporate food safety knowledge, production of safe food and to reduce the risk of disease transmission ([Soares et al., 2012](#); [Sarter and Sarter, 2012](#); [McIntyre et al., 2013](#)).

### 3.3. Food safety attitudes of respondents

Attitude is a fundamental factor apart from knowledge that could influence food safety behaviour and practice, thus decrease the rate of food-borne disease. Almost all of the fish farmers were agreed that training on hygiene practices was necessary to reduce the chance of contamination and they were also willing to receive training in their spare time ([Table 3](#)). On the other hand, one-fourth of the fish farmers agreed hands on training of hygienic handling of food is not necessary and eating fish produced in contaminated water can cause disease. Our research outcome is similar to the findings of [Soon and Baines \(2012\)](#) who stated almost 97% of farm workers believed that hand-washing should be practiced before harvesting and packing fresh produce on farms. On the other hand, [Thongpalad et al. \(2019\)](#) stated even though farmers appeared to have a good range of knowledge on food safety, positive attitudes are important for their implementation into farm-level to avoid the risk of contamination. Following this, in the present study, fish farmers responded positively on food safety attitude questions but their existing knowledge did not motivate their attitudes in applying that knowledge to the farm-level. The motivation and support for workers from the farm management might work as a solution to increase the knowledge and adopt positive attitudes that could eventually contribute

**Table 1.** Demographic characteristics of fish farmers (n = 50) and food handlers (n = 50) in Noakhali, Bangladesh.

Category	Sub Category	Fish Farmers n (%)	Food handlers n (%)
Age	≤20 years	6 (12)	6 (12)
	21–40 years	14 (28)	34 (68)
	Above 40 years	30 (60)	10 (20)
Family size	Small (≤4)	8 (16)	10 (20)
	Medium (5–6)	16 (32)	18 (36)
	Large (>6)	26 (52)	22 (44)
Religion	Muslim	40 (80)	46 (92)
	Hindu	10 (20)	4 (8)
Education level	Illiterate	20 (40)	18 (36)
	Can Sign	14 (28)	12 (24)
	Up to primary	12 (24)	10 (20)
	Up to Secondary	2 (4)	6 (12)
	Above Secondary	2 (4)	4 (8)
Working experience	≤10 years	36 (72)	34 (68)
	11–25 years	10 (20)	10 (20)
	Above 25 years	4 (8)	6 (12)
Electricity facilities	No electricity	6 (12)	4 (8)
	Solar	6 (12)	2 (4)
	Electricity	38 (76)	44 (88)
Toilet facilities	Open space/others	4 (8)	2 (4)
	Kancha	16 (32)	12 (24)
	Sanitary/pucca	30 (60)	36 (72)
Monthly income in BDT	Below 5000	16 (32)	20 (40)
	5000–15000	26 (52)	24 (48)
	Above 15000	8 (16)	6 (12)

*Kancha*: made with corrugated iron sheet; *pucca*: made with brick.

**Table 2.** Fish farmers and food handler's knowledge about food safety in Bangladesh.

Comments	Fish Farmers			Food Handlers		
	Agree n (%)	Uncertain n (%)	Disagree n (%)	Agree n (%)	Uncertain n (%)	Disagree n (%)
Food contamination reduced by washing hands after using the toilet	50 (100)	0 (0)	0 (0)	50 (100)	0 (0)	0 (0)
The risk of food contamination is reduced by the use of sanitary toilet	50 (100)	0 (0)	0 (0)	50 (100)	0 (0)	0 (0)
Use of sanitary toilet reduces the risk of food contamination	50 (100)	0 (0)	0 (0)	50 (100)	0 (0)	0 (0)
Washing transportation materials is important	20 (40)	30 (60)	0 (0)	32 (64)	18 (36)	0 (0)
Washing farming/cooking equipment is important	20 (40)	30 (60)	0 (0)	38 (76)	12 (24)	0 (0)
Use of face mask when spreading fertilizer, insecticide and serving food is important	32 (64)	18 (36)	0 (0)	20 (40)	30 (60)	0 (0)
If you have diseases (diarrhoea, dysentery, cholera etc.) it is necessary to stay away from farm/restaurants	50 (100)	0 (0)	0 (0)	50 (100)	0 (0)	0 (0)
Diseases can be transmitted by food	30 (60)	20 (40)	0 (0)	38 (76)	12 (24)	0 (0)
There are many types of hazard, which are responsible for contamination	32 (64)	18 (36)	0 (0)	38 (76)	12 (24)	0 (0)
Water is the major source for disease transmission	20 (40)	30 (60)	0 (0)	32 (64)	18 (36)	0 (0)
The refrigerator is the safest fish storage facility	50 (100)	0 (0)	0 (0)	50 (100)	0 (0)	0 (0)

to minimize the food-borne disease outbreaks of fish farmers (Todd et al., 2007).

About 76% of food handlers believed that seafood handling is an essential part of their job responsibilities and 60% of food handlers agreed to wear masks, cap, adequate clothing and protective gloves, which reduces the chance of food contamination (Table 4). Additionally, most of the food handlers (68%) agreed that inappropriate storage of foods is detrimental to health. Similar results were reported by Al-Shabib et al. (2016) highlighting almost 96% of the respondents believed that handling food with food safety in mind is of the utmost importance in reducing secondary contamination and food-borne diseases and approximately 84% of the food handlers agreed that infected people with cuts on their hands should not handle food. Besides, Sani and Siow (2014) and Zanin et al. (2015) found that almost 87% of food handlers

did not touch food during a time when their hand were injured, and nearly 82% of the handlers kept the cooked and raw food in the kitchen fridge to avoid spoilage. However, findings from our study showed that only 40% of food handlers agreed the temperature of the refrigerator is important for reducing the risk of contamination, however Adams and Moss (2008) found respondents believed temperature is one of the major factors affecting contamination and improper maintaining of temperature leads to increase food spoilage.

Codex Alimentarius Commission (2003) suggested that food handlers suffering from any disease would be responsible for transmitting the disease by handling food and should not be allowed to the workplace or to handle food. As the KAP model, food handlers who have sufficient food safety knowledge show positive attitudes towards food safety practices such as kitchen hygiene, personal hygiene and diseases prevention

**Table 3.** Fish farmer's attitude about food safety in Bangladesh.

Comments	Agree n (%)	Uncertain n (%)	Disagree n (%)
The risk of food contamination is reduced by the use of hand-wash	50 (100)	0 (0)	0 (0)
Fish feed must be kept in dry place	50 (100)	0 (0)	0 (0)
Training in hygiene practice is necessary	50 (100)	0 (0)	0 (0)
Training in sanitation practices has not applied in everyday life	34 (68)	16 (32)	0 (0)
I am looking forward to taking training in my spare time	50 (100)	0 (0)	0 (0)
Sick people should not be involved in farm activities	50 (100)	0 (0)	0 (0)
Theoretical training is less important in hygienic food management	8 (16)	34 (68)	8 (16)
Fish kept at room temperature can be contaminated	50 (100)	0 (0)	0 (0)
Inadequate practices could be changed after learning about hygienic management	50 (100)	0 (0)	0 (0)
Eating fish produced in contaminated water can cause disease	16 (32)	26 (52)	8 (16)

practices (Asmawi et al., 2018). Our study found among the food handlers there was a positive attitude towards attending food safety related training and workshops to enhance their safety-related awareness.

### 3.4. Food safety practices of respondents

Personal hygienic practices are vital to ensure production of harmless food for consumers. Data reveals that most of the fish farmers washed their hands before eating (88%), about 16% of fish farmers used toilet papers and 60% washed their hands after using toilet (Table 5). More than a half of the farmers (52%) always used a mask while spreading fertilizers and chemicals. Findings of this research matched with Soon and Baines (2012) who reported that approximately 60% of the farmers washed their hands regularly after sneezing and coughing and Todd et al. (2007) stated one-third of the respondents did not use liquid soap for washing hands after using toilet. In addition, almost 54% of food handlers in food restaurants did not show interest in washing their hands before cooking meals. The negative attitudes towards the practice of food safety guidelines are not only due to the lack of proper training, proper time management and insufficient facilities, but also improper management of farm managers as well as owners who usually claim their management system to be superior to other farms with low chance for contamination (Coleman and Roberts, 2005; Todd et al., 2010; Thongpalad et al., 2019). Nevertheless, insufficient knowledge of fish farmers in food safety, fish farmers are in the habit of applying various chemicals in the aquatic environment which are toxic to users and non-targeted aquatic organisms (Little et al., 2018). In fact, adequate knowledge of food safety assists fish farmers in efficient use of chemicals, which is crucial for prevention of antimicrobial resistance and to ensure safe food for public health.

About 32% of food handlers used gloves and protective clothing when touching or distributing unwrapped foods whereas only 12% used a mask. None of them were found to wear any cap during touching and distributing unwrapped foods in the kitchen. Most of the food handlers (64%) washed their hands after handling raw foods and before handling ready-to-eat food (Table 6). The research outcome of this study differed

from the findings of Çakıroğlu and Uçar (2008) and Al-Shabib et al. (2016) who found almost 80%–97% food handlers were frequently wearing hand gloves, masks and caps during handling food. This may be a possible outcome of the implementation of food safety training programs for food handlers. Abdul-Mutalib et al. (2012) also showed high level of personal hygiene practices while the food handlers were serving food. Unfortunately, food handlers of the present study did not attend any training program associated with food safety. Soon et al. (2011) and Powell et al. (2011) stated that proper food safety knowledge is useful to minimize food-borne diseases and to improve the positive attitudes towards the practice of food safety knowledge, adequate training on food safety would be helpful to food handlers.

### 3.5. Nexus of KAP (knowledge, attitudes and practices)

The correlation of knowledge, attitudes and practices is presented in Table 7. Highly significant positive correlation was found between knowledge with attitudes ( $r_s = 0.9754$  for fish farmers and  $0.9841$  for food handlers,  $p < 0.05$ ), knowledge with practices ( $r_s = 0.9776$  for fish farmers and  $0.8415$  for food handlers,  $p < 0.05$ ) and attitudes with practice ( $r_s = 0.9999$  for fish farmers and  $0.7322$  for food handlers,  $p < 0.05$ ). It is also clear that a causal relationship exists among these three domains of food safety. The correlation values revealed a strong positive relationship among the knowledge, attitudes and practices and knowledge level of fish farmers and food handlers. These findings coincide with several earlier studies which found a strong positive significant relationship among the knowledge, attitudes and practices (Sani and Siow, 2014; Al-Shabib et al., 2016). Apart from this, several studies claimed that only knowledge of food safety is not sufficient to implement positive hygienic attitude and practice among fish farmers and food handlers (Walker et al., 2003). In addition, training is one of the most efficient techniques for preventing food-borne diseases (WHO, 2004). Therefore, appropriate training program should be launched by the management committee of fish farms and restaurants, and adequate documents should be provided during training program to enhance the food safety concepts among the fish farmers and food handlers.

**Table 4.** Food handlers' attitudes on food safety in Bangladesh.

Comments	Agree n (%)	Uncertain n (%)	Disagree n (%)
Harmless food management is a consequential part of my work duties	38 (76)	12 (24)	0 (0)
Knowledge of food safety management is consistent	20 (40)	20 (40)	10 (20)
Food management is related to food safety	30 (60)	20 (40)	0 (0)
Raw and prepared foods should be kept separate	44 (88)	6 (12)	0 (0)
The danger of food adulteration is minimized by wearing a cap, masks, protective gloves and appropriate outfits	30 (60)	10 (20)	10 (20)
It is essential to know the temperature of the kitchen fridge to reduce the danger of food safety	20 (40)	28 (56)	2 (4)
It is mandatory to observe the thermometer of kitchen fridge and freezers circadian	32 (64)	12 (24)	6 (12)
Inappropriate storage of food that is dangerous to the consumers	34 (68)	16 (32)	0 (0)
Staff with scraping or cuts to their hands or fingers may not physically contact foods without packing	42 (84)	0 (0)	8 (16)



**Table 5.** Fish farmer's practices toward food safety measures in Bangladesh.

Statements	Agree n (%)	Uncertain n (%)	Disagree n (%)
Do you wash your hand before eating?	44 (88)	2 (4)	4 (8)
Do you use hand wash after using toilet?	30 (60)	14 (28)	6 (12)
Do you use toilet paper?	8 (16)	20 (40)	22 (44)
Do you clean around your hands after finishing the job at the end of the day?	50 (100)	0 (0)	0 (0)
How often do you consume fish from your farm?	14 (28)	36 (72)	0 (0)
Do you keep fish feed in dry place?	50 (100)	0 (0)	0 (0)
Do you use face mask when using insecticides, fertilizers, chemicals?	26 (52)	8 (16)	16 (32)
Do you clean transportation materials, vehicles with clean water after use?	46 (92)	4 (8)	0 (0)

**Table 6.** Food handlers' practices towards the obstacle of foodborne diseases in Bangladesh.

Comments	Agree n (%)	Uncertain n (%)	Disagree n (%)
Do you wear gloves when physical contacting or distributing foods without packing?	16 (32)	26 (52)	8 (16)
Do you wipe your hands after going to the toilet?	30 (60)	20 (40)	0 (0)
Do you clean your hands after dealing with raw foods and before handling prepared food?	32 (64)	14 (28)	4 (8)
Do you wear defensive attire when distributing foods without packing?	16 (32)	6 (12)	28 (56)
Do you wear a mask when you touch or distribute foods without packing?	6 (12)	8 (16)	36 (72)
Do you wear a cap when you distribute foods without packing?	0 (0)	0 (0)	50 (100)
Do you wash your hands before touching foods without packing?	24 (48)	16 (32)	10 (20)
Do you clean your hands after moving fresh foods without packing?	28 (56)	18 (36)	4 (8)
Do you wipe your hands before moving prepared diets without packing?	42 (84)	6 (12)	2 (4)

**Table 7.** Correlation among knowledge, attitudes and practices level of fish farmers and food handlers.

Level	Fish farmers	Food handlers	p values
Knowledge-attitudes	0.9754**	0.9841**	0.00
Knowledge-practices	0.9776**	0.8415**	0.00
Attitudes-practices	0.9999**	0.7322**	0.00

\*\* Correlation is highly significant at the <0.001 level.

#### 4. Conclusion

The study concluded that respondents, farmers and restaurants food handlers had moderate levels of knowledge, attitudes and practices toward food safety and hygiene. The major reason for this may be that the majority of fish farmers and food handlers had no formal training on food safety. Thus, strong regulations in training, legislation and certification, as well as holistic, systematic and effective management strategy should be taken by the government and other appropriate regulatory authority for ensuring suitable food safety programs. At the same time, fish farm and food restaurant employee awareness programs should be launched to expand the food safety knowledge. To some extent, food chain risk management policies are limited by sector separation: the broader food production wing and public health institutions (de Roos et al., 2019). To tackle such challenges a holistic approach needs to be incorporated in every sphere of value chain node to keep the communities safe from food-borne diseases. In addition, governments should arrange effective training programs on good aquaculture practices for fish farmers and good hygiene practice for food handlers, which might help them to produce safer fish and to reduce food-borne diseases. In addition, more research is needed to design these training programs based on observations assessing food safety knowledge, attitudes and practices among different age groups, religious groups, genders, various educational levels, and different income levels of fish farmers and food handlers.

#### Declarations

##### Author contribution statement

Mohammad Hashanuzzaman, Md. Shafiqur Rahman: Performed the experiments; Wrote the paper.

Shuva Bhowmik: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

M. U. M. Abu Zakaria, Liton Chandra Voumik: Analyzed and interpreted the data; Wrote the paper.

Abdullah-Al Mamun: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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##### Data availability statement

Data included in article/supplementary material/referenced in article.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

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