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Research Article

Food Safety Knowledge, Attitudes, and Practices Among Fish Vendors in Local Fish Markets of Bangladesh: A Cross-Sectional Study

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Abstract

Fish markets are crucial in ensuring food security and nutrition in Bangladesh, where fish is a primary protein source for millions. However, inadequate food safety practices among vendors can lead to contamination, posing significant public health risks and undermining consumer confidence. Conducted between October to December 2024, this cross-sectional study used semi-structured questionnaires, face-to-face interviews, and focus group discussions to collect data. The research covered fish markets in northern and southern regions of Bangladesh, encompassing both urban and rural environments. A total of 446 fish vendors were selected using the Yamane equation, with a precision level of 5%. The majority of respondents were male

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(97.09%), aged 31–40 years (45.29%), and primarily operating in urban markets (73.32%). While no direct interventions were implemented, findings were used to propose targeted measures, including vendor training, infrastructure improvements, and stricter regulatory enforcement. Food safety practices and their association with socio-demographic factors were analyzed using descriptive statistics, binary logistic regression, and multivariate analyses. Data analysis revealed that full-time employment (OR = 4.51) and urban market operation (OR = 2.75) were strongly associated with better food safety outcomes. Although fish vendors demonstrated good knowledge of food safety, significant gaps in contamination control and hygiene practices were observed, with challenges including limited infrastructure, lack of training, and inadequate regulatory oversight. The study underscores the need for targeted interventions to improve food safety practices among fish vendors.

Keywords

Food Safety, Fish Vendors, Hygiene Practices, Bangladesh

1. Introduction

With over 60% of animal-based protein in Bangladesh coming from fish, the country's fisheries are a vital cornerstone of nutrition and daily sustenance. Fish provides an essential source of micronutrients, playing a significant role in the population's diet. With a per capita consumption of 67.8 grams per day, surpassing the target demand of 60 grams, fish remains central to the health and well-being of millions of the people of Bangladesh. (Dof, 2024). Fish is vital to Bangladesh's diet, which is key to food security and nutrition. The fisheries sector supports the population's protein needs and contributes significantly to the economy, driving GDP growth, creating jobs, and sustaining livelihoods [1]. Over 18 million people are in Bangladesh's fisheries sector, the population's primary protein source. With a steady growth rate of 5.3% from 2009 to 2019, the sector is the fastest-growing food industry, offering significant potential in combating protein deficiency, reducing malnutrition, and boosting employment and foreign exchange earnings [2]. Dried fish is also a significant component of the Bangladeshi diet, especially for those in coastal regions [3]. Despite the high nutritional value of fish, their consumption is greatly limited by challenges like spoilage and foodborne diseases, which spread through contamination along the fish supply chain [4].

By linking primary, secondary, and final consumer markets, local fish markets act as vital distribution hubs, promoting the movement of a variety of fish species [5]. By acting as middlemen, these marketplaces help local economies and improve rural and coastal communities' access to seafood. To enhance nutrition and food security, they make use of local customs and social networks [6]. Food handlers play a crucial role in ensuring food safety and preventing foodborne illnesses [7, 8]. Improper handling practices are a major cause of fish deterioration, microbial contamination, and foodborne diseases [9, 10]. In fish markets, inadequate hygiene, lack of awareness about foodborne diseases, and improper handling contribute to these risks, posing a significant threat to public health [4]. Fish vendors face several significant challenges in maintaining food safety, including inadequate sanitation, poor infrastructure (especially refrigeration), and limited technical capacity [11]. Common issues such as spoilage, contamination throughout the fish supply chain, and insufficient hygiene practices further exacerbate the risk of foodborne diseases [4]. Additionally, many fish vendors lack formal education in food safety and are often exposed to poor handling practices, the need for targeted public health management strategies to improve their knowledge and skills [12]. Other challenges include a lack of potable water, insufficient financial support, and inadequate training, which all contribute to the difficulties vendors face in ensuring food safety [13]. Addressing these issues requires a comprehensive approach focused on improving infrastructure, providing training, and strengthening food safety regulations. Vendors often face a lack of essential resources, such as proper storage facilities and basic amenities, which are critical for maintaining hygiene [14]. This shortage, combined with limited training, leads to inadequate food handling practices. To address this, there is a clear need for workshops that can enhance vendors' knowledge and help them implement effective food safety measures [15]. Bangladesh has set up a legal structure of food safety and hygiene measures which are mainly determined by the Food Safety Act of 2013 [16, 17]. This act gives a detailed procedure for handling, storing, and distributing food to reduce food-borne diseases [18, 19]. The regulations are aimed at fish handling and storage, which is considered due to the importance of fish in the Bangladeshi diet and the adverse effects unsafe practices might have [20, 21]. The Bangladesh Food Safety Authority (BFSA) is the main regulatory agency to enforce these regulations [17, 22]. The BFSA collaborates with other ministries for example with the Department of Fisheries in charge of food safety in fish markets locally [21]. These regulations concern different aspects of fish processing, starting from the moment the fish is caught to the time it is sold and the goal is to reduce the

contamination hazards at all stages of the distribution channel [22]. However, the enforcement of these regulations together with the effectiveness of these regulations is still a major issue [17, 22]. Some of the studies point to the areas where the implementation is lacking, especially in the informal markets where most fish vendors work with relatively less resources and knowledge [16].

However, the effectiveness of current food safety regulations in Bangladesh is hampered by several factors. Some enforcement mechanisms do not receive enough funds and personnel to adequately supervise and punish the vendors who do not meet the food standards [23-25]. In addition, because some vendors have little knowledge of these regulations and proper practices, unsafe practices continue [24]. Although the regulatory bodies are present, the implementation of laws is quite a challenge due to the lack of funds, the lack of adequate training centers for the vendors, and the fact that most fish markets are operated as informal markets [19, 23, 26]. Low consumer awareness of safety inspections and concerns about food safety push the necessity of enhancing regulatory activity and increasing its effectiveness. The absence of authorized inspection hampers consumer confidence and market prospects in the industry [19]. The current literature suggests that there is a lack of studies that address exclusively the fish market vendors' food safety knowledge, attitudes, and practices in the fish markets of Bangladesh [21]. Though several research studies in Bangladesh have explored food safety practices among food handlers in different settings [27, 24, 28]. Yet, there is scarce work done specifically focusing on fish vendors in local fish markets. This lack of understanding prevents implementing the necessary steps that can enhance this aspect of food safety in one of the important segments of the food supply chain [21]. Research has shown that the Bangladeshi markets are flooded with fish products contaminated with foodborne pathogens and chemical agents [29, 20], the factors influencing those at the vendor level are however not well understood. Research conducted in other countries, for instance, Kenya, suggests that fish vendors have a moderate level of knowledge about food safety and some of the barriers they experience include inadequate storage equipment and poor hygiene [4]. Nevertheless, these results cannot be applied to Bangladesh because the cultural norms, legal environment, and economic conditions are quite different. Awareness of current knowledge, attitudes, and practices of fish vendors is important for crafting interventions to increase food safety in Bangladesh. This information is critically important for the implementation of evenly appropriate educational campaigns, instructional training, and concrete policy interventions that will address the stated issues identified by the vendors [24]. Such targeted intercessions can therefore focus on cause elimination; promote better hygiene; and thus, optimize the safety of fish products offered in local markets. Enhancing the food hygiene standards of fish sellers greatly minimizes the incidences of food-borne diseases hence a boost of the health standards of the people and the level of trust from consumers [19]. There are economic consequences as well and that involves better food safety measures bringing better market access higher prices and decreased post-harvest losses [4, 23]. Consequently, this study aims to assess the knowledge, attitudes, and practices related to food safety among fish vendors in local markets throughout Bangladesh. It intends to explore their understanding of appropriate fish storage, handling, hygiene, and measures to prevent foodborne illnesses. Furthermore, the research will evaluate their perspectives on food safety regulations and the challenges they face in implementing safe practices.

2. Materials and Methods

2.1. Study Design

This cross-sectional study was conducted between October to December 2024, using semi-structured questionnaires and face-to-face data collection through KoboToolbox. The study gathered data from fish vendors above 18 years old who are residents of Bangladesh. The study focused on fish markets in both the northern and southern regions of the country, covering a total of 13 districts (Figure 1). The sample size for the proportion was determined using Open-Source Epidemiologic Statistics for Public Health (OpenEpi v3.01), with an anticipated prevalence (p) of 68.3% of respondents possessing knowledge of food safety [30]. Therefore, all-time data monitoring ensures all data are appropriate in this study, and these questionnaires are reviewed by professional persons (two university professors, one Upazila Fisheries Officer, and one food Nutritional specialist).

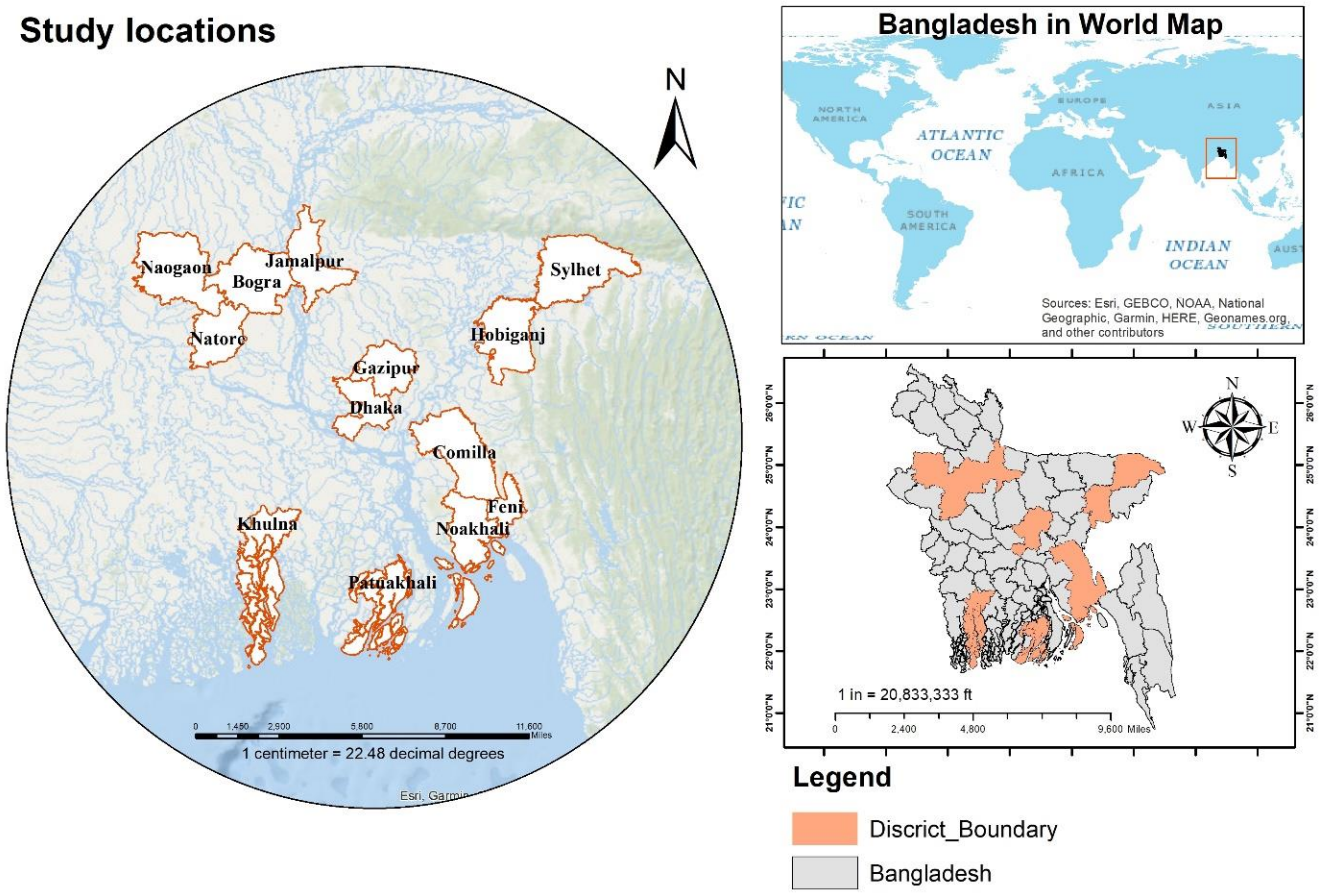

Figure 1. The map in the top right (blue-colored) represents the World Map, with Bangladesh highlighted in an orange box to indicate its location. In the bottom right, the map displays the entire country of Bangladesh with district boundaries marked using ash and light orange colors. On the left side, the map illustrates the specific locations of fish vendors within the district map of Bangladesh.

2.2. Determination of the Number of Fish Vendors

To determine the necessary sample size, the Yamane equation was applied to find the number of fish handlers (n) needed for the study [31]

$$N=N/(1+Ne^2)$$

In this equation, 'n' represents the sample size, 'N' denotes the population size, and 'e' signifies the level of precision, set at 5% with a corresponding 95% confidence interval. The overall population of the fish vendors in the North-south region was 2040000 people. Using the above Yamane equation, represent sample size (n) 399. The final total sample was 446 fish vendors.

2.3. Data Collection

Primary data were collected using a face-to-face interview and Focus group discussion (FGDs) method applied for this survey. Non-fish vendors have been excluded from this study. Initially 30 fish vendors pre-tested for the final survey but were not included in this study. The necessary modification of these questions and the questions were clear for the final survey. The questionnaires aim to food safety, hygiene practices, foodborne illness, and the extent of knowledge, attitudes, and practices on challenges in ensuring the safety of food. The questionnaires had five sections (I-V): Section I. Demographic Information; Section II. Food safety knowledge: raw fish store, unpleasant fish smell, fish handling safety measures, Cross-contamination between raw fish and other fish, visible signs of spoilage, proper waste disposal for hygiene maintenance, and food hazards; Section III. Attitudes; Section IV. Practice; Section V. Challenges and needs.

2.4. Ethical Standard

The research complied with institutional protocols and received approval from the Ethics Board of the Institutional Review Board at Sylhet Agricultural University, Sylhet-3100, Bangladesh [Memo no: SAU/Ethical committee/APR/24/05]. It adhered to the medical ethical principles established in the Helsinki Declaration of 1975.

Before participation, written consent was secured from the fish vendors involved in the study.

2.5. Data Analysis

A descriptive analysis was conducted for all continuous and categorical data, including the mean, standard deviation, frequency, and percentage calculations. Odds ratios were computed to evaluate the risk association, with confidence intervals providing precision estimates. Additionally, binary logistic regression analysis was performed. Multivariate analyses, including the Chi-square/Fisher's Exact test and independent t-test/Mann-Whitney test. The data were analyzed using R programming within RStudio (version 4.3.2), with statistical significance defined as $p < 0.05$.

3. Results

The socio-demographic data of the study participants is summarized in the table below. The majority of respondents are male (97.09%), with females comprising only 2.91%. In terms of age distribution, the largest group falls within the 31-40 years age range (45.29%), followed by the 41-60 years group (34.98%). Most respondents are from the Northern region (62.33%), with the remaining 37.66% coming from the Southern region. Education-wise, a significant portion of respondents have only completed primary education (42.15%), and a large number of vendors work full-time (81.84%) (Table 1). Additionally, most participants operate in urban markets (73.32%) and have access to government-sourced electricity (68.16%).

Table 1. *Socio-demographic information of the respondents.*

Socio-Demographic Data	Frequency	Percent
Gender		
Male	433	97.09
Female	13	2.91
Age (Years)		
18-30	33	7.4
31-40	202	45.29
41-60	156	34.98
61<	55	12.33
Residents (Region)		
Northern	278	62.33
Southerner	168	37.66
Level of Education		
Illiterates	155	34.75
Primary	188	42.15
Secondary	83	18.61
Higher Secondary	18	4.04
Graduate	2	0.45
Work Status		
Full time	365	81.84
Part-time	81	18.16
Years of Experience in Fish Vending		
0-2	53	11.88
3-10	158	35.43
11-20	109	24.44
21<	126	28.25

Socio-Demographic Data	Frequency	Percent
Types of Market		
Urban	327	73.32
Rural	119	26.68
Electricity		
Solar	31	6.95
Government sources	304	68.16
None	111	24.89
Toilet facility		
Sanitary	267	59.87
Without sanitary	169	31.17
Open spaces	40	8.97
Family size		
1-3	333	74.66
3<	113	25.34

The majority of respondents recognize the importance of proper storage, such as refrigerating raw fish and using protective gloves, although some areas, like cleaning fish-touch surfaces and using separate platters for different fish types, need further attention (Table 2). Overall, the data highlights a strong understanding of food safety practices, but there is room for improvement in specific hygiene and contamination control methods (Figure 2).

Table 2. *Food Safety Knowledge and Practices Among Fish Vendors Regarding Fish Storage and Handling.*

Statement	Yes	No
Raw fish should be stored in a cool place (refrigerated) to prevent spoilage	343 (76.91)	103 (23.09)
Washing hands earlier at work reduces the risk of external contamination	267 (59.87)	179 (40.13)
Using protective gloves while handling fish decreases the chance of fish contamination	299 (67.04)	147 (32.96)
Personal hygiene can prevent food contamination	290 (65.02)	156 (34.98)
Taste or distributing any food with unprotected hands is harmful to health	291 (65.25)	155 (34.75)
While coughing or sneezing, it is necessary to use protective measures to cover your mouth	231 (51.79)	215 (48.21)
Ice produced in contaminated water can cause disease	276 (61.88)	170 (38.12)
A clean working environment is essential for the prevention of contamination	393 (88.12)	53 (11.88)
Cleaning all fish touch surfaces with water and soap before using a sanitizer is important	212 (47.53)	234 (52.47)
Using different platters and instruments to process other types of fish is essential	255 (57.17)	191 (42.83)
Before using it, washing the knife used to cut wet fish with water or sanitizer is important	229 (51.35)	217 (48.65)
Washing fish contact surfaces with water and sanitizer every day is important	293 (65.7)	153 (34.3)
It is best to store wet fish in a refrigerator for 2–3 days Preserving the fish while it is as fresh as possible	250 (56.05)	196 (43.95)
Freezing destroys the bacteria that could cause food poisoning	295 (66.14)	151 (33.86)
Ice and refrigeration in general, make the possible extension of fish shelf life	302 (67.71)	144 (32.29)

Statement	Yes	No
Improper fish storage can threaten consumers' health	319 (71.52)	127 (28.48)
Contaminated fishes always have some variation in color, texture, odor, or taste	384 (86.1)	62 (13.9)

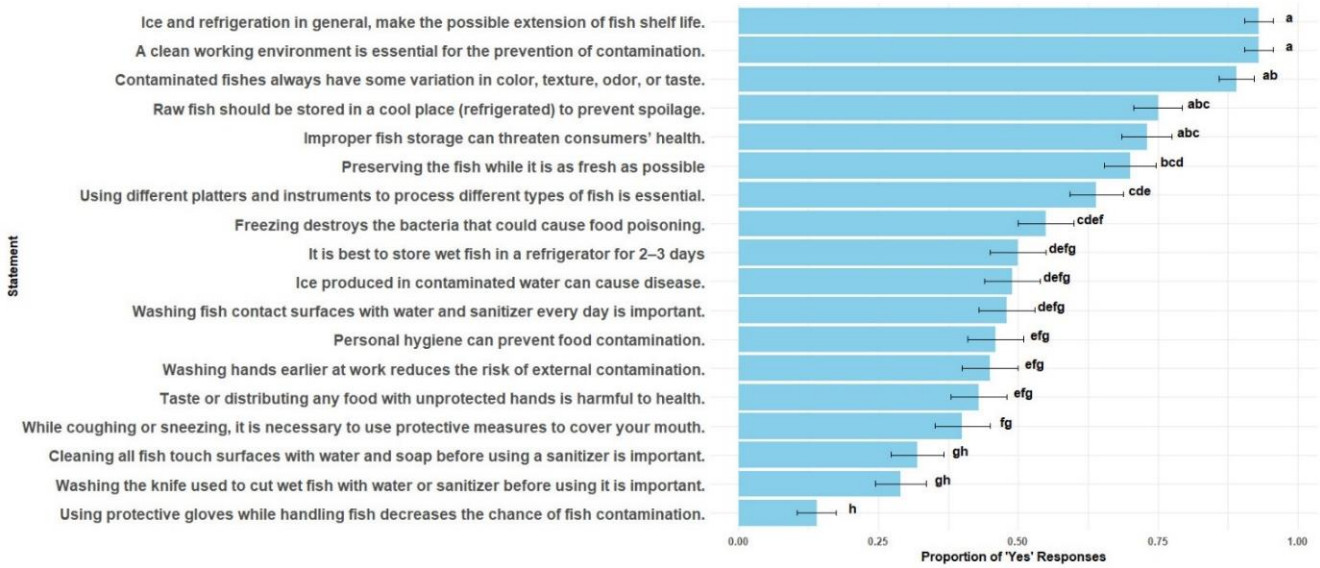

Figure 2. *Proportion of positive responses to food safety practices among fish vendors in local fish markets.*

Table 3 presents the odds ratios (OR) and their 95% confidence intervals (95% CI) along with P-values (χ^2) for various socio-demographic variables and their association with outcomes related to fish vendors. Key findings include that male vendors have significantly higher odds (OR = 33.31) compared to females with a *P*-value of <0.001. Northern residents have increased odds (OR = 1.65) of the outcome, while Southerners are not significantly different. Full-time workers show a significantly higher likelihood (OR = 4.51) compared to part-time workers. Market types also influence outcomes, with urban vendors having higher odds (OR = 2.75) than rural vendors. Additionally, solar electricity use is associated with a significantly lower likelihood (OR = 0.09) of the outcome, with a *P*-value of <0.001.

Table 3. *Logistic Regression Analysis of Factors Influencing Food Safety Knowledge, Attitudes, and Practices Among Fish Vendors in Bangladesh.*

Variables	OR	(95% CoI)	*P* value (χ^2)
Gender			
Male	33.31	(16.93, 65.53)	< 0.001
Female			
Age (Years)			
18-30			
31-40	1.11	(0.72, 1.72)	0.659*
41-60			
61<			
Residents (Region)			
Northern	1.65	(1.07, 2.56)	0.024*

Variables	OR	(95% CoI)	*P* value (χ^2)
Southerner			
Level of Education			
Illiterates			
Primary	0.82	(0.53, 1.29)	0.426*
Secondary			
Work Status			
Full time	4.51	(2.84, 7.14)	< 0.001
Part-time			
Years of Experience in Fish Vending			
0-2			
3-10	1.33	(0.85, 2.09)	0.249*
11-20			
21<			
Types of Market			
Urban	2.75	(1.76, 4.29)	<0.001
Rural			
Electricity			
Solar			
Government sources	0.09	(0.06, 0.15)	<0.001
None			
Toilet facility			
Sanitary			
Without sanitary	1.58	(0.98, 2.55)	0.064*
Open spaces			
Family size			
1-3	2.95	(1.89, 4.60)	<0.001
3<			

Note: * represents values that are significant at $p < 0.05$

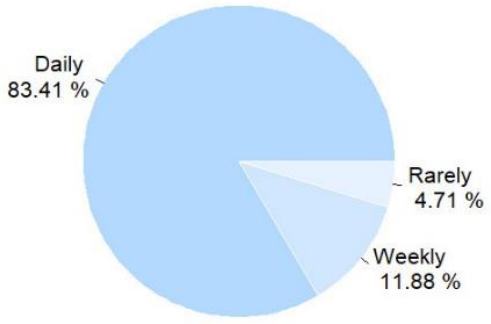

Figure 3. *Frequency of Washing Stall and Fish-Selling Equipment.*

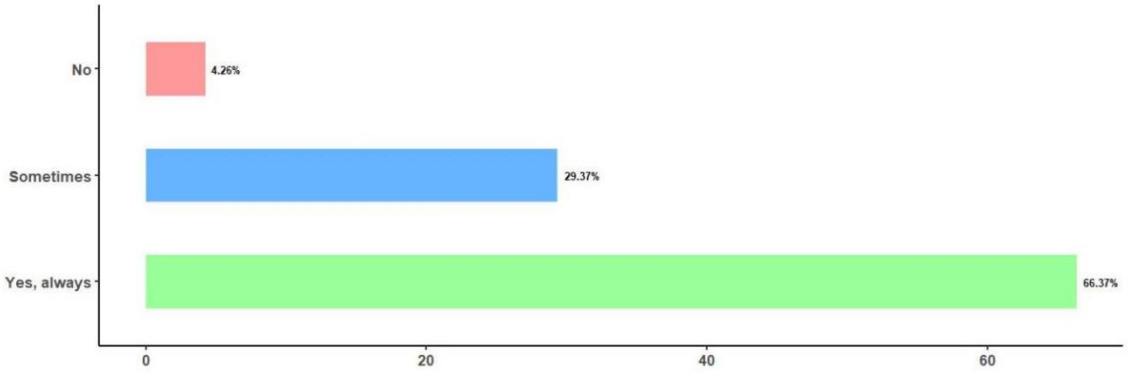

Figure 4. Assessment of fish freshness before market sale.

In Bangladesh's local fish markets, maintaining hygiene by regularly cleaning stalls and fish-selling equipment is crucial for preserving fish freshness before sale. Vendors typically rely on sensory evaluations to assess freshness; however, the effectiveness of these methods differs across various market regions. Interestingly, the age distribution among vendors reveals distinct patterns in hygiene awareness and food safety practices. Younger vendors often demonstrate a more proactive approach to hygiene, whereas older, more experienced vendors tend to advocate for training programs as a means to enhance food safety. In contrast, the younger demographic shows a preference for adopting technology-driven solutions, reflecting generational differences in addressing these challenges (Figures 3-6).

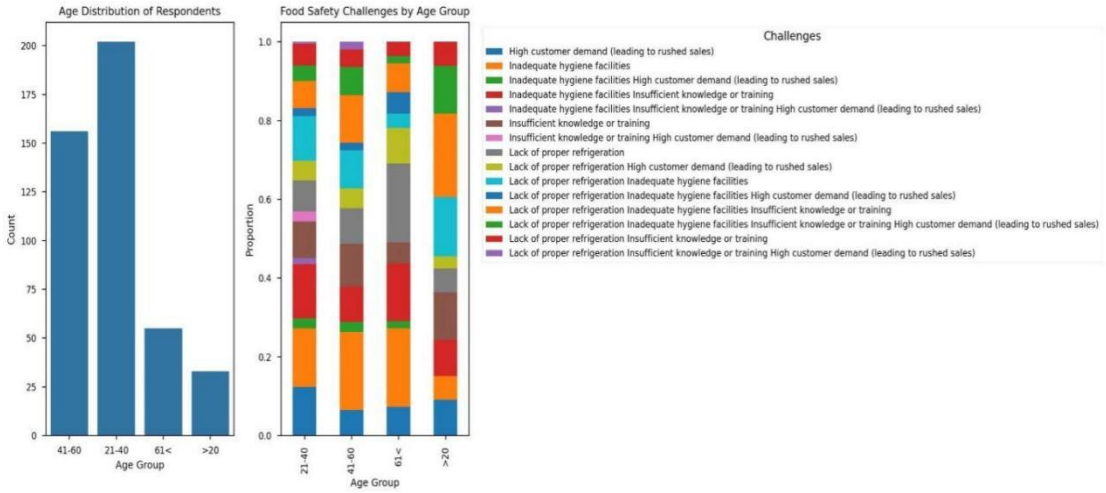

Figure 5. Age distribution of respondents and food safety challenges across age groups in local fish markets in Bangladesh.

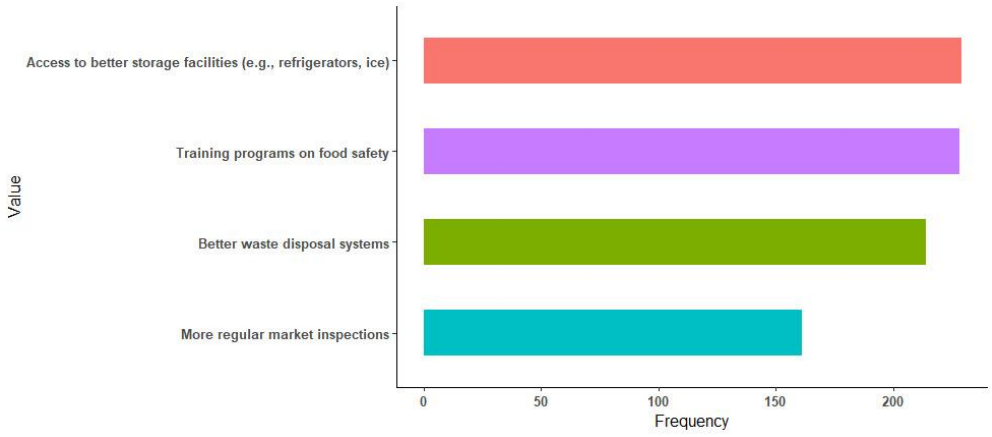

Figure 6. Frequency of preferred interventions for enhancing food safety among fish vendors.

4. Discussion

Vendors generally exhibit good knowledge and attitudes but poor practices regarding food hygiene. Significant correlations have been observed between knowledge and attitude levels [32]. While high adoption rates for certain hygienic practices were noted, significant deficiencies were found in waste disposal and maintenance practices. Educational levels have been shown to influence adherence to hygiene practices [33]. The majority of fish vendors (56%) had a positive attitude toward education in hygiene practices, with an average level of knowledge, attitude, and hygiene practices regarding food safety [4]. Over 62.5% of vendors were well-versed in food safety, particularly in areas such as cross-contamination and personal hygiene [34].

Although fishing remains a predominantly male occupation, women make up the majority of fish sellers in the Medina Coura market (84.6%). Fish spoilage was known to all fishermen, and their expertise in food safety was reflected in their methods [12]. Additionally, 64.1% of respondents were aware of marine fish-associated diseases, but only 64.7% of fishermen washed their hands overboard without soap, and 41.6% of fishermen and 16% of vendors sold spoiled fish [35]. Hygiene practices were found to have gaps, with 66.2% pre-rinsing hands, only 1.4% properly washing with soap, and no use of sanitizer after handwashing. In terms of food contact surfaces, 48.7% were maintained in good condition, and proper sanitizing steps were applied in 68.9% of cases [36].

In Tripura, fish retailers showed a high adoption of hygienic practices, with personal cleanliness (90.04%) and hygienic sorting of fish (85.28%) being most common, although lower adoption was noted for using ice to prevent spoilage (77.48%) (Table 2). Infrastructure availability was moderate (76.87%), with good access to electricity (84.9%) but inadequate icing facilities (70.28%) and waste disposal systems (71.66%). Education significantly influenced hygienic practices, explaining 56% of the variation in adoption behaviors [37]. In Port Blair, fish marketing personnel demonstrated high adoption of personal hygiene (77.77%) and clean container use (74.99%), but showed poor adoption of waste disposal (36.11%) and washing fish with clean water (41.66%). Constraints such as the high cost of ice (76.66%) and insufficient space in markets (73.33%) were major challenges [38]. Fish quality is significantly influenced by storage conditions, such as chilling at 0-4°C, freezing at -18°C to -40°C, temperature, species, ice use, and stress during capture [39, 40]. The implementation of handling techniques like plug aerator systems, ice cooling, and sanitation is critical [41, 58]. The 3C+Q (Clean, Careful, Cool Chain, Quick) method minimizes stress and injuries caused to fish [42], with cleanliness and proper chill temperature being essential [43, 44]. Fish quality can be inspected at auctions [45], and refrigerated trucks or ice containers are ideal for transport [46]. Sorting and discarding damaged fish is another recommended practice [47]. Adding crushed ice at a ratio of 1 kg per 4 kg of fish helps improve quality [48]. However, prolonged transport results in diminishing fish quality [49, 58], and vigorous movements during catching and landing can impair fish flesh quality [50].

Research in Poland found poor prevalence of hygienic practices at fish sales points (44%), personal hygiene (18%), and conditions of the seafood departments (23%) [51, 59, 60]. In Kenya, deep-fried fish vending was associated with numerous microbial contaminants, including a higher coliform count of 2.46 ± 0.43 at the Clay City ward [52]. In Port Blair, India, infrastructural adequacy for fish markets was inconsistent, with proper sheds accounting for 90.55%, clean water at 55.11%, and hygienic toilets at 33.88% [38]. Fishermen in Kerala demonstrated an overall 54.96% adoption index for hygiene practices [53].

In the United States, foodborne illnesses affect an estimated 76 million people annually, resulting in 325,000 hospitalizations and around 5,000 deaths (USDA, 2008; CDC, 2005). The most important pathogens include *Salmonella*, *Campylobacter*, *Shigella*, *Cryptosporidia*, STEC O157, and *Noroviruses*, costing the U.S. economy over $10–83 billion [54, 55]. Key practices to prevent foodborne illnesses include keeping foods at safe temperatures, using thermometers, preventing cross-contamination during food preparation, handwashing, and avoiding high-risk foods [56-57]. Fish vendors show good knowledge but poor hygiene practices, influenced by education and infrastructure. Proper handling, like using ice and maintaining chill temperatures, ensures fish quality and safety.

5. Conclusions

The critical importance of food safety knowledge, attitudes, and practices among fish vendors in local markets across Bangladesh. Findings reveal significant gaps in hygiene standards, with socio-demographic factors such as education, age, and experience playing a pivotal role in shaping vendors' food safety behaviors. Poor food handling practices, lack of proper storage facilities, and limited awareness of contamination risks emerged as key barriers to ensuring safe fish supply to consumers. Binary logistic regression and multivariate analyses identified education and training as significant predictors of improved food safety compliance. These findings underscore the urgent need for targeted interventions to enhance vendors' food safety practices, including training programs and policy reforms. Strengthening food safety regulations and promoting public awareness campaigns can significantly reduce foodborne illnesses, ensuring healthier consumer outcomes. This study provides essential insights for policymakers, public health officials, and stakeholders working toward improving food

safety standards in Bangladesh.

Abbreviations

FGDs	Focus Group Discussion
GDP	Gross Domestic Product
OR	Odds Ratio

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Author Contributions

Md. Abdullah Al Mamun Hridoy: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

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Monirojjaman Momin: Data curation, Validation

Andleeb Masood: Review and editing

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Md. Salmanur Rahman: Data curation, Validation

Mominul Haque: Data curation, Validation

Jannat Ara: Review and editing

Anik Sarker: Review and editing

Kamrul Hasan: Review and editing

Md. Zahid Hasan Fahad: Data curation, Validation

Md. Tasin Nur Rahim: Data curation, Validation

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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